

Innovation management: a literature review about the evolution and the different innovation models

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Abstract

The term 'Innovation' is increasingly being used to explain and justify the changes in the business strategy. It is clear for anyone that innovation is an important piece for organization growth. However, one issue that remains is how to recognize what kind of innovation management it is necessary for each company. One of the reasons for this issue is the multiple dimensions that innovation can be addressed – technological, organizational, process, and product among others. Using bibliometric techniques, this paper revisited the papers about innovation management that were published in the last 36 years (1975 – 2011). The aim was to identify and consolidate the many innovation management models. Also, an analysis of these models was made in order to identify their antecedents.

Key-words: Innovation, Innovation Management, Innovation Management Model

1 Introduction – Innovation and its dimensions

Technological advances, customer behavior changes, intensified competition and the changing business environment are some of the factors that are creating the need for innovations in the organizations (Goffin & Mitchell, 2010). According to Tidd, Bessant and Pavitt (2008), innovation can be related to the organizations' ability to recognize the market opportunities and establish commercial relationships that make them economically viable. It is related to the development of new products, new processes or to the creation of new ways to work on established and mature markets. However, one of the biggest challenges organizations face is to test and manage the innovation process, considering several circumstances (type of innovation, product or industry) that innovation management process might differ.

Innovation might be analyzed through many dimensions. Authors like Nonaka and Takeuchi (1995), Nonaka (1994), Cohen and Levinthal (1990), Van der Bij, Song and Weggeman (2003), among others, discuss the importance of the generation and management of knowledge cycles in order to create and sustain innovation.

The organizational strategy is also indicated in the literature as an influencing factor for innovation. Tidd (2001) analyzes how complexity and uncertainty influence the decision about different strategies and principles companies can choose to manage innovation. Miles and Snow (1978) developed what they call adaptive cycle, consistent with three strategic types of organization: defenders, analyzers and prospectors. Each type has its own strategy and configuration of technology, structure and process that will shape the way organizations solve the entrepreneurial, engineering and administrative problems when leading with innovation.

Project management is another aspect that has a strong influence on innovation management. It is common to find organizations that manage their innovation process similar to the way they manage a new product project. Based on this perception, Cooper (1990) presented the "Stage Gates" model and Wheelwright and Clark (1992) the "Funnel" model, which have become a reference for innovation management. Many models that have emerged since are variations of these two models.

Other dimensions such as technological innovation (Dosi, 1982; Goffin & Mitchell, 2010; Shea, 2005) and open innovation (Chesbrough, Vanhaverbeke, & Wet, 2006; Sawhney & Prandelli, 2000) are also cited in the literature. There are also authors like Henderson and Clark (1990), Griffin and Page (1996) and Mikolla

(2001) that proposed innovation typologies that help companies understand the level of innovation they have the capability to offer to the market (incremental or radical).

In the context where organizations and individuals are discussing the innovation management aspects, the present work objective is to understand how different innovation management models emerged during the last thirty six years by applying bibliometric methods and reviewing the innovation management publications.

2 Methodology

The research method used is a bibliometric study with content analysis. The bibliometric study involves a series of techniques that allow quantitative and qualitative analysis of the literature (Ikpaahindi, 1985). One of the ways to conduct this kind of study is the publications analysis that allows the identification of the relevant group of journal, the evolution of the publications along the years and the related subject areas (Prasad & Tata, 2005). Some bibliometric papers also analyze the citations, looking for finding the most cited and authors, as well as the possible research trends (Neely, 2005).

Other used technique is the snow ball, or bibliographic coupling, that expands the analysis for the references of the extracted data base. Applying this technique books and papers from other sources can be retrieved, also those papers that are relevant for the subject but do not use the key-words used in the first search engine (Fink, 1995a, 1995b; Kessler, 1963).

