

Changes in the Axes of Convergence of Innovation Management Research

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Abstract

The multidisciplinary character of the theories that support research in the discipline of Innovation Management (IM), the growing importance being attributed to the increasingly rigorous approach to IM studies by academics, and the impact of IM on the competitive advantage of firms are just some of the indicators demonstrating the relevance of this discipline in the broader field of management. These developments explain why a quantitative analysis of IM studies based on bibliometric techniques is particularly opportune.

The aim of this paper is to analyze the dynamics of the intellectual structure of IM research throughout the last 20 years, to find out the main convergence axis within the field. The analysis of the intellectual structure shows that there are four convergence axes during the said period: (1) the study of how to manage innovation from the Strategic Management and Business Administration ambit; (2) New Products Development; (3) The importance of Organizational Learning and Knowledge Management for IM; and (4) The importance of the technological change, supply of technology, innovation process and innovation model. The dynamic analysis of all this, shows that in the 90's there was a predominance of the axis (1) and (2). Subsequently, the predominance changed during the first decade of the XXI century, because the axis (2) remained dominating, but axis (4) began to appear strongly. Finally, it's evident the strengthening of the authority of axis (4) in the intellectual structure of the IM research during the last period of study.

Keywords: innovation management, bibliometric, co-citation analysis, citation mapping

1. Introduction

Innovation Management (IM) is a recurrent topic within the management and business research nowadays. The study of innovation was also an important theme during a previous stage. Subsequently, the academic interest of how to administer this innovation has increased considerably. Pavon and Hidalgo (1997) state that the capacity to innovate constitutes a resource of the company, together with the financial, commercial, and productive capacities, and all of them must be administrated in a rigorous and efficient way. On the other hand, Biemans, Griffin and Monaert (2007) explain that the academic community engrossed in the research of the IM field has been globalized and widely diffused. This then, has meant a specialization of the discipline (Biemans, Griffin, & Moenaert, 2007).

Candelin, Sandberg, and Mylly (2012) state that the number of researches on IM has increased, although this is happening just in recent times. So, it's evident that IM is a topic that has gained importance both for business people, and academics. That's why it deserves to be analyzed one more time. The objective of this paper is to determine the relations among the most important documents in this field to identify approaches, theories and their influence within the academic community, schools of thought, or in general, convergence axis.

With the identification of the most studied research subjects, it will be possible to identify and assess how these research subjects have modified their influence throughout the time. This knowledge might help to guide future research. Besides, the fact of performing a literature review which considers a wide horizon of time, as well as its classification within the traditional ordination scheme of bibliometric methods, constitutes by itself a contribution which might be of interest for the scientific community.

2. Literature Review

In recent years a variety of works have appeared which have analyzed different aspects of the field of IM with a

bibliometric approach. For example, Husain and Sushil (1997) undertake a literature review exercise to identify the research issues in the area of Management of Technology. The articles reviewed were grouped under seven headings which are strategic management of technology, technology planning and forecasting, technology transfer and acquisition, development and IM, technology and organizational issues, adoption and implementation of new technologies, and technology management with the implications for developing countries.

Cheng et al. (1997) present a paper in Portland International Conference on Management of Engineering and Technology, which consists of a citation-analysis based follow-up to the subjective survey conducted in 1993 by the Technology IM Division (TIMD) of the Academy of Management. The purpose of both studies was to establish a hierarchical rating of journals publishing articles in the field of Technology IM (TIM). Cheng et al. (1999) publish their research in the IEEE Transactions on Engineering Management. That study establishes a hierarchical rating of journals publishing articles in the field of TIM.

Linton and Thongpapanl (2004) conduct a citation analysis of the 10 leading TIM specialty journals to gain insights into the relative ranking of the journals. Later, García, Pereira, and Santos (2006) characterize the Journal of Technological Innovation, Entrepreneurship and Technology Management (Technovation) in its 25th anniversary, which celebrates it holding a prominent position within the field of TIM.

Gang et al. (2007) analyzes some characteristics of research on IM in China between 2000 and 2005, including the main institutions, key authors and regional distribution, based on China National Knowledge Infrastructure (CNKI) full paper Database, and by using Bibliometrics. Biemans, Griffin, and Moenaert (2007) analyze The Journal of Product IM (JPIM) from a knowledge-flow perspective by looking at the scientific sources used by JPIM authors to develop their ideas and articles. To this end a bibliometric analysis was performed by analyzing all references in articles published in JPIM. It suggested a growing specialization of the field of TIM, with JPIM being firmly entrenched as the acknowledged leading journal. Thieme (2007) using 959 articles reflecting the work of 1,179 scholars, ranks the world's top scholars in IM on the basis of the number of research articles published across 14 top academic journals in technology and IM, marketing, and management between 1990 and 2004. Linton and Embrechts (2007) perform an updating of the standing of the TIM journals as a specific domain (Linton, 2006), and they use a Kohonen self-organizing map to show how journals relate to each other with respect to content (Kohonen, 1997).

In that very year, Junquera and Mitre (2007) assess the contribution to the international literature of Spanish scientific production in the research stream of innovation and technology management. A year later, Pilkington (2008) explores the suitability of using diffusion S-curves to describe and compare the diffusion of citations within the IM discipline. The ISI Citation data on the ten leading journals in the IM field are modeled and compared using a wide range of distributions. The resulting grouping of journals appears to be a useful proxy for academic-practitioner involvement and warrants further research.

McMillan (2008), using co-citation analysis, identifies the invisible colleges associated with publications in R&D Management from 1986 through 2005 (he divides the temporal horizon into four time periods to reveal changes in its intellectual base). The results indicate that Cohen and Levinthal's absorptive capacity model dominates the final two periods. The conclusions suggest how the absorptive capacity model might be more effectively utilized in future R&D Management research.

Tipu (2011) presents the classification of academic publications on IM in banks. And in 2012 four researches were identified: Yang and Tao (2012), an extension of Thieme's article published in 2007 in JPIM, which was already mentioned; Choi et al. (2012), with a paper that presents an updated ranking of the leading TIM specialty journals where citation data from the years 2006–2010 of the fifteen base journals are collected and analyzed; Thongpapanl (2012), who presents an updated ranking of top journals specialized in TIM, using citation data corresponding to 15 base journals, from 2006 through 2010; and Schiederig, Tietze, and Herstatt (2012), with a paper that provides a current overview of the existing body of literature in the field of green innovations, identifying the most active scholars, institutions and relevant publications.

Finally, Shafique (2013) with a study that presents a 'global view' of the innovation field by combining longitudinal and structural perspectives from 1988 through 2008; and Zupic and Cater (2013), which main objective is to analyze the intellectual structure of high-technology research. They analyze journals that publish high-technology research, journals that publish most cited works by this research and most influential authors and documents, by means of citation and co-citation analysis, and social network analysis as visualization technique.

3. Methodology

We chose to use articles published in journals, because these can be considered ‘certified knowledge.’ This is the term commonly used to describe knowledge that has been submitted to the critical review of fellow researchers and has succeeded in gaining their approval. Research articles play a fundamental role in the said certification process (Callon, Courtial, & Penan, 1993). The use of citations from articles in journals, moreover, is a standard practice that enhances the reliability of results (Ramos-Rodríguez & Ruíz-Navarro, 2004).

