

INNOVATION MANAGEMENT: A SYSTEMATIC LITERATURE ANALYSIS OF THE INNOVATION MANAGEMENT EVOLUTION

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Abstract

Innovation management has been received increasing attention in the operations management field during the last years. Academics and managers have long been discussing the innovation nature and its importance for the organization's growth and competitive advantage. However, one issue that remains unclear is how to recognize what type of innovation management is necessary for each company or situation. One of the reasons for this issue is the different dimensions to which innovation can be addressed – technological, organizational, process and product, among others. Moreover, the differences between incremental and disruptive innovation lead to different ways of management. This paper examines the literature on innovation management in the last 38 years (1975 – 2013) aiming at identify and classify innovation management models. The methodological approach encompasses bibliometric and content analysis. The results show seven models' categories: project management, organizational strategy, knowledge management, product management, types of innovation, technological innovation, and open innovation.

Keywords: Innovation, Innovation Management, Innovation Management Model

1. INTRODUCTION

Advances in information technology are rapidly changing the market environment, and companies cannot rely only in their internal resources and knowledge anymore. They have to look outside and try to identify new skills and knowledge to complement their own. In this context, the ability to innovate, combining internal and external knowledge is becoming one of the most critical components that lead to a sustainable competitive advantage (Stanko *et* Calantone, 2011). For many organizations, innovation is not just an alternative to present new products or increase their production capacity by changing their internal processes, but a way to influence and change the industry they belong.

There is neither a unique formula for innovation nor an innovation model that fits to all companies. Innovation carries multiple facets and definitions and this characteristic turn its understanding difficult, mainly to recognize which innovation model should be adopted for each situation

or company (Boer *et* Duing, 2001). Also, there are many business aspects that influence the way innovation is conducted in the companies.

Innovation can be classified into four types (OECD, 2005), as follows: product innovation (introduction of a new product or significantly improved); process innovation (introduction of a method of producing new or significantly improved); organizational innovation (introduction an organizational method that has not been previously used by the company and is the result of strategic decisions); marketing innovation (introduction of a new marketing method).

Another typology classifies innovation into four types (Henderson *et* Clark, 1990), being: incremental innovation (products with improvements that make use of existing technologies); modular innovation (similar to radical about the concepts required); architectural innovation (similar to incremental about the concepts required); radical innovation (introduction of a new technology). A third typology classifies innovation according to the technological

uncertainty in low, medium, high and very high (Shenhar *et al.*, 1995).

A final typology classifies innovation in open and closed (Chesbrough, 2003). The term open innovation is opposed to the concept of closed innovation, where the innovation process, from conception of the idea to the marketing happens internally in the organization. One of the pillars of closed innovation is the profit generated by the price premium achieved by pioneering innovation in the market. In open innovation, it involves not only the internal environment of the organization, but also the external environment, consisting, for example, customers, suppliers, competitors, universities.

In this context, this paper aims to analyze the innovation management evolution. This article contains the following sections: section 2 examines some definitions and the scope of the literature associated with innovation management;

section 3 explains the methodology and the bibliometric techniques applied, and also content analysis; section 4 presents the result of the study; section 5 presents some conclusions as well as some possible directions for future studies in the subject.

2. INNOVATION MANAGEMENT

Within the literature, innovation management is referred in many ways, routed in different theories that include: technological innovation (Dosi, 1982; Shea, 2005; Nambisan *et Nambisan*, 2008), process innovation (Tidd *et al.*, 1997), open innovation (Sawhney *et Prandelli*, 2000; Chesbrough *et al.*, 2006), and new product development (Cooper, 1990; Wheelwright *et Clark*, 1992). As a first step, Table 1 highlights a sample of definitions associated with the concept of innovation and the possible antecedents.

Table 1 - Sample of definitions of innovation management.

Definition
Innovation in industrial products can be carried out by means of a carefully planned innovation process that can be divided in different steps: objective formulation, potential product search, license search or product development, negotiation and finally market introduction.
Product innovation is a continuous and cross-functional process involving and integrating different competencies inside and outside the organizational boundaries. It is the process of transforming business opportunities into tangible products and services.
Innovation management in turbulent environments requires from the companies the ability to turn the development process flexibility into a life-cycle flexibility, which is characterized by the ability to introduce innovations during the life cycle.
Industrial technological innovation can be seen as a process including technical, design, manufacturing, management and commercial activities involved in the marketing of a new or improved product or the first use of a new or improved manufacturing process or equipment.
Innovation is related to changes in what a firm offers the world (product/service innovation), the ways it creates and delivers those offerings (process innovation), how a new product or service is introduced in an established market (market position innovation) and how new challenges and opportunities are seen (business model innovation).
Innovation is driven by the ability companies have to establish connections, to spot opportunities and to take advantage of them, both opening up new markets and also offer new ways of serving established and mature markets. Innovation can go from incremental to radical and have four dimensions that is called 'innovation space': paradigm (mental model), product (service), position and process.

The lack of a common definition of innovation is partly explained because of its multidisciplinary origin that influences the theory on innovation management. Innovation can be treated as a new product development process since the idea generation (conception of the product) until the market introduction. Similarly, authors incorporate the project management processes for new product development in the innovation management

context (Cohen *et Levinthal*, 1990; Wheelwright *et Clark*, 2003).

Acquisition and knowledge management also influenced the innovation management field, mainly when the cultural aspects are considered when talking about innovation and the process of creating and sustaining innovation (Nonaka, 1994; Nonaka *et Takeuchi*, 1995; Chiesa *et al.*, 1996).

3. RESEARCH METHOD

The research method used is a bibliometric study with content analysis. The bibliometric study involves a series of techniques that provide quantitative and qualitative analysis of the literature (Ikpaahindi, 1985). One of the ways to run a bibliometric study is the publications analysis that allows the identification of the relevant set of journal, the evolution of the publications along the years and the related subject areas (Prasad *et al.*, 2005). Some bibliometric works also analyze the citations, from where the main works, most cited authors and also the potential research trends can be identified (Neely, 2005).

In this work, besides the usual technique of searching the publications through the use of keywords, the snow ball (or bibliographic coupling technique) was also applied. It allowed the retrieve of books and works from other sources, as well as the works that are relevant for the subject but do not use the keywords used in the first search engine, as mentioned in the works of Fink (1995a, 1995b). The analysis of articles and bibliographic references, based on citation networks, enables one to determine the existence or absence of bibliometric clustering, which can reveal a cluster of a given research stream (Kessler, 1963).

3.1 Sample

Data was collected from the ISI Web of Science database. This database was chosen because of its comprehensiveness and for the embedded resources that provide different publication analysis regarding to authors, citations, sources, year of publication, countries, and references among others. The journal performance metrics or the Journal Citation Reports (JCR) that evaluate the performance of the indexed journals comparing each one with others in the same subject area was also considered.