The data were collected from the ISI Web of Science database, using the keyword 'innovation management' in the topic, resulting in 774 papers (377 proceedings papers, 315 articles, 33 book review, 22 editorial material, 22 reviews, 4 meeting abstract, 1 note). For this study, only the 315 articles were analyzed, discarding the others. These 315 articles come from 48 different countries, written by 500 authors, 128 journals in 55 subject areas. To analyze this group of articles, two analysis techniques were applied:

- **Technique one: analysis of the publications**- publications between 1975 and 2011 were analyzed in order to identify the journals with the highest number of publications, publications over time, subject areas related to the topic of study and citation analysis. Since the timeframe is long, to facilitate the analysis it was divided as follows: Q1 (1975-1980), Q2 (1981 – 1986), Q3 (1987-1992), Q4 (1993-1998), Q5 (1999-2004) and Q6 (2005 – July/2011).
- **Technique two: 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, O'Reilly, & Chatman, 1990; Neely, 2005; Ramos-Rodriguez & Ruiz-Navarro, 2004). Those papers with more than 20 citations were extracted and these set of articles were used to generate social networks with the most cited references (10 times or more) of these articles. This kind of analysis is useful to identify the papers (articles and books) with most relevance for the topic. To construct the network the bibliometric software Sitkis 2.0 (Schildt, 2002) and the social network analysis program, Ucinet (Borgatti, Everett, & Freeman, 2002) were used.

3 Findings

3.1 Technique one: publications analysis

The 315 papers were published in 128 journals, which reinforce the multidisciplinary approach. In Table 1 it is listed all the publications per journal and per quartile and it shows that only six journals are responsible for the 43% of the published articles. These six journals focus on technological innovation, research and development, new products development, innovation management and technology management.

Although the first publication occurred in 1975, it is only from 1993 that the topic on innovation started to gain interest among academics and managers.

Table 1 – List of the publications per journal and per quartile

JOURNAL	QUARTILE						TOTAL
	Q1 (1975/1980)	Q2 (1981/1986)	Q3 (1987/1992)	Q4 (1993/1998)	Q5 (1999/2004)	Q6 (2005/2011)	
International Journal of Technology Management				5	11	19	35
Journal of Product Innovation Management			1	5	5	18	29
Technovation				3	11	15	29
R & D Management		1	2		5	11	19
Research-Technology Management				1	1	11	13
Research Policy	1			2	4	4	11
Technology Analysis & Strategic Management				2	1	5	8
Technological Forecasting and Social Change				1	2	4	7
Journal of Engineering and Technology Management				3	1	2	6
IEEE Transactions on Engineering Management				1	4		5
International Journal of Production Economics					5		5
Journal of Technology Transfer						5	5
Health Care Management Review				1		2	3
International Journal of Operations & Production Management					2	1	3
Management Decision						3	3
Nachrichten aus der Chemie					1	2	3
Sotsiologicheskoe Issledovaniya					2	1	3
System Dynamics Review				2	1		3
Asian Journal of Technology Innovation						2	2
DYNA						2	2
Government Information Quarterly						2	2
Industrial and Organizational Psychology-Perspectives on Science and Practice						2	2
Innovar - Revista de Ciencias administrativas y Sociales						2	2
International Journal of Production Research						2	2
International Journal of Vehicle Design				1	1		2
Journal of Business Research						2	2
Journal of Scientific & Industrial Research			1		1		2
Management International Review			1			1	2
PPS Management						2	2
Service Industrial Journal						2	2
Strategic Management Journal						2	2
Total Quality Management					2		2
Total Quality Management & Business Excellence						2	2
TOTAL	2	4	9	33	73	194	315

Analyzing the Table 2 it is possible to see the concentration of the publications in areas like "Management", "Business", "Industrial Engineering", "Operations Research and Management Science", "Multidisciplinary Engineering" and "Planning and Development".