To obtain a representative collection of the IM research articles, we decided to retrieve all the articles published in the Social Science Citation Index (SSCI) from 1956 through 2012 with the sequence of characters “IM” in their titles, keywords or abstracts. The reasoning behind this choice can be summarized as follows: (1) by their nature, all the published articles address Social Science issues, which saves us the arduous task of sifting through other databases in search of articles relating to the discipline that concerns us, as well as help us avoiding other publications corresponding to Sciences we are not interested to include in the present study; (2) it is highly regarded by researchers in the field; (3) its entire contents have the type required for citation analysis techniques. Once the set of articles was retrieved from the database (387 in total, from now on, citation sample), we then created a file with all the references cited in the said articles. There are, however, certain inconsistencies in the coding used in the database. Since the bibliometric software (Note 1) employed in this study recognizes only exactly coinciding strings of characters, a manual normalization process is required in order to guarantee accuracy, especially in the spelling of authors’ names, the journals in which the articles appear, and the first edition of each book cited.

After analyzing the production of citations per year, we were able to identify the emergence of the discipline in 1990. Then, a deepest study was performed from 1990 through 2012.

Another file with the references corresponding to the period of 1990-2012 was then retrieved from the one which included 1956 to 2012. This file is the citation sample for that stage (1990-2012). Then, the cited references were determined with Bibexcel, and the inconsistencies were normalized. The cited references file was used later to count the appearance frequency. The frequency distribution obtained shows a classification of the cited documents arranged by its influence degree. After that, three sub-periods were distinguished just to identify the changes of influence throughout the time: 1990-1999, 2000-2008, and 2009-2012.

Then, and specifically it’s what was done in this research, the relations among the most influential works are analyzed, in order to group them into homogeneous blocks. A co-citation analysis was performed to that end (Fernandez-Alles and Ramos-Rodríguez, 2009; Gmür, 2003; McCain, 1990; Ramos-Rodríguez, 2004; Small, 1973; Shafique, 2013; White and Griffith, 1981; White and McCain, 1998).

The co-citation analysis is based on the count of the frequency with which appears cited any couple of documents corresponding to the most influential ones which were identified before. These counts are then ordered in a square and symmetrical matrix, with a dimension equal to the number of the cited documents that were chosen and with an undefined main diagonal (known as gross co-citation matrix).

Subsequently, the gross co-citation matrix is converted into another matrix which reflects similarity or normalized distance between each couple of documents. Most of the works performing co-citation analysis of authors use the Pearson correlation coefficient as a measure of normalized similarity (McCain, 1990). In this paper this criterion has been followed, although the study in this case is not about authors, but about documents.

Because of the large number of cited references which usually is handled in this kind of co-citation studies, to perform the procedure described before, it’s necessary to establish a citation threshold. So, the references with a citation frequency higher or equal to that threshold are the chosen ones to perform the analysis. In the present paper, the correlation matrices contained the measures of proximity among works which had a citation threshold higher to 3,42 % from the citation sample.

Table 1 shows the number of articles in the citation sample corresponding to each period, the citation threshold already established, which is the same for all the periods, and the number of references of each case.

Table 1. Citation thresholds established for each period

Periods	Number of articles in the citation sample	Citation threshold = 3,42%	Number of references to analyze
1990-2012	380	13 (12,99)	51
1990-1999	49	2 (1,68)	38
2000-2008	152	5 (5,20)	70
2009-2012	179	6 (6,12)	91

With the values which were used for the co-citation analysis, the necessary matrices for the application of traditional multivariate analysis techniques were obtained. In this occasion, and following the methodological recommendations of White and Griffith (1981), McCain (1990), White and McCain (1998) and Ramos-Rodríguez (2004), a factor analysis with a varimax rotation to the correlation matrices was carried out.

Despite of the application of the said techniques, a graphical representation of the underlying structure corresponding to the correlation matrices was also performed, to complement the study. The graph of each matrix with a correlation coefficient superior to 0,7 was represented. The final outcome of it all consists of the identification of components which reflect the homogeneous research themes and permit to interpret the results of the factor analysis in a better way

4. Results and Discussion

Considering that the emergence of the discipline was at the beginning of the 90's, firstly, the results gotten from the analysis of the whole period (1990-2012) are shown then.

Later, the same analysis was performed for each sub-period which had been established: one comprising the decade of the 90's, another including the first years of the 21st Century, and another with the last four years until 2012. All this was done to detect changes in the intellectual base of the field throughout the time.

4.1 The Intellectual Structure of IM research during the Period of 1990-2012

In this section, the proximity relations of contents among the co-citation profiles of the 51 most cited documents (cited by the 380 articles which constitute the citation sample of this period, corresponding to a citation threshold of 3,42 %), are analyzed by using Pearson correlation coefficient.

As shown in Table 2 for the period 1990-2012, seven factors with eigenvalues higher than one were extracted, which together explain the 86.575% of the total variance.

Table 2. Total variance explained (Period 1990-2012)

Component	Initial Eigenvalues			Sum of Squared Loadings Rotation		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	24,146	47,345	47,345	22,323	43,770	43,770
2	6,605	12,952	60,297	5,548	10,879	54,648
3	5,509	10,802	71,098	5,399	10,587	65,235
4	3,571	7,002	78,100	4,106	8,052	73,287
5	1,846	3,620	81,720	2,744	5,380	78,667
6	1,336	2,620	84,341	2,610	5,118	83,785
7	1,140	2,235	86,575	1,423	2,790	86,575

Extraction method: principal component analysis. Varimax rotation.

As it is shown in Table 3, the documents with higher factor loading in the first factor (explained variance 43, 770 %) are Utterback (1994), Dosi (1982), Teece (1986) and Porter (1980). Those documents belong to the topic of Product Development, Technology, Innovation and Strategic Management.

Table 3. Rotated component matrix, 1990-2012 (Rotated component matrix (a))

	Components						
	1	2	3	4	5	6	7
Utterback (1994)	,954						
Dosi (1982)	,945						
Cooper and Kleinschmidt (1987)	-,922						
Teece (1986)	,901						
Porter (1980)	,899						
Schumpeter (1934)	,897						
Griffin and Page (1996)	-,889						
Griffin (1997)	-,888						
Montoyaweiss and Calantone (1994)	-,876						
Von Hippel (1988)	,858						
Nelson and Winter (1982)	,856						
Cooper, Edgett and Kleinschmidt (1999)	-,856						
Rothwell et al. (1974)	-,851						
March (1991)	,846						
Von Hippel (2005)	,835						
Cohen and Levinthal (1990)	,827						
Henderson and Clark (1990)	,817						
Tushman and Anderson (1986)	,802						
Chesbrough and Crowther (2006)	,797						
Dougherty (1992)	-,796						
Chesbrough (2003)	,777						
Kogut and Zander (1992)	,776			,556			
Brown and Eisenhardt (1995)	-,759						
Porter (1985)	,756						
Prahalad and Hamel (1990)	,704			,644			
Porter (1990)	,702						
Barney (1991)	,672			,641			
Miles et al.(1978)	-,645		,512				
Clark and Fujimoto (1991)	-,601						
Teece, Pisano and Shuen (1997)	,577	,510					
Von Hippel (1986)	,513						
Rothwell (1992)		-,853					
Garcia and Calantone (2002)		,837					
Leonardbarton (1992)		,747					
Eisenhardt (1989)		,590					,503
Christensen (1997)		,575					
Wheelwright and Clark (1992)							
Damanpour (1991)			,880				
Tidd (2001)			,849				
Amabile et al. (1996)			,813				
Tidd and Trehwella (1997)			,642				
Linton and Thongpapanl (2004)			-,624				
Eisenhardt and Martin (2000)							
Nonaka (1994)	,518			,749			
Takeuchi and Nonaka (1995)				,650			
Adams, Bessant and Phelps (2006)					-,766		
Senge (1990)					,559		
Burns and Stalker (1961)							
Yin (1994)						,833	
Yin (2003)						,783	
Pavitt (1984)	-,569						,702

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. a Rotation converged in 23 iterations.