Using the keyword 'innovation management' in the topic, the search resulted in 1.208 works split in 653 proceedings papers, 492 articles, 35 book review, 32 editorial materials, 26 reviews, 5 meetings abstracts and 1 note. For this study, only the 492 articles were analyzed. These articles come from 57 different countries, 182 journals in 37 research areas. The Figure 1 presents the articles' search and analysis plan.

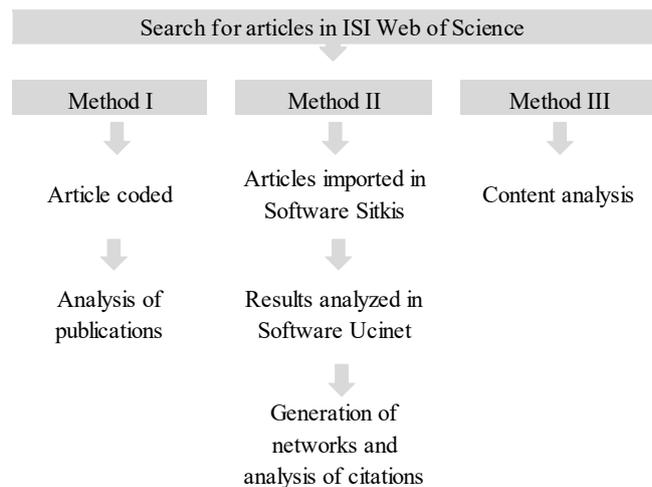


Figure 1 - Scheme of analysis of the articles.

To analyze this set of articles, three methods were applied:

- Method I: analysis of the publications - publications between 1975 and 2013 were analyzed in order to identify the journals with the highest number of publications, publications over time, and related subject areas. Since the timeframe is long, to facilitate the analysis, it was divided in three quartiles of ten years and one quartile of nine years, as follows: Q1 (1975-1984), Q2 (1985-1994), Q3 (1995-2004), Q4 (2005-2013).

- Method II: analysis of the citations - considering that the number of the citations of one article is directly related to the importance of the work to the research area, an analysis of the most cited articles were made (Culnan, 1987; Culnan *et al.*, 1990; Ramos-Rodriguez *et al.*, 2004; Neely, 2005). To the citation network, the bibliometric software Sitkis 2.0 (Schildt, 2002) was used to extract the data from the ISI database and the social network analysis program, Ucinet for Windows – Version 6.289 (Borgatti *et al.*, 2002) was used to build the network.

- Method III: content analysis - Each paper included in the sample was registered individually using Mendeley software and a Microsoft Access file that contained the metadata generated by Sitkis software. For the content analysis, papers were classified according with the innovation management models.

4. FINDINGS

This section presents the results of this research.

4.1 Method I: analysis of the publications

The 492 papers were published in 182 journals, which underpin the multidisciplinary nature of the theme. Table 2 lists all the publications per journal and per quartile, considering only the 21 journals that published at least 4 articles.

Table 2 - Publications by journal and quartile.

Journal	Period				Total
	Q1 (1975- 1984)	Q1 (1985- 1994)	Q1 (1995- 2004)	Q1 (2005- 2013)	
DYNA				3	11
International Journal of Technology Management			22	30	52
Journal of Product Innovation Management		1	10	27	38
Technovation		2	13	22	37
R & D Management		3	5	14	22
Research Policy	1		6	7	14
Research-Technology Management			2	11	13
Technological Forecasting and Social Change			4	8	12
IEEE Transactions on Engineering Management			5	4	9
Journal of Technology Transfer				9	9
Technology Analysis & Strategic Management			3	6	9
Journal of Engineering and Technology Management			4	4	8
California Management Review			1	6	7
International Journal of Production Economics			6	1	7
Creativity and Innovation Management				6	6
Innovation Management Policy & Practice				5	5
Organization Science				5	5
Total Quality Management & Business Excellence				5	5
Health Care Management Review			1	3	4
Industrial management Data Systems				4	4
International Journal of Operations & Production Management			3	1	4
Service Industrial Journal				4	4

Note. Periodical publications in descending order of total.

Only seven journals are responsible for the 69% of the published articles: “International Journal of Technology Management”; “Journal of Product Innovation Management”; “Technovation”; “R&D Management”; “Research Policy”; “Research-Technology Management” and “Technological Forecasting and Social Change”. They are academic and management journals that encompass all facets of technological innovation, research and development, new products development, innovation management and technology management.

Although the first publication occurred in 1975, it is only from 1995 that the publications regarding to innovation started to grow – part because of the overall growth on publications and part because of the researchers’ interest in the subject of innovation.

Subject areas such as business economics, engineering, operations research management science, public administration, and computer science are the most cited ones. Figure 2 lists the publications by country, considering only the 16 countries that published at least 10 articles.

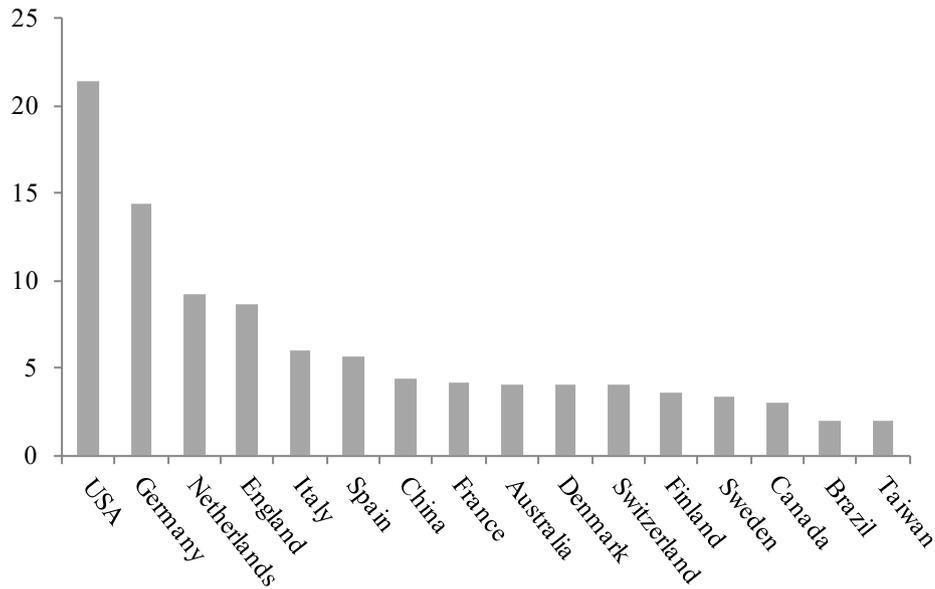


Figure 2 – % Publications by country.

