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# Successful Areas of Scientific Research Outputs at the Beginning of the XXI Century: Open Innovation

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**Abstract.** This paper covers current topics as well as matters of significant future prospect in regards to innovation within business management. An analysis of the scientific output over the last decade has been carried out by examining 9,368 papers published between 2001 and 2010 which have been gathered in the ISI database. By means of analysing key words in each paper, frequency of occurrence and year of publication, the importance of key words, intensity of use and future outreach can be defined. Appropriate handing of the knowledge obtained will allow researchers to identify research systems and will highlight future lines of research.

**Key words:** key words, innovation, scientific production, open innovation, text data mining, knowledge management

## 1. Introduction

Since the early XX century, innovation has inspired numerous works, mainly after Schumpeter introduced the concept of business-based innovation as an essential element of economic analysis. The concept of innovation has evolved over time. Several definitions of innovation have been presented over the past century and early on in the current century, where the common nexus of the concept lies on "the introduction of something new". Originally, the concept of innovation only applied to new products (or services) and new processes. In this century, the concept of innovation widens and further embraces the introduction of both new marketing and organisational methods ([1],[2]).

Innovation has been widely discussed in the scientific literature over the years, through the analysis or development of several types of innovation such as product innovation, finance innovation, induced innovation, etc., hence the works dealing with the different types of innovation are already abundant in the literature ([3],[4],[5],[6],[7],[8],[9],[10]). In our study, innovation is examined from a different point of view, considering innovation related with a series of multiple concepts through a multidimensional intellectual approach. By doing this, we want to propose a novel viewpoint about how innovation is studied within the scientific community and what kind of topics relate to innovation.

## 2. Innovation construct

A common practice in scientific paper publication is the association of a series of key words to each paper. Each of these key words provides thematic or technical information that allows identification of the nature of the paper, understand the general content of the article, carry out specific searches within the database, classify papers, etc. [11]. Analysing key words allows concepts, methodologies and other aspects to be determined. Key words can be grouped in order to identify homogeneous characteristics. Thus, the innovation construct is defined by the composite of dimensions obtained.

The analysis of the scientific output is performed by using the text/data mining technique on papers held in the "Web of Science" database. The "Web of Science" database (within the ISI "Web of Knowledge" platform) has bibliographic references of approximately 11,000 international publications and it is supported by authors such as Dant and Brown [12], He et al [13], Chang et al [14], or Pillania [15].

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The period of reference is between 2001 and 2010. The search criteria presented in table 2 was applied when choosing the articles.

Table 2. Search criteria of samples

1. Publications whose "Topic" is INNOVATION
2. Publications on the following fields of study: Management, Business, Economics, Operations Research & Management Science
3. Publications that are papers
4. Papers published between 2001 and 2010
5. Papers written in English

We have therefore selected those papers containing the word "innovation" in their title, their "*key words"* or "*abstract"*, furthermore the database has been filtered to exclude a priori publications which are not related with business management or that are not papers. Those papers in the English language have also been selected given that, within the scientific community, these publications gain higher qualifications according to ISI. The result of the initial choice and the consequent revision of the magazines are shown in table 1.

Table 1. Search results

| | |
|---|---|
| Initial paper choice | 9437 |
| Initial magazine choice | 507 |
| Papers not selected | 70 |
| Magazines not selected | 11 |
| Valid papers | 9368 |
| Valid magazines | 496 |

The large amount of papers and publications obtained permits a transverse analysis of the scientific output including diversity of authors, sources of the work, schools, etc to be carried out. Avoiding bias choices of samples will lead to valid and credible results.

The number of papers in the sample has been reduced 29% due to the absence of "*key words"* in 2,718 papers. Following this refinement, the sample holds a remaining 6,650 valid papers, characterised by 31,342 *"key words"*, 13,433 of which are different. It can be observed within the sample that each year more papers include "*key words"*, to such an extent that in 2001, 40% of the papers were excluded from the sample, whilst in 2010 only 21% were excluded for the lack of their defining "*key words"*.

Some of the *"key words"* are used in a number of papers equal or less than 14, which only represents 1‰ of the total sample, meaning that it is a *"key word"* used by authors only in very particular occasions. These "*key words"* are useful to identify specific works rather than to identify large scope thematic areas, hence they are excluded from the analysis. Additionally, it was also considered that the words innovation or innovations, which appeared in 1,497 occasions, shall be excluded from the group of *"key words"*, as they were the dependent variable of the study. Therefore, the final count of *"key words"* included in the text categorisation is 4,857 grouped in 303 topics.

Dimensions consist in three different kinds of *"key words"*. *"Pure key words"* are those *"key words"* within the paper and there are no others similar *"key words"* with the same meaning (for instance: "absorptive capacity", "agglomeration"). *"Concept key words"* are several *"key words"* grouped because of their same meaning (for instance: "start-ups/start-up/startups"). *"Other key words"* are those clusters of *"key words"* containing at least one pure *"key word"* or a concept *"key word"* (for instance: "agglomeration others" include: Agglomeration economies, agglomeration and dispersed equilibria, agglomeration economics, agglomeration externalities, etc.)

93% of the sample of papers is properly characterised using between 2 and 7 of the selected "*key words"*. Consequently, a total of 6,156 papers form the body of the innovation construct defined by the 303 dimensions.

## 3. Methodology

The structure of the innovation construct is analysed by measuring the relative and current importance of each dimension.