Along with Schumpeter (1934), which is a work clearly belonging to the economic field, can be grouped Nelson and Winter (1982), with their analysis about the theory of change, and Porter (1990), with his study on the growing role of nations in achieving and keeping the competitive advantage. The latter, aside from being classified within that group, encompasses other topics related to Management and, Strategic Management.

Also, with positive loadings, and within the Organizational Learning ambit, can be found the document of March (1991), and the so-widely-consulted book of Cohen and Levinthal (1990). Then, within the Innovation field, including elements like Innovation sources, Innovation Process, and technology, are grouped Von Hippel (1988 and 2005), Henderson and Clark (1990), and Tushman and Anderson (1986). Within the field of Strategic Management, and Knowledge Management, emerge by one side Porter (1985), a classic, and by other, Kogut and Zander (1992). The latter has elements which correspond to Knowledge Management mainly, as well as, technological transference, imitation, capabilities and learning in organizations. These documents can be observed on the graph of the intellectual structure corresponding to this period (Figure 1). They are located in the right-hand area, identified with a color green. It's possible to note how concentrated and interconnected they are in that part of the graph. Within this first component, and with negative factor loadings, a series of works about New Product Development and Strategic Management are found, such as Clark and Fujimoto (1991), Miles et al. (1978), Brown and Eisenhardt (1995) and Dougherty (1992).

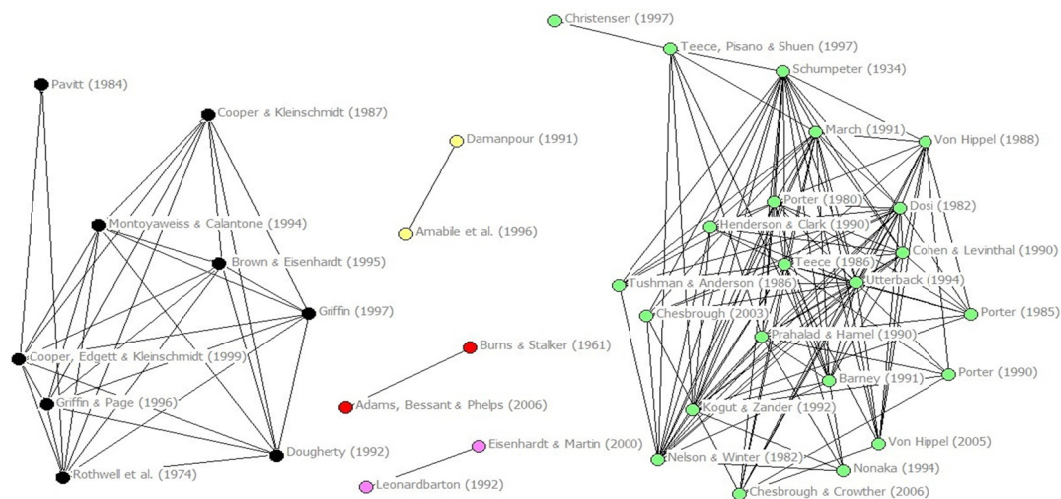


Figure 1. The intellectual structure of research in IM during the period of 1990-2012

These documents, with negative loadings can be seen on the graph (Figure 1), in the left-hand area, colored in black, except for Miles et al. (1978), and Clark and Fujimoto (1991) which are not represented.

The second factor, which explains the 10,879 % of the total variance, and the 54,648 % together with the first factor, emerge firstly through works about Innovation, New Products Development, and Management. Examples of this are Garcia and Calantone (2002), Leonardbarton (1992) and Eisenhardt (1989).

The book of Christensen (1997) is a prominent document in this factor. The author of this work tries to solve the dilemma that all the innovators have to face: the reason for which the new technologies provoke the death of large companies.

Within this same factor, but with a negative loading, the work of Rothwell (1992) is found. It's about IM Models.

Documents corresponding to this second factor can be seen in Figure 1, specifically in the center of the graph, colored in rose ((Leonardbarton, 1992; Eisenhardt, 1989), and in the superior part of the sub-graph, colored in green with the work of Christensen (1997), because this factor is united to the first one through Teece, Pisano and Shuen (1997).

The third factor explains a 10,587 % of the total variance, and a 65,235 % along with the other two. It's not difficult to characterize it, due to that in general some of its documents belong to the topic of Innovation, Creativity, Technology Supply, and Strategic Management. These works are Damanpour (1991), with an analysis about the relations between Organizational Innovation and its determinants, Tidd (2001) with a review about

Innovation, Organizational Behavior, and Strategic Management, Amabile et al. (1996) who evaluate the work environment, and the way in which this environment affects creativity, and Tidd and Trewhella (1997), with their analysis on external technology acquisition by the company.

Within this same factor, but with a negative loading, stands out the work of Linton and Thongpapanl (2004).

The documents corresponding to this factor can be located on the graph of the intellectual structure of the discipline (Figure 1), just in the center of it, colored in green.

The fourth factor explains an 8,052 % of the total variance. It seems to be a factor where clearly Knowledge Management predominates. Surely, it's because of the importance that Knowledge Management has for IM. Two main works stand out in this case, which at the same time are classics, above all within the topic of Knowledge Management: Nonaka (1994), and Takeuchi and Nonaka (1995).

Nonaka (1994) can be located in the right-hand part of the graph (Figure 1), colored in green, where the documents corresponding to the first factor are predominant. This is because it has important factor loadings in that component as well. On the other hand, the relation between this fourth factor and the first one is more than evident, because there are several documents which correspond to the first factor, nevertheless, they have considerable loadings in the fourth factor and are related to Nonaka (1994), as it can be seen in Figure 1. They are: Barney (1991), Prahalad and Hamel (1990), and Kogut and Zander (1992).

The fifth factor explains a 5,380 % of the total variance; 78,667 % along with the other factors already commented. Two main documents belong to this component: Senge (1990), with a positive loading, about the topic of Organizational Learning, in which he establishes five competent technologies that keep strong the learning organizations; and with a negative loading, the work of Adams, Bessant and Phelps (2006), which is about the innovation process, and where the author propose a frame to evaluate the activity of innovation, with the certainty that innovation can be measured.

The sixth factor explains only a 5,118%, and 83,785% along with the others. Both works belong to the same author: Yin (1994 and 2003), with positive loadings. Both documents are hard to classify, because of the theme they treat: the future of the case study method in evaluative research.

Finally, the seventh factor explains the 2,790 % of the total variance. It's made up by a work; Pavitt (1984), about Technological Change.

Eisenhardt (1989) can be analyzed as a part of this factor too (because of its loading), although it belongs to the second factor. In this work the author studies the Theory of the Agency, and recommends an agency perspective to study the problems in organization with a cooperative structure.

Von Hippel (2005) is a document that has an important loading within this factor, although it's less than 0,5. It's a book about democratizing innovation.