The country that most published was USA, followed by Germany, Netherlands and England. Brazil published 10 articles between 2001 and 2013 in the following journals: “Health Research Policy and Systems”; “Plos One”; “R&D Management”; “Revista Brasileira de Gestão de Negócios”; “Revista de Saúde Pública”; “Technological Forecasting and Social Change”; “Technology Analysis & Strategic Management”; and “Texto & Contexto Enfermagem”.

4.2 Analysis of citations - Method II

Table 3 lists the 28 works that received more than 40 citations. The result shows that although there is no authors’ concentration, it is possible to identify some influential works that received more than two hundred citations (Chen *et al.*,1998; Hobday, 1998). Their works constitute a significant foundation for the innovation subject. The content analysis of the most cited articles led to the identification of models of innovation management in 14 of them.

Table 3 - Most cited articles.

Article	Journal	Citations
Chen <i>et al.</i> ,(1998)	Journal of Business Venturing	248
Hobday (1998)	Research Policy	200
Teece (2010)	Long Range Planning	148
Chiesa <i>et al.</i> ,(1996)	The Journal of Product Innovation Management	143
Sawhney <i>et Prandelli</i> (2000)	California Management Review	143
Tatikonda <i>et Rosenthal</i> (2000)	Journal of Operations Management	111
Shane (2002)	Management Science	109
Tidd (2001)	International Journal of Management Reviews	77
Verganti (2008)	Journal of Product Innovation Management	62
Smits (2002)	Technological Forecasting and Social Change	52
Cormican <i>et O’Sullivan</i> (2004)	Technovation	51
Oke (2007)	International Journal of Operations & Production Management	50
Francis <i>et Bessant</i> (2005)	Technovation	48
Linton <i>et Thongpapanl</i> (2004)	Journal of Product Innovation Management	47
Luthje <i>et Herstatt</i> (2004)	R&D Management	47

Sicotte <i>et Langley</i> (2000)	Journal of Engineering and Technology Management	47
Coates <i>et al.,</i> (2001)	Technological Forecasting and Social Change	46
Mikkola (2001)	Technovation	46
Huizingh (2011)	Technovation	45
Meyer-Krahmer <i>et Reger</i> (1999)	Research Policy	45
Nightingale (2000)	Research Policy	45
Russell <i>et Russell</i> (1992)	Journal of Management	44
Toivonen <i>et Tuominen</i> (2009)	Service Industries Journal	44
Kohler <i>et al.,</i> (2009)	Technovation	43
Adamides <i>et Karacapilidis</i> (2006)	Technovation	42
Cheng <i>et al.,</i> (1999)	IEEE Transactions on Engineering Management	42
Gales <i>et Mansour-Cole</i> (1995)	Journal of Engineering and Technology Management	41
Costa <i>et Jongen</i> (2006)	Trends in Food Science & Technology	41

The articles to reference network (Figure 3) generated a list of 93 publications (12 books and 81 articles. All the 93 works from the network were analyzed in order to identify the antecedents of the innovation management models. Note. The circles represent the references and the squares represent the articles. The models were identified in articles in bold, according to Table 4.

It was observed that academics and managers interested in innovation management are directly influenced by practices from organizational strategy, project management, knowledge management, innovation typology and technological innovation, as shown in Figure 4.

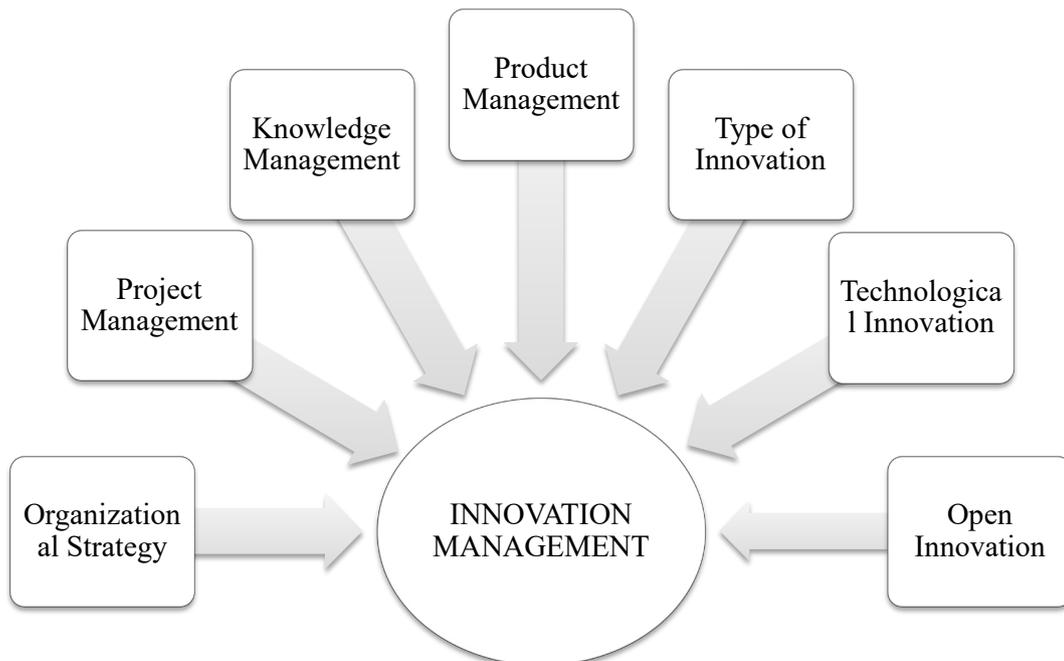


Figure 4 – Model classification of innovation management.

To facilitate the understanding about the different models that influences the innovation management practice, it was established a codification according to the main objective and the model purpose. Analyzing the documents, in 37 of the publications among books and articles, there is

some mention about models. Each of them was classified under one model classification. Table 4 lists the models codifications and the number of the articles that mention them.