Table 2 – List of the subject category of the 315 articles

SUBJECT CATEGORY	FREQUENCY	SUBJECT CATEGORY	FREQUENCY
Management	216	Environmental Studies	2
Business	115	Ergonomics	2
Industrial Engineering	101	Material Science	2
Operations Research and Management Science	77	Transportation Science and Technology	2
Multidisciplinary Engineering	41	Aerospace Engineering	1
Planning and Development	20	Art	1
Manufacturing Engineering	9	Civil Engineering	1
Multidisciplinary Sciences	8	Communication	1
Economics	7	Computer Science and Software Engineering	1
Information Science and Library Science	7	Computer Science and Theory & Methods	1
Mechanical Engineering	5	Education and Educational Research	1
Psychology	5	Educational Psychology	1
Health Policy and Services	4	Electrical and Electronic Engineering	1
Sociology	4	Energy and Fuels	1
Chemical Engineering	3	Environmental Engineering	1
Computer Science and Information Systems	3	Ethics	1
Environmental Public and Occupational Health	3	Finance Business	1
Food Science and Technology	3	Geography	1
Industrial Relations and Labor	3	Gerontology	1
Interdisciplinary Social Sciences	3	History	1
Multidisciplinary Agriculture	3	Metallurgy and Metallurgical Engineering	1
Multidisciplinary Chemical	3	Multidisciplinary Humanities	1
Public Administration	3	Multidisciplinary Psychology	1
Social Sciences and Mathematical Methods	3	Nursing	1
Computer Science and Artificial Intelligence	2	Pharmacology and Pharmacy	1
Computer Science and Interdisciplinary Applications	2	Surgery	1
Construction and Building Technology	2	Tourism	1
Environmental Sciences	2		

3.2 Technique II: citations analysis

Looking at the first extract of 315 articles it was not possible to identify any pattern regarding to innovation management model. So, using the snow ball technique, the study was expanded to the articles' references. Table 3 lists the first 20 references that received more than 20 citations.

Table 3 – List of the most cited articles

ARTICLE	JOURNAL	CITATIONS
Hobday (1998)	Research Policy	141
Chen, Greene and Crick (1998)	Journal of Business Venturing	118
Chiesa, Coughlan and Voss (1996)	Journal of Product Innovation Management	103
Sawhney and Prandelli (2000)	California Management Review	82
Tatikonda and Rosenthal (2000)	Journal of Operations Management	70
Smits (2002)	Technological Forecasting and Social Change	37
Cheng, Kumar, Motwani, Reisman and Madan (1999)	IEEE Transactions on Engineering Management	36
Sicotte and Langley (2000)	Journal of Engineering and Technology Management	36
Chakrabarti and Hauschildt (1989)	R&D Management	33
Nijssen, Arbouw and Commandeur (1995)	Journal of Product Innovation Management	32
Linton (2004)	Journal of Product Innovation Management	30
Tidd (2001)	International Journal of Management Reviews	29
Russel and Russel (1992)	Journal of Management	29
Meyer-Krahmer and Reger (1999)	Research Policy	29
Coates et al. (2001)	Technological Forecasting and Social Change	29
Sun, Xie and Cao (2004)	Marketing Science	27
Nightingale (2000)	Research Policy	27
Gales and Mansour-cole (1995)	Journal of Engineering and Technology Management	26
Cormican and O'Sullivan (2004)	Technovation	24
Hoecht and Trott (2006)	Technovation	24

The article to references network analysis generated a group of 93 (12 books and 81 articles) referenced articles that were fully analyzed, identifying seven related subject areas from where innovation management models derive (Figure 1): organizational strategy, project management, knowledge

management, product management), types of innovation, innovation technology and open innovation). In 37 of the publications among books and articles some mention about innovation management models were made. According to the model's characteristics and to the central objective of the models they were clustered under one of the related areas. Models like Funnel and Stage Gate were classified under project management. The number of the articles referring these models is listed in Table 4.

The articles which references network generated a list of 93 publications (12 books and 81 articles), that were qualitatively analyzed in order to extract the innovation management model. In 37 of the publications were identified innovation management model, classified according to the Table 4.