4.2 Dynamic Analysis: Changes in the Intellectual Structure of IM

Even though the study of the intellectual structure of IM during the last 22 years is interesting, a dynamic vision of its evolution, and transformation might contribute with the results of the current research in a very positive way. So, in the following sections we replicate the previous analysis to three correlative sub-periods.

Taking into consideration that the number of works which have been published and constitute the citation sample is not the same in each sub-period, the citation threshold of 3, 42 % was taken as the criterion to include a certain document in the analysis. Every document which had a quantity of citations, in relative terms, greater than the threshold (including it), was then included in the study.

4.3 The Intellectual Structure of IM Research: 1990-1999

The correlation matrix which resulted from the co-citation profiles of the 38 documents cited by the 49 articles for this period was used to perform an extraction of the main components. These components needed a varimax rotation, and eigenvalues higher than 1 to be taken into consideration. As it is shown in Table 4, the result consists of four factors which explain the 90,243 % of the total variance.

Table 4. Total variance explained (period 1990-1999)

Component	Initial Eigenvalues			Sum of Squared Loadings Rotation		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	20,434	53,773	53,773	16,308	42,915	42,915
2	6,915	18,198	71,972	7,430	19,553	62,468
3	4,489	11,814	83,785	7,135	18,777	81,245
4	2,454	6,457	90,243	3,419	8,998	90,243

Extraction method: principal component analysis. Varimax rotation.

Table 5 shows that the documents with a higher positive loading in the first factor (which explains a 42,915%, almost the half) correspond to three well-defined topics: Management and Strategic Management, Product and Process Innovation and Technology Management, and finally, Organizational Learning and Organizational Theory.

Table 5. Rotated component matrix, 1990-1999 (Rotated component matrix (a))

	Components			
	1	2	3	4
Lindblom (1959)	,962			
Hayes and Wheelwright (1984)	,958			
Leonardbarton (1988)	,958			
Gardiner and Rothwell (1985)	,957			
Rothwell and Gardiner (1989)	,956			
Hammer and Champy (1993)	,955			
Tushman and Anderson (1986)	,953			
Stata (1989)	,948			
Utterback and Abernathy (1975)	,941			
Burns and Stalker (1961)	,830			
Porter (1985)	,823			
Cooper and Kleinschmidt (1987)	-,765		,576	
Cooper (1984)	-,736		,626	
Rothwell et al. (1974)	-,728		,570	
Cooper (1979)	-,723		,619	
Maidique and Zirger (1984)	-,705		,544	
Cooper and Kleinschmidt (1986)	-,705			
Porter (1990)	,697			
Prahalad and Hamel (1990)		,971		
Voss (1992)		,971		
Wheelwright and Clark (1992)		,945		
Clark and Fujimoto (1991)		,868		
Voss (1988)	,541	,823		
Debrentani (1989)		,794		
March and Simon (1958)		-,652		
Freeman and Soete (1974)	-,529	,599		
Nelson and Winter (1982)				
Milling (1986b)			-,877	
Milling and Maier (1993)			-,877	
Bass (1969)			-,825	
Miles et al.(1978)	-,571		,673	
Zaltman, Duncan and Holbek (1973)	-,660		,663	
Peters and Waterman (1982)	-,534		,637	
Vandeven (1986)		,502	,628	
Simon (1976)				-,897
Cooper (1980)	-,586			-,685

	Components			
	1	2	3	4
Schumpeter (1934)		-,581		,657
Nonaka and Takeuchi (1986)	-,610			-,620

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a Rotation converged in 7 iterations.

Figure 2 shows the intellectual structure of IM for this period, and all the documents that belong to this first factor are located in the top left-hand area of the graph and a little in the center, colored in red.

In that very factor, but with a negative loading, appears only a work: Cooper and Kleinschmidt (1986). This document belongs to the topic of New Products Development and constitutes a detailed study of the New Products Management Process.

The second factor, which explains a 19,553 % of the total variance, and a 62,468% along with the first one, is composed by a series of references that clearly study four topics: Innovation in Service, Strategic Management and Project Management, New Product Development and Technology Implementation, and Economics.

Prahalad and Hamel (1990) is one of the documents which possess the highest factor loading of the component. These authors run a survey about the core competences of the corporations. With an equal loading appears Voss (1992), with a study about the importance of innovating in the field of services for the corporations which want to remain competitive. This author states that few companies evaluate the processes that lead to service innovation and the outcomes of those innovations. Based on an empirical study of firms in the United Kingdom, in this document Chris Voss articulates an approach and specific criteria that managers can use in this type of performance analysis.

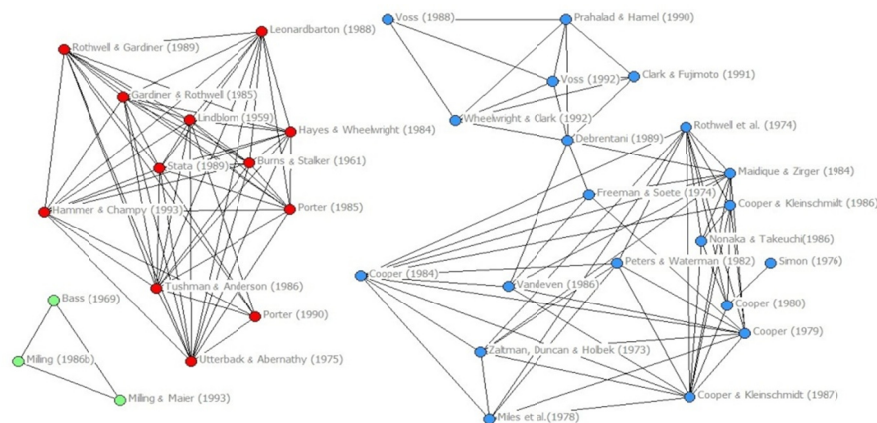


Figure 2. The intellectual structure of research in IM during the period of 1990-1999

The references corresponding to this factor, mainly those with a positive loading, can be observed in Figure 2, in the right-hand part of the graph, colored in blue.

The third factor explains an 18,777% of the total variance, and an 81, 245% along with the other two factors. The documents which appear within this component correspond to two fundamental lines of inquiry: Management and Strategic Management, Innovation Success and Product Development. Cooper (1984) and Cooper and Kleinschmidt (1987) are examples of these documents; one of them is about The Strategy-Performance Link in Product Innovation, and the other is about the success of the products, as well as the importance of enhancing the innovation abilities of the firm through the open innovation.

Most of these documents can be seen on the graph represented in Figure 2, in the right-hand part of it, colored in blue. That location can be explained due to the fact that all of them have significant loadings in the first and the second factor, as well.

Within this very factor, but with negative loadings, are found Bass (1969), where a growth model for the timing

of initial purchase of new products is developed and tested empirically against data for eleven consumer durables; Milling (1986b), whose author states that the control of new product growth and market penetration is a key task for corporate management; and Milling and Maier (1993), about the influence of price strategies on the diffusion of innovation and R+D performance. These references, clearly related to Product Development and Marketing, are located in the bottom left-hand area of the graph in Figure 2, colored in green.

The fourth factor, which explains an 8,998% of the total variance, is constituted by the following works: Schumpeter (1934) with a positive loading, which belongs to the economic field, and Simon (1976), which belongs to the same field, but in this case with a negative loading.

4.4 The Intellectual Structure of IM Research: 2000-2008

The correlation matrix which resulted from the co-citation profiles of the 69 documents cited by the 152 articles for this period was used to perform an extraction of the main components. These components needed a varimax rotation, and eigenvalues higher than 1 to be taken into consideration. As it is shown in Table 6, the result consists of seven factors which explain the 87,900 % of the total variance.