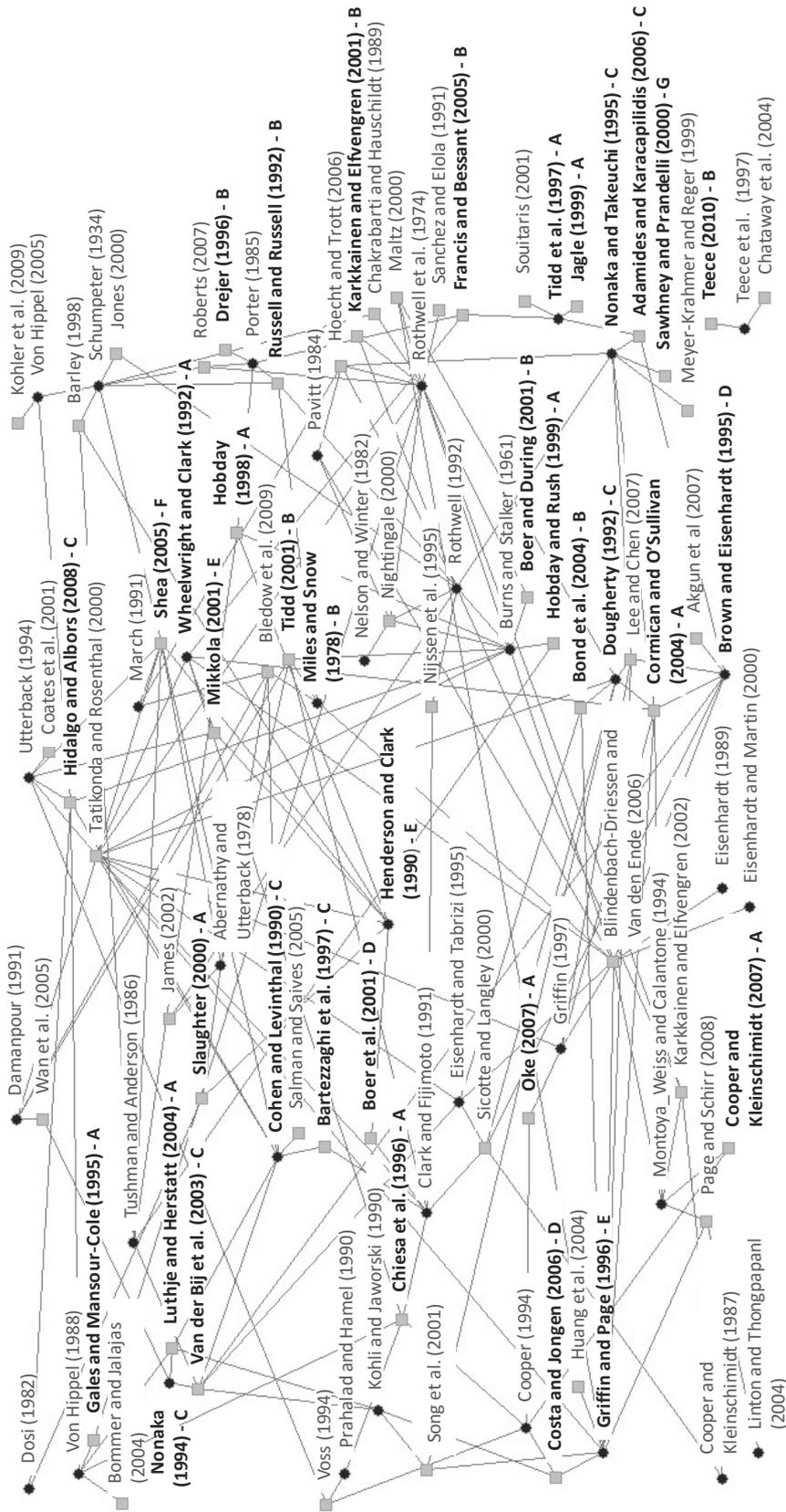


Figure 3 – Citation network of articles to references (minimum of ten citations).

Table 4 - Classification codes of the models.

Codes	Classification of models	Articles	Number of articles
A	Project Management	Wheelwright <i>et</i> Clark (1992); Gales <i>et</i> Mansour-Cole (1995); Chiesa <i>et al.</i> , (1996); Tidd <i>et al.</i> , (1997); Hobday (1998); Hobday <i>et</i> Rush (1999); Jagle (1999); Slaughter (2000); Cormican <i>et</i> O'Sullivan (2004); Luthje <i>et</i> Herstatt (2004); Cooper <i>et</i> Kleinschmidt (2007); Oke (2007)	12
B	Organizational Strategy	Miles <i>et</i> Snow (1978); Russell <i>et</i> Russell (1992); Drejer (1996); Boer <i>et</i> Durning (2001); Karkkainen <i>et</i> Elfvengren (2001); Tidd (2001); Bond <i>et al.</i> , (2004); Francis <i>et</i> Bessant (2005); Teece (2010)	9
C	Knowledge Management	Cohen <i>et</i> Levinthal (1990); Dougherty (1992); Nonaka (1994); Nonaka <i>et</i> Takeuchi (1995); Bartezzaghi <i>et al.</i> , (1997); Van der Bij <i>et al.</i> , (2003); Adamides <i>et</i> Karacapilidis (2006); Hidalgo and Albors (2008)	8
D	Product Management	Brown <i>et</i> Eisenhardt (1995); Boer <i>et al.</i> , (2001); Costa <i>et</i> Jongen (2006)	3
E	Types of Innovation	Henderson <i>et</i> Clark (1990); Griffin <i>et</i> Page (1996); Mikkola (2001)	3
F	Technological Innovation	Shea (2005)	1
G	Open innovation	Sawhney <i>et</i> Prandelli (2000)	1

Following, the models will be presented and discussed according to their codes and the chronological order in which they emerged.

Project Management Models – Code A

Wheelwright *et* Clark (1992): the authors presented the “funnel model” as an innovation model, where ideas are being filtered through the funnel and become products that can be sold on the market. The phases of the funnel are: input of ideas, development goals, project planning, project management, execution, learning, improved post-project.

Gales and Mansour-Cole (1995): they presented “the user involvement model” that focuses on customer involvement in innovation projects regarding: design features, stage design, interdependence, external environment, frequency of interactions and project performance.

Chiesa *et al.*, (1996): their innovation management model is called “process-based model”. The model identifies four main processes: concept generation, product development, innovation and technology acquisition.

Tidd *et al.*, (1997): proposed the “capacity distribution of the innovation model”, that follows the same logic of the funnel model. This model argues that, despite variations that may exist between the companies, there are common processes for innovation: demand (analysis of internal and external scenarios), selection (decision taking into account the strategic vision), and implementation (phase which is divided in knowledge acquisition, project execution, launching innovation, long-term sustainability and learning).

Hobday (1998): the emerging of a “complex product system research project model” led the author to investigate the relationship between product complexity and coordination of innovation.

Hobday *et* Rush (1999): continuing the work started in 1998, Hobday and Rush presented the “CoPs web of innovation model”, an integrative model of innovation encompassing: customer, government, suppliers and others.

Jagle (1999): following the same logic of the Stage Gate and Funnel models the author proposed the “stage gate approach model”, a model that combines the logic of the stage gate model with the logic of the funnel, which enables to transform uncertainty into measurable risk.

Slaughter (2000): also following the same logic of the Stage Gate model, the “implementation stages for innovations model” was presented, focusing innovations in construction, consisting of six stages: identification, evaluation, commitment, detailed preparation, effective use and evaluation of post-use.