Table 4: Innovation management model antecedents

RELATED AREA	NUMBER OF WORKS
Organizational Strategy	9
Project Management	12
Knowledge Management	8
Product Management	3
Types of Innovation	3
Technological Innovation	1
Open Innovation	1

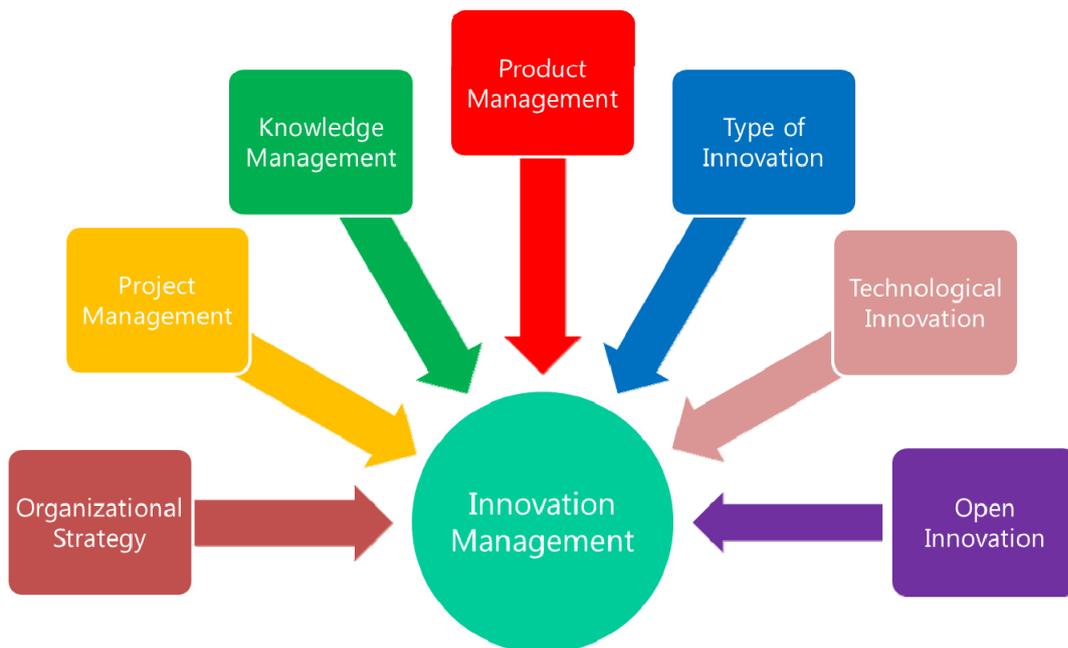


Figure 1- Innovation management models

Source: from the authors

In 68 out of the 81 articles it was possible to identify the research method that was applied. The research method was classified in conceptual and empirical researches. Table 5 lists the classification and the quantity of the articles using each one of the methods.

Table 5 – Research methods

RESEARCH METHOD	NUMBER OF ARTICLES
Conceptual research	
CR1: Literature review	22
CR2: Simulations or theoretical modeling	10
Empirical research	
ER1: Survey	18
ER2: Case study	17
ER3: Action research	-

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 on the environment, company's 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.

Also, there is a lack of concentration of papers in particular authors. So, to be possible to identify the relevant papers it was necessary to analyze the number of citations of the articles' references. As a result, papers like Hobday (1998) that investigated the influence of the product complexity on innovation; Chen et al. (1998) that researched the factors related to the management efficiency; Chiesa et al. (1996) that analyzed the process and mechanisms that lead to innovation and Sawney and Prandelli (2000) that reinforced the importance of the social interactions in communities that seeks innovation were identified.

4 Conclusion

Organizations that seek to gain competitive advantage need to manage their business in a highly changing environment with lower time lead, reduction in the new products development costs and the increasing pressure for innovation. Innovation is not just about new product or service. New organizational methods, management model or production processes also are seen as innovation.

Considering that innovation is a multidisciplinary topic, this research analyzed the publications in the last 36 years (1975 – 2011), identifying that areas such as organizational strategy, knowledge management, project management, technological innovation and product management might be considered innovation management antecedents. Also, there is no single model for innovation management and some of them are derived from or follow the logic of "Stage Gate" (Cooper, 1990) and "Funnel" (Wheelwright & Clark, 1992) models.

Project management, organizational strategy and knowledge management are subject areas that according to the literature review influence the innovation management models. It might indicate first, 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. In the second place there is an understanding that 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 product or project development. The link with subject areas like organizational and knowledge management might indicate this complexity. In newer papers, 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 strong impact in internal processes.

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

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