Table 6. Total variance explained (period 2000-2008)

Component	Initial Eigenvalues			Sum of Squared Loadings Rotation		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	30,907	44,793	44,793	26,648	38,620	38,620
2	10,588	15,344	60,137	7,941	11,509	50,129
3	7,006	10,154	70,291	7,700	11,160	61,289
4	5,400	7,826	78,117	6,189	8,970	70,259
5	3,906	5,660	83,778	5,050	7,318	77,577
6	1,728	2,505	86,283	3,873	5,613	83,190
7	1,176	1,705	87,987	3,310	4,797	87,987

Extraction method: principal component analysis. Varimax rotation.

As it is shown in Table 7, the first factor which explains more than 38 % of the total variance is composed by a series of works with positive loadings such as Dosi (1982), Teece (1986), Von Hippel (2005), Utterback (1994) and Schumpeter (1934); the first four are about Technologies, Innovation Process and Product Development, and the last one, about Economics. These documents have been explained previously.

Christensen and Raynor (2003) stands out within the topic of Competitiveness and Technology Management in the industry. In his international bestseller "*The Innovator's Dilemma*", the authors expose the paradox behind the failure of many industry leaders: by placing too much focus on pleasing their most profitable customers, these firms actually paved the way for their own demise by ignoring the disruptive technologies that aggressively evolved to displace them.

Table 7. Rotated component matrix, 2000-2008 (rotated component matrix (a))

	Components						
	1	2	3	4	5	6	7
Dosi (1982)	,969						
Teece (1986)	,959						
Utterback (1994)	,956						
Von Hippel (2005)	,953						
Schumpeter (1934)	,947						
Christensen and Raynor (2003)	,933						
March (1991)	,924						
Henderson and Clark (1990)	,915						
Tushman and Anderson (1986)	,912						
Christensen (1997)	,910						
Cohen and Levinthal (1990)	,885						
Nelson and Winter (1982)	,872						

	Components						
	1	2	3	4	5	6	7
Porter (1980)	,861						
Abernathy and Utterback (1978)	,860						
Song (1997)	-,817						
Cooper and Kleinschmidt (1987)	-,812						
Ottum and Moore (1997)	-,803						
Griffin (1997)	-,797						
Montoyaweiss and Calantone (1994)	-,781						
Griffin and Page (1996)	-,780						
Cooper (1998)	-,775						
Damanpour (1991)	,765						
Freeman (1997)	,760						
Cooper (1996)	-,760						
Dougherty (1992)	-,740						
Cooper (1994)	-,734						
Cooper (1990)	-,723						
Rothwell et al. (1974)	-,712						
Moenaert and Souder (1990)	-,690						
Linton and Thongpapanl (2004)	-,657						
Cooper, Edgett and Kleinschmidt (1999)	-,644						
Teece, Pisano and Shuen (1997)	,640				,611		
Nelson and Winter (1977)	,639						
Takeuchi and Nonaka (1995)	-,626						
Eisenhardt and Martin(2000)	,597			,543			
Von Hippel (1988)	,583		-,531				
Brown and Eisenhardt (1995)							
Rothwell (1992)		,889					
Lundvall (1992)		,885					
Powell, Koput and Smith-Doerr (1996)		,826					
Porter (1990)		,791					
Pavitt (1984)		,787					
Burns and Stalker (1961)		,739					
Tidd and Trehwella (1997)	,599	,607					
Ettlie, Bridges and O'Keefe (1984)			,894				
Nonaka (1991)			,828				
Clark and Fujimoto (1991)			,817				
Kanter (1988)			,703				
Wheelwright and Clark (1992)			,682				
Urban and Hauser (1993)			-,573				
Wind and Mahajan (1997)			-,568				
Eisenhardt and Tabrizi (1995)							
Yin (1994)				,867			
Eisenhardt (1989)				,818			
Von Hippel (1986)				,758			
Leonardbarton (1992)				,664			
Roussel, Saad and Erickson (1991)				,633			
Kogut and Zander (1992)					,822		
Nonaka (1994)					,813		
Prahalad and Hamel (1990)					,790		
Mintzberg (1979)	-,527				,644		
Cooper and Kleinschmidt (1993)					-,595		,520
Chandler (1962)					,569		

	Components						
	1	2	3	4	5	6	7
Chiesa (1996)						,609	
Rothwell (1994)						-,558	
Tidd (2001)						-,555	
Senge (1990)							,718
Atuahenagima (1995)			-,585				-,646
Kohli and Jaworski (1990)							-,610

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a Rotation converged in 12 iterations.

Within this factor there are some important documents with a positive loading which are worth mentioning: March (1991), from the ambit of Organizational Learning; Henderson and Clark (1990), with Innovation as the main topic; Tushman and Anderson (1986), clearly about Technologies; and Christensen (1997), whose author tries to determine the reason for which the new technologies provoke the death of large companies. These references have already been explained previously, and can be consulted visually in the right-hand area of the graph, colored in blue (Figure 3).

Moenaert and Souder (1990) is a document which stands out in this factor, but with a negative loading. It's about the Innovation Process. In this article, they report the findings of an exploratory research conducted in Belgium and present a model to describe essential elements of this process. They argue that the value of extra functional information is determined by channel, message, source and receiver attributes.

Finally, within the topic of Product Development that seems to be the one which predominates in the factor, must be mentioned Dougherty (1992), and Cooper with a series of documents: Cooper (1990, 1994, 1996 y 1998).

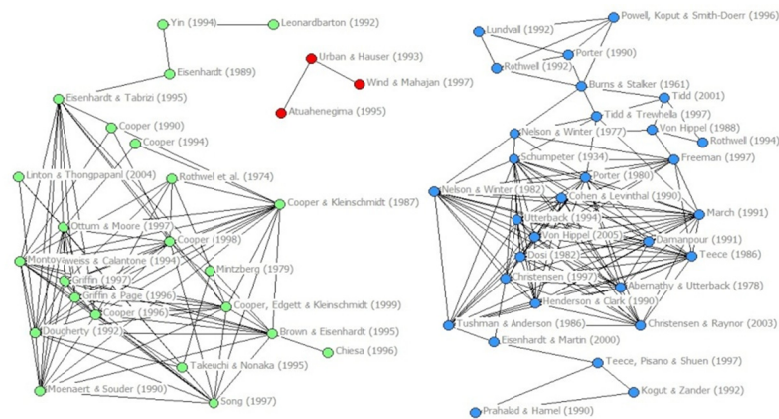


Figure 3. Intellectual structure of research in IM during the period of 2000-2008

These last documents with a negative loading can be seen on the graph of the intellectual structure (Figure 3) in the left-hand area, colored in green.

The second factor explains an 11,509 %, and a 50,129 % along with the first one. This factor is a little hard to characterize, because although it's composed by very close topics, each one of them constitutes specific themes. Thus, Rothwell (1992) that was already explained, deals with the topic of IM Models; Lundvall (1992), focuses the interest on Innovation Systems; Koput and Smith-Doerr (1996), is about Organizational Learning; and other works which have been explained previously, such as Pavitt (1984), about Technological Change; Porter (1990), corresponding to the economic topic, and Burns and Stalker (1961), about Organizational Theory. The elements of this factor can be seen on the graph of Figure 3 in the top right-hand part, colored in blue.