Cormican *et O’Sullivan* (2004): proposed a “basic model of product innovation management”, a variant of the stage gates model, which includes five relevant activities in the management of product innovation: environmental analysis and identification of opportunities, generation of innovation, project planning, project prioritization, implementation of an innovation plan.

Luthje *et Herstatt* (2004): with a slightly different focus, the authors developed the “process of the lead user method”, which focus of research was the lead user method in systems of innovation management. The method consists of four stages: initiation of the lead user, identification of needs and trends, identification of lead users, design concept.

In 2007 two models have been proposed, and that one following the logical the stage gate model and the other the logical model of the funnel model:

Cooper *et Kleinschmidt* (2007): developed the “business’s new product performance model”, where the authors identified four critical success factors in projects of new product development: quality of product development processes, the existence of new product strategy, the adequate utilization of human resources and financial resources, adequate investment in R&D.

Oke (2007): proposed the “innovation types and management practices model” that investigates the influence of type of innovation in the performance of organizations considering three phases: idea generation, selection and implementation, which are influenced by human resource management and innovation strategy.

Organizational Strategy Models – Code B

Miles *et Snow* (1978): the authors presented the “adaptive cycle model” that shows that the innovation strategy depends on the solution of three problems: business (product and market definition), engineering (choice of technology) and administrative (choice of structure and process innovation).

Russell *et Russell* (1992): fourteen years later, they proposed the “initial model of corporate entrepreneurial strategy” which analyzes the relationship between business strategies and the uncertainties of the external environment in innovation strategy.

Drejer (1996): the “reasons for failure of traditional approaches to MOT model” emerged, a model that relates

technology management with the strategic management of the organization.

Boer *et Daring* (2001): proposed the “process-based contingency model of innovation” where the authors found that for each type of innovation (product, process and organizational), there is a more appropriate form of management. They proposed a model composed of three parts: problem solving, internal diffusion and organizational adaptation.

Karkkainen *et Elfvingren* (2001): proposed the “links between customer’s need assessment, product development processes and strategic planning processes model”. This model presents ten tools related to customer’s needs during product development: the need to evaluate the draft; creative group interview; tools for the interviews; trace of the matrix chains for business; interpretation table’s voice client, analysis of competitive position; QFD; table concept selection, source evaluation, assessment of future competitiveness.

Tidd (2001): also in 2001, the “effect of uncertainty and complexity on the management of innovation model” was presented. The author argues that the contingencies of the environment (uncertainty and complexity) influence the organization and innovation management.

Bond *et al.*, (2004): developed the “antecedents of reputational effectiveness model”, a model of effective inter-personal relations. The authors concluded that access to information; resources and proximity to the people who favor the success of innovation management.

Francis *et Bessant* (2005): they proposed the “diamond diagram model” that analyzes the relationship of innovation with: product performance, process performance, positioning the company’s products, the company’s dominant paradigm and presented a model that provides indications of how and where to build an innovation agenda.

Teece (2010): presented the “elements of business model design”, a cyclic model that encapsulates both the financial and organizational architecture. The phases are: selection of the technology product / service, determination of benefits for consumers, identification of the market, disposable income, and value capture.

Knowledge Management Models – Code C

Cohen *et Levinthal* (1990): proposed the “model of absorptive capacity and R&D incentives”, a model that recognizes the influence of investment in R&D in obtaining knowledge. The “absorptive capacity” is what leads to differentiation in the development of new projects in R&D.

Dougherty (1992): developed the “cycles of market knowledge creation model”, a model that suggests three

cycles of knowledge generation: definition, selection and retention.

Nonaka (1994) et Nonaka and Takeuchi (1995): the “knowledge creation model” emerged. In the next year Nonaka and Takeuchi proposed a similar “knowledge creation model”, that concluded that success in knowledge creation increases the degree of innovation.

Bartezzaghi *et al.*, (1997): proposed the “multi-level learning model”, which considers that the ability of companies to innovate their products effectively encourages the acquisition of competitive advantage.

Van der Bij *et al.*, (2003): developed the “potential antecedents of the level of knowledge dissemination model”, that argue that the dissemination of knowledge is crucial for strategic planning of new products.

Adamides et Karacapilidis (2006): linking knowledge with innovation, the authors proposed the “basic structure of knowledge breeder model” where consider innovation as an ongoing process of problem solving. They presented a model which relates knowledge generation with innovation and product development. The authors concluded that innovation is considered a process that depends on people for the generation of knowledge and requires analysis stages, which is similar with the stage gate model. Hidalgo et Albers (2008)

Hidalgo *et Albers* (2008): proposed the “management of technological innovation model” that analyzes various techniques for managing innovation relating them to knowledge management and performance.

Product Management Models – Code D

Brown *et Eisenhardt* (1995): presented the “communication web model of product development”. This model shows the factors that affect the success of a product development process (team leadership, customers and suppliers). These factors were grouped into three research areas: product development, networking and problem solving.

Boer *et al.*, (2001): developed the “knowledge and continuous innovation model”, a model to support companies in gaining competitive advantage by concentrating efforts in the various phases of the lifecycle of the product, facilitating the generation of knowledge and innovation.

Costa *et Jongen* (2006): presented the “product design stage model” that investigates the influence of the consumer in the development of new products.

Types of Innovation Models – Code E

Henderson *et Clark* (1990): presented the “defining innovation model”, a model that divides into four quadrants categories of innovations: incremental, modular, architectural and radical.

Griffin *et Page* (1996): they proposed the “project strategy typology model that analyzes the factors that influence success in the project of new product development.

Mikkola (2001): developed the “R&D project portfolio model”, where the author proposed a matrix of project portfolio management as a tool that assists the innovation management.

Technological Innovation – Code F

Shea (2005): the author presented the only one model in this classification - the “contingency model of the effect of nanotechnology-based innovation on firms” – that is based the contingency model for innovation.

Open Innovation Model – Code G

Sawhney *et Prandelli* (2000): these authors presented the “communities of creation model”, that recognizes the importance of social interactions to create a community of innovation. Transfer the location of the creation of innovation to the external environment, but draws attention to the need to create mechanisms that provide a balance between chaos (open environment) and stable (closed). The concept of open innovation is based on the funnel model. However, this model does not explain how the selection, development and dissemination of the innovation occur.

In the open innovation model category it is worth to highlight that although Chesbrough is the most known author explaining the model, in this work it did not appear. The keyword “innovation management” used and the focus of the study probably contributed for this point.

5. CONCLUSIONS

Ensure sustainable competitive advantage in a highly changing environment with reduced time lead, reduction in the new products development costs and the increasing pressure for innovation are a challenging task for organizations. Innovation is not just about new products or services but it encompasses other aspects like new organizational methods, management models and new production (Oslo Manual, 2005).