The third factor explains the 11,160% of the total variance, and the 61,289 %, along with the other two. Ettlie, Bridges y O'Keefe (1984) is the first to stand out, within those having a positive loading. The purpose of this study was to test a model of the organizational innovation process that suggests that the strategy-structure causal

sequence is differentiated by radical versus incremental innovation. All seems to indicate that this document can be classified within the group of those that studies the topic of Strategic Management and its relation with IM.

Another important work is Nonaka (1991), with the notion of “tacit knowledge” and the contribution of a new vision for firms, about the different kinds of knowledge.

Kanter (1988) is about the factors that stimulate innovation. This author defends the idea that innovation happens in the micro level, and depends on the abilities of individuals and ideas. Nevertheless, for this innovation goes further, it needs the support of the macro level, in many ways.

Within this same factor, but with negative loadings, there are some documents related in general to the topic of Product Development and Marketing: Urban and Hauser (1993), and Wind and Mahajan (1997). There are located in the top central part of the graph (Figure 3), colored in red.

The fourth factor explains an 8,970 % of the total variance, and a 70,259 % along with the other three. It seems to be a factor consecrated to the study of Strategic Management and Product Development. Examples of this are the works of Yin (1994), Eisenhardt (1989), Von Hippel (1986), and Leonardbarton (1992), which were already explained.

Some of the elements of this fourth factor can be visualized on the graph (Figure 3), in the top left-hand area, colored in green.

The fifth factor explains a 7,318 % of the total variance, and it seems very easy to characterize, considering that in this case the topics are homogeneous. On one side, appear Kogut and Zander (1992), and Nonaka (1994), which were explained previously and belong to the Knowledge Management field. On the other side, it's found Prahalad and Hamel (1990), that was already explained and corresponding to the topic of Strategic Management; Mintzberg (1979), whose author performs a research on the process of strategy formation, deliberate strategies, and emergent ones; and Chandler (1972), which studies the changing strategy and the structure of large industrial firms in USA.

Some of the references of this factor are shown on the graph (Figure 3). Prahalad and Hamel (1990) is one of them, located in the bottom right-hand part, just on a vertex of the triangle, colored in blue; and Mintzberg (1979), located in the center and in the left-hand part of the graph, colored in green. Surely, this last location is like that because the said document has a considerable negative loading in the first factor.

The sixth factor explains a 5,613%, and has just three works. Chiesa (1996) is one of them, about internationalization of R+D and with a positive loading. This document is on the graph (Figure 3) in the bottom left-hand part, colored in green. Rothwell (1994) is another example, but with a negative loading, and is about the periods of the innovation process, generations, and introduces topic of the fifth-generation Innovation Process. This document is also on the graph, in the top right-hand part, colored in blue.

The seventh factor explains a 4,797% of the total variance and is composed by some documents: firstly with positive loadings, Senge (1990), and in second place, Cooper and Kleinschmidt (1993) corresponding to three documents about Product Development. With a negative loading stands out Kohli y Jaworski (1990), in which the authors synthesize extant knowledge on the Marketing concept and provide a foundation for future research by clarifying the construct's domain. This document can be seen in Figure 3, in the top central part of the graph, colored in red.

4.5 The Intellectual Structure of IM Research: 2009-2012

The correlation matrix which resulted from the co-citation profiles of the 91 documents cited by the 179 articles for this period was used to perform an extraction of the main components. These components needed a varimax rotation, and eigenvalues higher than 1 to be taken into consideration. As it is shown in Table 8, the result consists of ten factors which explain the 91,180 % of the total variance.

Table 8. Total variance explained (period 2009-2012)

Component	Initial Eigenvalues			Sum of Squared Loadings Rotation		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	32,043	35,212	35,212	24,238	26,636	26,636
2	19,607	21,546	56,758	16,233	17,838	44,474
3	9,381	10,308	67,066	15,905	17,478	61,952
4	6,744	7,411	74,477	8,594	9,444	71,396
5	5,827	6,403	80,880	6,865	7,544	78,940
6	3,635	3,994	84,874	3,801	4,176	83,117
7	1,957	2,151	87,025	2,191	2,407	85,524
8	1,409	1,548	88,573	1,890	2,077	87,601
9	1,366	1,501	90,074	1,653	1,816	89,417
10	1,006	1,105	91,180	1,604	1,762	91,180

Extraction method: principal component analysis. Varimax rotation.

Figure 4 complements the results of the factor analysis. As it was stated in the section of methodology, the graph of each matrix with a correlation coefficient superior to 0,7 would be represented in the present work. But in this case, this coefficient is 0,85, because if not, the graph would be too much compact, and particularities would be difficult to visualize.

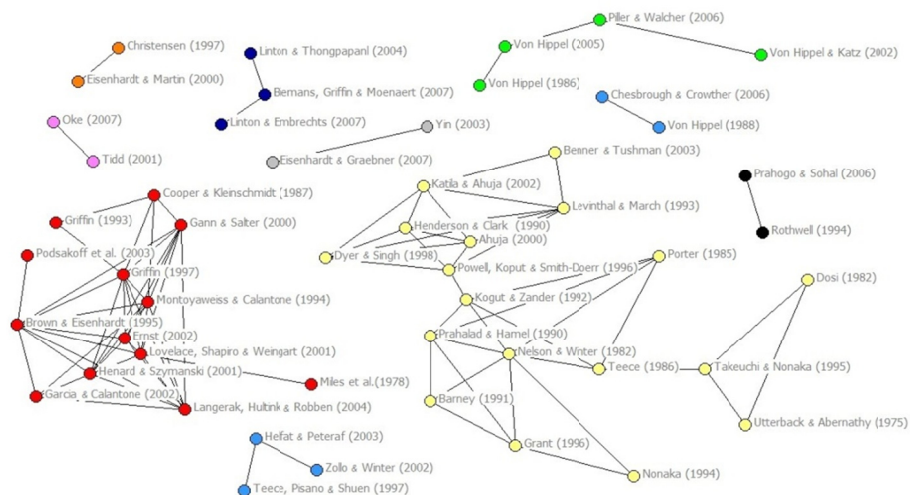


Figure 4. Intellectual structure of research in IM during the period of 2009-2012

The first factor explains the 26,636% of the total variance. Table 9 shows that it's made up by a series of works about Strategic Management, Organizational Learning, and several topics related to Innovation. Katila and Ahuja (2002), stands out in the first place, with a positive loading, and treats the topic of how the firms solve certain problems to create new products.

Table 9. Rotated component matrix, 2009-2012 (rotated component matrix (a))

	Components									
	1	2	3	4	5	6	7	8	9	10
Katila and Ahuja (2002)	,930									
Henderson and Cockburn (1994)	,929									
Levinthal and March (1993)	,919									
Dyer and Singh (1998)	,912									
Henderson and Clark (1990)	,902									
Ahuja (2000)	,899									
Powell, Koput and Smith-Doerr (1996)	,898									
March (1991)	,861									
Williamson (1985)	,860									
Barney (1991)	,853									
Kogut and Zander (1992)	,848									
Benner and Tushman (2003)	,825									
Zollo and Winter (2002)	,800									
Nelson and Winter (1982)	,791									
Prahalad and Hamel (1990)	,783									
Grant (1996)	,778									
Cooper, Edgett and Kleinschmidt (1999)	-,758									
Cohen and Levinthal (1989)	,755							,523		
Porter (1985)	,749									
Teece (1986)	,734									
Hagedoorn (2002)	,730									
Leonardbarton (1992)	,728									
Cohen and Levinthal (1990)	,723									
Hamel and Prahalad (1994)	,673									
Teece, Pisano and Shuen (1997)	,663									
Rogers (2003)	-,634									
Nonaka (1994)	,626					,625				
Helfat and Peteraf (2003)	,612									
Aiken and West (1991)	,592							,519		
Griffin (1993)	-,582		,553							
Porter (1990)	,566									
Arrow (1962)	,546									
Dosi (1982)										
Eisenhardt and Graebner (2007)		,918								
Yin (2003)		,889								
Rothwell (1994)		,834								
Tushman and Anderson (1986)		,829								
Chesbrough (2003)		,818								
Yin (1994)		,806								
Von Hippel (2005)		,806								
Eisenhardt (1989)		,801								
Von Hippel (1986)		,795								
Piller and Walcher (2006)		,783								
Chesbrough (2007)		,735								
Katz and Allen (1982)		,726								
Chesbrough and Crowther (2006)		,709								
Prahogo and Sohal (2006)		,699								
Von Hippel (1988)		,639	-,513							
Etzkowitz et al. (2000)		,638								
Schumpeter (1934)	,570	,633								
Abernathy and Utterback (1978)		,605								,530
Cooper (1994)		,549								
Fornell and Larcker (1981)		-,538								

	Components									
	1	2	3	4	5	6	7	8	9	10
Von Hippel and Katz (2002)		,522								
Ernst (2002)			,896							
Brown and Eisenhardt (1995)			,886							
Langerak, Hultink and Robben (2004)			,868							
Montoyaweiss and Calantone (1994)			,855							
Lovelace, Shapiro and Weingart (2001)			,854							
Henard and Szymanski (2001)			,852							
Miles et al.(1978)			,850							
Garcia and Calantone (2002)			,820							
Griffin (1997)			,816							
Gann and Salter (2000)			,807							
Dougherty (1992)			,804							
Christensen (1997)			,722							
Eisenhardt and Martin (2000)			,691							
Podsakoff et al. (2003)		-,555	,680							
Wheelwright and Clark (1992)			,627		-,537					
Cooper and Kleinschmidt (1987)	-,592		,603							
Hidalgo and Albors (2008)			-,582						,506	
Oke (2007)				,827						
Amabile et al. (1996)				,822						
Tidd (2001)				,804						
Woodman, Sawyer and Griffin (1993)				,800						
Damanpour (1991)			,517	,733						
Wernerfelt (1984)	,556			,675						
Hurley and Hult (1998)				,649						
Chandy and Tellis (1998)			,543	,586						
Adams, Bessant and Phelps (2006)				,531						
Zahra and George (2002)				,513						
Linton and Embrechts (2007)					,918					
Biemans, Griffin and Moenaert (2007)					,916					
Linton and Thongpapanl (2004)					,897					
Takeuchi and Nonaka (1995)	,553				,627					
Utterback and Abernathy (1975)					,542					
Armstrong and Overton (1977)						,765				
Oecd (2005)						,717				
Dosi (1988)						,711				
Rogers (1995)				,507			,521			
Tidd, Bessant and Pavitt (2005)								,784		

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a Rotation converged in 11 iterations.

Within the ambit of the Strategic Management there are some documents: Henderson and Cockburn (1994) in which the authors study the theme of heterogeneous organizational 'competence' in competition, in the context of pharmaceutical research; Dyer and Singh (1998), which suggests that a firm's critical resources may span firm's boundaries and may be embedded in interfirm resources and routines; Barney (1991), about the firm's resources and sustained competitive advantage; and Williamson (1985), also related to the economic field.

Within the topic of Organizational Learning stand out some works: Levinthal and March (1993), that examines the ways in which organizations approach the problems of the learning process through simplification and specialization; Powell, Koput and Smith-Doerr (1996), whose authors argue that when the knowledge base of an industry is both complex and expanding and the sources of expertise are widely dispersed, the locus of innovation will be found in networks of learning, rather than in individual firms; March (1991), explained previously; and Zollo and Winter (2002), which performs a research on the mechanisms through which

organizations develop dynamic capabilities, defined as routinized activities directed to the development and adaptation of operating routines.

On the other hand, within the topic of Innovation, mainly about mergers, Knowledge Management and Innovation Process Management, stands out Henderson and Clark (1990); Ahuja (2000), with the elaboration of a theoretical frame about interfirm networks in Innovation; Kogut and Zander (1992), which was already explained; and Benner and Tushman (2003), where a contingency view of process management's influence on both technological innovation and organizational adaptation is developed.

These elements can be visualized on the graph corresponding to Figure 4 in the central part, colored in yellow, except for Zollo and Winter (2002) which is in the bottom part, colored in blue, together with Teece, Pisano and Shuen (1997), and Helfat and Peteraf (2003), these documents belong to this very factor, but with lower loadings.

There are three important works in the same factor, but with a negative loading. One of them belongs to the topic of Product Development and Marketing, another to Diffusion of Innovation, and the third to Management.

The second factor explains the 17,838% of the total variance, and a 44,474% along with the first one. The first document to be commented is Eisenhardt and Graebner (2007), about the opportunities and challenges to building theory from case studies, then there are a group of works that have been explained previously: Yin (2003) about the method of case study; Rothwell (1994), about the Innovation Process; Tushman and Anderson (1986), about Technology; Chesbrough (2003), Chesbrough and Crowther (2006), and Yin (1994), about Open Innovation, IM Models, and Case Study; Von Hippel (1986 and 2005), the first about Product Development and the second about Innovation Process; and Eisenhardt (1989), clearly from the ambit of Management.

There are other documents within this factor which also stand out and haven't been explained before: Piller and Walcher (2006) which treats the topic of generating competitive ideas through certain tools as a novel method to integrate the users with the development of the new products; Chesbrough (2007), and Prahalad and Sohal (2006). Some of the mentioned references can be seen in Figure 4, in the top part of the graph, colored in grey, green, blue, and black.

The third factor explains the 17,478 % of the total variance, and a 61,952 % along with the rest of factors. It's a component very easy to characterize because most of the documents that compose it can be classified as studies related to the topic of Product Development: with positive loadings stand out Ernst (2002), with an empirical review of success factors of new product development; Brown and Eisenhardt (1995), that was already explained; Langerak, Hultink, and Robben (2004), which represents two documents, one of them published in the *R&D Management Journal*, about the role of pre-development activities related to the orientation and performance of the market; and the other published in the *Journal of Product IM*, about the importance of the activities of New Products Development for the companies with a market orientation, both documents belong to the same research; Montoyaweiss Calantone (1994), explained previously; Lovelace, Shapiro and Weingart (2001), about cross-functional new product teams' innovativeness and constraint adherence; Henard and Szymanski (2001), with the conduction of a meta-analysis of the new product performance literature; Griffin (1997), and Dougherty (1992), both of them were explained before.

In this very factor, but with a negative loading, appears the work of Hidalgo y Albors (2008). The objective of these Spanish researchers is to conduct a detailed review of the scope, trends, and most important actors (organizations, companies, government, consultants, academy, etc.) in the development and use of methods to manage innovation in a knowledge-driven economy. In this research they identify the main IM techniques which better improve competitiveness through Knowledge Management. This research study, is based on a survey at the European level, and concludes that a knowledge-driven economy affects the innovation process and its approach. This reference can be classified as one of those which deal with the topic of Knowledge Management and Innovation.