Considering that innovation is a multidisciplinary topic, this research analyzed the publications in the last

38 years, identifying that areas such as organizational strategy, knowledge management, project management, technological innovation and product management might be considered innovation management antecedents.

There is a lack of concentration of works and also in particular authors, so, in order to identify the group of articles and authors that are relevant to the innovation field it was necessary analyze the most cited references of the primary set of articles.

The research methodology used by the authors from the analyzed sampling reveals a slight predominance of literature review, what can indicate that innovation does not have a consolidated or unique model. Since innovation is highly dependent of the environment, company objectives, strategy and culture, many studies are made in order to try to understand and find some ways that can help identify the innovation management models that better suit for each context.

Project management, organizational strategy, and knowledge management are a subject area that according to the literature review influences the innovation management models. It might indicate that innovation is still strongly related to the process of development of a new product. Companies try to understand, implement and measure innovation with product development logic and metrics. However, in many situations innovation cannot be measured, implemented or understood as a project or product development. Innovation encompasses situations of uncertainty and complexity that is not related to a product or project development. The link with subject areas like organizational and knowledge management might reflect this complexity. In newer works, strategies like open innovation, which opens the R&D department for external participants, are mentioned, indicating the emergence of new ways of dealing with innovation that will have a strong influence in internal processes.

The subject of innovation management and its impact on operation management are still in an evolutionary stage. A better understanding regarding the subject and its effect in the internal processes and organizational strategy is needed, mainly if it is considered the emergence of new models like open innovation and the increased advances in technology.

REFERENCES

- Abernathy, W.J., Utterback, J.M. (1978). Patterns of industrial innovation. *Technology Review* 80, 41-47.
- Adamides, E.D., Karacapilidis, N. (2006). Information technology support for the knowledge and social processes of innovation management. *Technovation* 26 (1), 50-59.
- Akgun, A.E., Keskin, H., Byrne, J.C., Aren, S. (2007). Emotional and learning capability and their impact on product innovativeness and firm performance. *Technovation* 27 (9), 501-513.
- Barley, S.R. (1998). What can we learn from the history of technology? *Journal of Engineering and History of Technology* 15 (4), 237-255.
- Bartezzaghi, E., Corso, M., Verganti, R. (1997). Continuous improvement and inter-project learning in new product development. *International Journal of Technology Management* 14 (1), 116-138.
- Bledow, R., Frese, M., Anderson, N., Erez, M., Farr, J. (2009). A Dialectic Perspective on Innovation: Conflicting Demands, Multiple Pathways, and Ambidexterity. *Industrial and Organizational Psychology Perspectives on Science and Practice* 2 (3), 305-337.
- Blindenbach-Driessen, F., Van den Ende, J. (2006). Innovation in project-based firms: The context dependency of success factors. *Research Policy* 35 (4), 545-561.
- Boer, H., Duing, W.E. (2001). Innovation, what innovation? A comparison between product, process and organizational innovation. *International Journal of Technology Management* 22 (1/2/3), 83-107.
- Boer, H., Caffyn, S., Corso, M., Coughlan, P., Gieskes, J., Magnusson, M., Pavesi, S., Ronchi, S. (2001). Knowledge and continuous innovation - The CIMA methodology. *International Journal of Operations & Production Management* 21 (4), 490-503.
- Bond, E.U., Walker, B.A., Hutt, M.D., Reingen, P.H. (2004). Reputational effectiveness in cross-functional working relationships. *Journal of Product Innovation Management* 21 (1), 44-60.
- Boomer, M., Jalajas, D.S. (2004). Innovation sources of large and small technology-based firms. *IEEE Transactions on Engineering Management* 51 (1), 13-18.
- Borgatti, S., Everett, M., Freeman, L. (2002). *Ucinet for Windows: Software for social network analysis*.
- Brown, S.L., Eisenhardt, K.M. (1995). Product Development: Past Research, Present Findings, and Future Directions. *The Academy of Management Review* 20 (2), 343-378.
- Buganza, T., Verganti, R. (2006). Life-cycle flexibility: How to measure and improve the innovative capability in turbulent environments. *Journal of Product Innovation Management* 23 (5), 393-407.
- Burns, T., Stalker, G.M., (1961). *The management of innovation*. Tavistock Publishers: London.
- Chakrabarti, A.K., Hauschildt, J. (1989). The division of labor in innovation management. *R&D Management* 19 (2), 161-171.

- Chataway, J., Tait, J., Wield, D. (2004). Understanding company R&D strategies in agro-biotechnology: trajectories and blind spots. *Research Policy* 33, 1041-1057.
- Chen, C.C., Greene, P.G., Crick, A. (1998). Does entrepreneurial self-efficacy distinguish entrepreneurs from managers? *Journal of Business Venturing* 13 (4), 295-316.
- Cheng, C.H., Kumar, A., Motwani, J.G., Reisman, A., Madan, M.S. (1999). A citation analysis of the technology innovation management journals. *IEEE Transactions on Engineering Management* 46 (1), 4-13.
- Chesbrough, H. (2003). The Era of Open Innovation. *MIT Sloan Management Review* 44, 35-41.
- Chesbrough, H., Vanhaverbeke, W., West, J. (2006). *Open innovation: Researching a new paradigm*. Oxford University Press: New York.
- Chiesa, V., Coughlan, P., Voss, C.A. (1996). Development of a technical innovation audit. *Journal of Product Innovation Management* 13 (2), 105-136.
- Clark, K.B., Fujimoto, T. (1991). *Product Development Performance: Strategy, Organization, and Management in the World Auto Industry*. Harvard Business School Press: Boston.
- Coates, V., Farooque, M., Klavans, R., Lapid, K., Linstone, H.A., Pistorius, C., Porter, A.L. (2001). On the future of technological forecasting. *Technological Forecasting and Social Change* 67 (1), 1-17.
- Cohen, W.M., Levinthal, D.A. (1990). Absorptive Capacity: A New Perspective on Learning and Innovation. *Administrative Science Quarterly* 35 (1), 128-152.
- Cooper, R.G. (1990). Stage-gate systems: A new tool for managing new products. *Business Horizons* 33 (3), 44-54.
- Cooper, R.G. (1994). Perspective - Third generation new product process. *Journal of Product Innovation Management* 11 (1), 3-14.
- Cooper, R.G., Kleinschmidt, E.J. (1987). New products: what separates winners from losers? *Journal of Product Innovation Management* 4 (3), 169-184.
- Cooper, R.G., Kleinschmidt, E.J. (2007). Winning businesses in product development: The critical success factors. *Research-Technology Management* 50 (3), 52-66.
- Cormican, K., O'Sullivan, D. (2004). Auditing best practice for effective product innovation management. *Technovation* 24 (10), 819-829.
- Costa, A.I.A., Jongen, W.M.F. (2006). New insights into consumer-led food product development. *Trends in Food Science & Technology* 17 (8), 457-465.
- Culnan, M.J. (1987). Mapping the Intellectual Structure of MIS, 1980-1985: A Co-Citation Analysis. *MIS Quarterly* 11 (3), 341-353.
- Culnan, M.J., O'Reilly, C.A., Chatman, J.A. (1990). Intellectual structure of research in organizational behavior, 1972-1984: A cocitation analysis. *Journal of the American Society for Information Science* 41 (6), 453-458.
- Damanpour, F. (1991). Organizational innovation: a meta-analysis of effects of determinants and moderators. *Academy of management Journal* 5 (34), 555-590.
- Dosi, G. (1982). Technological paradigms and technological trajectories. *Research Policy* 11, 147-162.
- Dougherty, D. (1992). Interpretative barriers to successful product innovation in large firms. *Organization Science* 3 (2), 179-202.
- Drejer, A. (1996). Frameworks for the management of technology: Towards a contingent approach. *Technology Analysis & Strategic Management* 8 (1), 9-20.
- Eisenhardt, K.M. (1989). Building Theories from Case Study Research. *The Academy of Management Review* 14 (4), 532-550.
- Eisenhardt, K.M., Martin, J.A. (2000). Dynamic capabilities: what are they? *Strategic Management Journal* 21 (1), 1105-1121.
- Eisenhardt, K.M., Tabrizi, B.N. (1995). Accelerating adaptative processes: product innovation in the global computer industry. *Administrative Science Quarterly* 40(1), 84-110.
- Fink, A. (1995a). *How to sample in surveys*. Sage Publications: London.
- Fink, A. (1995b). *The survey handbook*. Sage Publications: London.
- Francis, D., Bessant, J. (2005). Targeting innovation and implications for capability development. *Technovation* 25 (3), 171-183.
- Gales, L., Mansour-Cole, D. (1995). User involvement in innovation projects: Toward an information processing model. *Journal of Engineering and Technology Management* 12 (1-2), 77-109.
- Griffin, A. (1997). PDMA Research on new product development practices: Updating trends and benchmarking best practices. *Journal of Product Innovation Management* 14 (6), 429-458.
- Griffin, A., Page, A.L. (1996). PDMA Success Measurement Project: Recommended Measures for Product Development Success and Failure. *Journal of Product Innovation Management* 13 (6), 478-496.

- Henderson, R.M., Clark, K.B. (1990). Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms. *Administrative Science Quarterly* 35 (1), 9-30.
- Hidalgo, A., Albors, J. (2008). Innovation management techniques and tools: a review from theory and practice. *R&D Management* 38 (2), 113-127.
- Hobday, M. (1998). Product complexity, innovation and industrial organisation. *Research Policy* 26 (6), 689-710.
- Hobday, M., Rush, H. (1999). Technology management in complex product systems (CoPS) - ten questions answered. *International Journal of Technology Management* 17 (6), 618-638.
- Hoecht, A., Trott, P. (2006). Innovation risks of strategic outsourcing. *Technovation* 26 (5-6), 672-681.
- Horsmans, L. (1979). Innovation management for an industrial product. *Research Policy* 8 (3), 274-283.
- Huang, X.L., Soutar, G.N., Brown, A. (2004). Measuring new product success: an empirical investigation of Australian SMEs. *Industrial Marketing Management* 33 (2), 117-123.
- Huizingh, E.K.R.E. (2011). Open innovation: State of the art and future perspectives. *Technovation* 31 (1), 2-9.
- Ikpaahindi, L. (1985). An overview of bibliometrics - Its measurements, laws and their applications. *Libri* 35 (2), 163-177.
- Jagle, A.J. (1999). Shareholder value, real options, and innovation in technology-intensive companies. *R&D Management* 29 (3), 271-287.
- James, W.M. (2002). Best HR practices for today's innovation management. *Research-Technology Management* 45 (1), 57-60.
- Jones, O. (2000). Innovation management as a post-modern phenomenon: The outsourcing of pharmaceutical R&D. *British Journal of Management* 11 (4), 341-356.
- Karkkainen, H., Elfvingren, K. (2002). Role of careful customer need assessment in product innovation management - empirical analysis. *International Journal of Product Economics* 80 (1), 85-103.
- Kessler, M.M. (1963). Bibliographic coupling between scientific papers. *American Documentation* 14 (1), 10-25.
- Kohler, T., Matzler, K., Fuller, J. (2009). Avatar-based innovation: Using virtual worlds for real-world innovation. *Technovation* 29, 395-407.
- Kohli, A.K., Jaworski, W.J. (1990). Market orientation: the construct research propositions, and managerial implications. *Journal of Marketing* 54 (2), 1-18.
- Lee, C., Chen, W.J. (2007). Cross-functionality and charged behavior of the new product development teams in Taiwan's information technology industries. *Technovation* 27 (10), 605-615.
- Linton, J.D., Thongpapanl, N. (2004). PERSPECTIVE: Ranking the technology innovation management journals. *Journal of Product Innovation Management* 21 (2), 123-139.
- Luthje, C., Herstatt, C. (2004). The Lead User method: an outline of empirical findings and issues for future research. *R&D Management* 34 (5), 553-568.
- Maltz, E. (2000). Is all communication created equal?: An investigation into the effects of communication mode on perceived information quality. *Journal of Product Innovation Management* 17 (2), 110-127.
- March, J.G. (1991). Exploration and Exploitation in Organizational Learning. *Organization Science* 2 (1), 71-87.
- Meyer-Krahmer, F., Reger, G. (1999). New perspectives on the innovation strategies of multinational enterprises: lessons for technology policy in Europe. *Research Policy* 28 (7), 751-776.
- Mikkola, J.H. (2001). Portfolio management of R&D projects: implications for innovation management. *Technovation* 21 (7), 423-435.
- Miles, R.E., Snow, C.C. (1978). *Organizational strategy, structure and process*. McGraw-Hill: New York.
- Montoya-Weiss, M.M., Calantone, R. (1994). Determinants of new product performance: A review and meta-analysis. *Journal of Product Innovation Management* 11 (5), 397-417.
- Nambisan, S., Nambisan, P. (2008). How to Profit From a Better "Virtual Customer Environment". *MIT Sloan Management Review* 49, 53-61.
- Neely, A. (2005). The evolution of performance measurement research: Developments in the last decade and a research agenda for the next. *International Journal of Operations & Production Management* 25 (12), 1264-1277.
- Nelson, R.R., Winter, S.G. (1982). *An Evolutionary Theory of Economic Change*. Harvard University Press: Cambridge.
- Nightingale, P. (2000). The product-process-organisation relationship in complex development projects. *Research Policy* 29 (7-8), 913-930.
- Nijssen, E.J., Arbouw, A.R.L., Commandeur, H.R. (1995). Accelerating new product development - A preliminary empirical test of a Hierarchy of implementation. *Journal of Product Innovation Management* 12 (2), 99-109.
- Nonaka, I. (1994). A Dynamic Theory of Organizational Knowledge Creation. *Organization Science* 5 (1), 14-37.