The fourth factor, which explains the 9,444% of the total variance, is composed by works related to the topic of Innovation, and Innovation Process. Oke (2007) performs a research on the different types of innovation that are predominant in companies in the United Kingdom services sector, the degree of innovativeness, the practices associated with the pursuit of innovation and their relationship with company performance; Damanpour (1991), that was explained previously; and Adams, Bessant and Phelps (2006), where a frame to evaluate the innovation activity is proposed, with the convincement that IM can be measured.

Within the ambit of Strategic Management and Management, are found Tidd (2001) and Wernerfelt (1984). The latter explores the usefulness of analyzing firms from the resource side rather than the product side (Barney,

1991).

Related to the field of Organizational Learning, Hurley and Hult (1998) present a conceptual framework for incorporating constructs that pertain to innovation in market orientation research. And about structure of firms, Chandy and Tellis (1998), provide an alternate view to the one which defends that firm size is the key organizational predictor of radical product innovation. Only two documents of this factor can be seen on the graph (Figure 4), in the top left-hand part, colored in rose.

The fifth factor explains an 8,514% of the total variance, and is composed by five documents. Linton and Embrechts (2007), a document which updates the standing of the Technology IM journals as a specific domain (Linton, 2006). Biemans, Griffin and Moenaert (2007), with the performance of a bibliometric analysis using all references in articles published in JPIM during its 20 years of existence. Linton and Thongpapanl (2004) with a bibliometric study, which was explained previously. If a document which uses network analysis, and two other more, that use bibliometric techniques, appear here as important documents, it's proper to suggest that the utilization of this kind of tools has increased lately within the study of IM.

Then stand out Takeuchi and Nonaka (1995) with a work which corresponds to the field of Knowledge Management, and Utterback and Abernathy (1975), with a research about Innovation of Product and Process.

Nonaka (1994) is a document that must be mentioned in this context too; a paradigm to administrate dynamical aspects of the processes of creation of organizational knowledge is proposed in it. Despite of the reality that this work corresponds to the first factor, since its higher loading is located there (0,626), the loading it has in the factor five (0,625), according to the opinion of the author, is as important as the first one.

Figure 4 shows that some elements of this factor are located in the central left-hand part of the graph, colored in a dark blue, almost black: (Linton and Embrechts (2007); Biemans, Griffin and Moenaert (2007); Linton and Thongpapanl (2004)). There are others which are in the bottom right-hand part of the graph, colored in yellow (Takeuchi and Nonaka (1995); Utterback and Abernathy (1975)), it's an area where Nonaka (1994) and several other documents that correspond to the first factor, are also located.

The sixth factor explains the 4,176%. It might be considered a component related to innovation measurement, and with the economic field. Only Dosi (1988) can be visualized on the graph (Figure 4) in the bottom right-hand part of it, colored in yellow.

The seventh factor explains a 2,407% and is constituted only by one document: Rogers (1995) which has the Theory of Diffusion of Innovation as the main topic.

There are other works that correspond to a different factor, but also have a considerable loading in the seventh factor, although not higher than 0,5: Utterback and Abernathy (1975), about Innovation of Product and Process; Cooper (1994), about New Product Development, and Woodman, Sawyer and Griffin (1993), about Creativity.

The eighth factor explains the 2,077% of the total variance. Similar to the last one, is made up only by a document: Tidd, Bessant and Pavitt (2005), with which the authors develop a theoretical frame to better understand Creativity within a complex social scenario.

There are other works that correspond to a different factor, but also have a considerable loading in this seventh factor, although not higher than 0,5: Cooper, Edgett and Kleinschmidt (1999), which corresponds to the ambit of Management; Porter (1985), from the ambit of Strategic Management, and Von Hippel and Katz (2002), about Product Development.

The ninth factor explains the 1,816% of the total variance and only has the contribution of Hidalgo and Albors (2008), which has already been explained in the third factor, and is about Knowledge Management and Innovation.

Just as it happened with the other two components, there are other works that correspond to a different factor, but also have a considerable loading in the ninth factor, although not higher than 0,5: Adams, Bessant and Phelps (2006), about the Innovation Process; Hamel and Prahalad (1994), related to Strategic Management; and Cohen and Levinthal (1989), about Organizational Learning and I+D Management.

The tenth and last factor explains the 1,762%, and is also represented by only a document, which even correspond to a different factor. It's Abernathy and Utterback (1978), about the Industrial Innovation Patterns. The authors of this work propose a new model that answers some issues related to the way in which Innovation changes in a company, while this company grows up and matures.

There are other works that correspond to a different factor, but also have a considerable loading in the tenth factor, although not higher than 0,5: Chandy and Tellis (1998), about Entrepreneurial Structure; Tushman and

Anderson (1986), about Technology and Technological Change; and Benner and Tushman (2003), about Process Management and Innovation.

5. Conclusions

The theme of IM, and its constitution as a discipline or field of study, has been studied in several occasions, trying to establish its origins and, in general, its development. (Alba et al., 2006; Nieto Antolin, 2003; Prahogo & Sohal, 2004b; Xu et al., 2002; Xu et al., 2007; Yang et al., 2003). Usually, when something like this happens with a discipline, a series of researches begin to appear with a quantitative approach, that seek to analyze the literature generated by the academics, with the intention to assess the state of the issue, identify the achieved progress, and propose research agendas for the future (see, for example, Busenitz et al., 2003; Fernandez-Alles and Ramos-Rodríguez, 2009; Shane, 2000; Landström, 2001; Shafique, 2013). Researches like these exist within the ambit of IM too, and have been already mentioned in the present paper. Starting from the limitations of the said researches, is that it's been possible to carry out the present one and finally arrive at the following conclusions, during the last 22 years the intellectual structure of the research in IM has had in general, some axes of convergence: (1) The study of how to manage innovation from the Strategic Management and Business Administration ambit; (2) New Products Development; (3) The importance of Organizational Learning and Knowledge Management for IM; and, (4) The importance of the technological change, technology supplying, innovation process and innovation model.

The dynamic analysis of all this, shows that in the 90's there was a predominance of the axis 1 and 2. Subsequently, the predominance changed during the first decade of the XXI century, because the axis 2 remained dominating, but axis 4 began to appear strongly. Finally, it's evident the strengthening of the authority of axis 4 in the intellectual structure of the research of IM during the last period of study.

In order to deepen the results of the present paper, in future research the author pretends to widen the citation sample including more datasets, extend the temporal horizon of analysis, use more terms related to IM to do the search on the Internet, increase the number of documents used to identify the intellectual base (through a reduction of the citation threshold), and improve the general interpretation by making a good use of the explanatory power of the typical methods of Social Network Analysis, for calculations of reachability, closeness, betweenness, centrality, and the identification of sub-groups, such as cliques, N-cliques, and the calculation of Lambda Set.

Finally, corresponds to recognize the usefulness of this kind of studies to assess the state of the art in an objective way, as a complement, but never a substitute of the traditional methods of literature review. In fact, they constitute a good tool for identifying relevant authors, works and journals for the researchers of a certain discipline, as well as for showing the relations thereof. Therefore, these studies might be useful as a guide for researchers, so that they can be able to identify the relevant literature within a certain subject, building up its intellectual map permitting in this way to have an objective vision of the field through the behavior of its own authors.

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Note

Note 1. We used BIBEXCEL software, designed by Professor Olle Persson of the Institute of Information Sciences at the University of Umeå (Sweden).

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