- Nonaka, I., Takeuchi, H. (1995). *The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation?* Oxford University Press: New York.
- OECD (2005). *Manual de Oslo: Diretrizes para coleta e interpretação de dados sobre inovação.* Finep.
- Oke, A. (2007). Innovation types and innovation management practices in service companies. *International Journal of Operations & Production Management* 27 (6), 564-587.
- Page, A.L., Schirr, G. (2008). Growth and development of a body of knowledge: 16 years of new product development research, 1989-2004. *Journal of Product Innovation Management* 25 (3), 233-248.
- Pavitt, K. (1984). Sectoral patterns of technical change: Towards a taxonomy and a theory. *Research Policy* 13 (6), 343-373.
- Porter, M.E. (1985). *Competitive advantage: Creating sustaining superior performance.* The Free Press: New York.
- Prahalad, C.K., Hamel, G. (1990). The core competence of the corporation. *Harvard Business Review* 90 (3), 79-91.
- Prasad, S., Tata, J. (2005). Publication patterns concerning the role of teams/groups in the information systems literature from 1990 to 1999. *Information & Management* 42 (8), 1137-1148.
- Ramos-Rodríguez, A.R., Ruíz-Navarro, J. (2004). Changes in the intellectual structure of strategic management research: a bibliometric study of the *Strategic Management Journal*, 1980-2000. *Strategic Management Journal* 25 (10), 981-1004.
- Roberts, E.B. (2007). Managing invention and innovation. *Research-Technology Management* 50 (1), 35-54.
- Rothwell, R. (1992). Successful industrial innovation: critical success factors for the 1990's. *R&D Management* 22 (3), 221-239.
- Rothwell, R., Freeman, C., Horsley, A., Jervis, V.T.P., Robertson, A.B., Townsend, J. (1974). SAPPHO updated-project - SAPPHO phase II. *Research Policy* 3 (3), 258-291.
- Russell, R.D., Russell, C.J. (1992). An examination of the effects of organizational norms, organizational structure, and environmental uncertainty on entrepreneurial strategy. *Journal of Management* 18 (4), 639-656.
- Salman, N., Saives, A.L. (2005). Indirect networks: an intangible resource for biotechnology innovation. *R&D Management* 35 (2), 203-215.
- Sanchez, A.M., Elola, L.N. (1991). Product innovation management in Spain. *Journal of Product Innovation Management* 8 (1), 49-56.
- Sawhney, M., Prandelli, E. (2000). Communities of creation_Managing distributed innovation in turbulent markets. *California Management Review* 42 (4), 24-54.
- Schildt, H.A. (2002). *Sitkis: Software for Bibliometric Data Management and Analysis.*
- Schumpeter, J.A. (1934). *The theory of economic development.* Transactions Publishers: New Jersey.
- Shane, S. (2002). Selling university technology: Patterns from MIT. *Management Science* 48 (1), 122-137.
- Shea, C.M. (2005). Future management research directions in nanotechnology: A case study. *Journal of Engineering and Technology Management* 22 (3), 185-200.
- Shenhar, A.J., Dvir, D., Shulman, Y. (1995). A two-dimensional taxonomy of products and innovations. *Journal of Engineering and Technology Management* 12 (3), 175-200.
- Sicotte, H., Langley, A. Integration mechanisms and R&D project performance. *Journal of Engineering and Technology Management* 17 (1), 1-37.
- Slaughter, E.S. (2000). Implementation of construction innovations. *Building Research and Information* 28 (1), 2-17.
- Smits, R. (2002). Innovation studies in the 21st century: Questions from a user's perspective. *Technological Forecasting and Social Change* 69 (9), 861-883.
- Song, M., Xie, J., Di Benedetto, C.A. (2001). Message and source factors, market uncertainty, and extrafunctional information processing: Hypotheses and empirical evidence. *IEEE Transactions on Engineering Management* 48 (2), 223-238.
- Souitaris, V. (2001). External communication determinants of innovation in the context of a newly industrialised country: a comparison of objective and perceptual results from Greece. *Technovation* 21 (1), 25-34.
- Stanko, M.A., Calantone, R.J. (2011). Controversy in innovation outsourcing research: review, synthesis and future directions. *R&D Management* 41 (1), 8-20.
- Tatikonda, M.V., Rosenthal, S.R. (2000). Successful execution of product development projects: Balancing firmness and flexibility in the innovation process. *Journal of Operations Management* 18 (4), 401-425.
- Teece, D.J. (2010). *Business Models, Business Strategy and Innovation.* *Long Range Planning* 43 (2-3), 172-194.
- Teece, D.J., Pisano, G., Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal* 18 (7), 509-533.
- Tidd, J. (2001). Innovation management in context: environment, organization and performance. *International Journal of Management Reviews* 3 (3), 169-183.



Tidd, J., Bessant, J., Pavitt, K. (1997). *Managing Innovation: Integrating Technological, Market, and Organizational Change*. John Wiley & Sons: New York.

Toivonen, M., Tuominen, T. (2009). Emergence of innovations in services. *The Service Industries Journal* 29 (7), 887-902.

Tushman, M.L., Anderson, P. (1986). Technological discontinuities and organizational environments. *Administrative Science Quarterly* 31 (3), 439-465.

Utterback, J.M. (1994). *Mastering the dynamics of innovation*. Harvard Business School Press: Boston.

Van der Bij, H., Song, M., Weggeman, M. (2003). An empirical investigation into the antecedents of knowledge dissemination at the strategic business unit level. *Journal of Product Innovation Management* 20 (2), 163-179.

Verganti, R. (2008). Design, meanings, and radical innovation: A metamodel and a research agenda. *Journal of Product Innovation Management* 25 (5), 436-456.

Von Hippel, E. (1988). *The Sources of Innovation*. Oxford University Press: New York.

Von Hippel, E. (2005). *Democratizing Innovation*. The MIT Press: London.

Voss, C.A. (1994). Significant issues for the future of product innovation. *Journal of Product Innovation Management* 11 (5), 460-463.

Wan, D. (2005). Determinants of firm innovation in Singapore. *Technovation* 25 (3), 261-268.

Wheelwright, S.C., Clark, K.B. (1992). *Revolutionizing Product Development: Quantum Leaps in Speed, Efficiency, and Quality*. The Free Press: New York.

Wheelwright, S.C., Clark, K.B. (2003). *Creating Project Plans to Focus Product Development*. *Harvard Business Review* 70, 70-82.