The relative importance of the dimension (IRj) is defined as,

$$IR_{jt} = \frac{\sum_{i=A}^{N} a_{ij}}{\left(\sum_{i=A}^{N} a_i\right) \Big/ D},$$

where $a_{ij}$ are the papers published in year i containing, at least, one keyword of the j dimension; D is the total number of dimensions of the innovation construct; A is the first year of each five year period and N is the last year of each five-year period; t equals 1 for the first five-year period (2001-2005), and equals 2 for the second one (2006-2010).

The contribution of each dimension to the innovation constructor is characterised by $IRj_2$ given that the number of papers published over the last decade has rapidly increased.

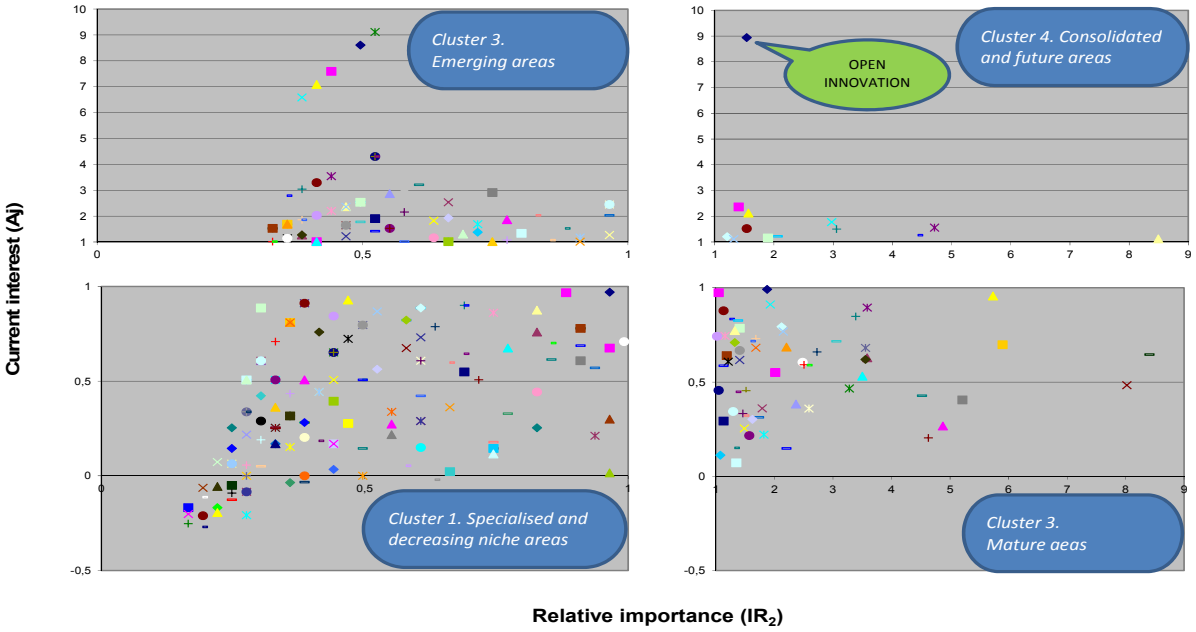
The current interest of the dimension (Aj) is defined as,

$$A_j = \frac{\left(\frac{IR_{j2} - IR_{j1}}{IR_{j1}}\right)}{\left(\sum_{j=1}^{D} \frac{IR_{j2} - IR_{j1}}{IR_{j1}}\right) \Big/ D}$$

A dimension j would be more current (Aj) when its relative growth is larger.

## 4. Results and conclusions

The relation between relative importance ($IRj_2$) and current interest (Aj) allows text clustering to be carried out which classifies dimensions in four clusters (graph 1). Variables are divided depending on their average values in order to be able to compare them. Different scales are used in each cluster because the dispersion of the values is large and heterogeneous.

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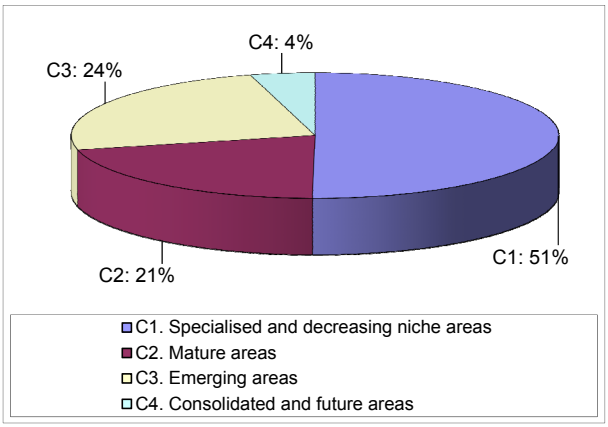
Graph 1. Structure of the innovation constructor

*Cluster 1. Specialised and decreasing niche areas.* Current interest (Aj) and relative importance ($IRj_2$) are below average. These are areas of research that have been extensively explored in the scientific literature in previous decades and thus are not so appealing to researchers or they are dimensions related to specialised papers with moderate outcome.

Within this cluster there are 152 dimensions, 50% of the dimensions analysed. 19 dimensions have a negative relevance, which means that they are out of use within the innovation construct (for instance: "transaction costs", "productivity growth" or "evolution"). Other dimensions such as "incentives", "universities/university", "organizational performance", have a relative importance ($IRj_2$) and a current interest (Aj) around 0,5. Although they appear in more articles than in the first five-year period, they are less appealing for researchers than dimensions from other clusters.

*Cluster 2. Mature areas.* Their current interest (Aj) does not reach the average although their relative importance ($IRj_2$) is larger than average. They are primary areas that continue in scientific works over the decade. This cluster is formed by 64 dimensions (21% of the total dimensions). Half of the dimensions on this cluster are *other "key words"*, such as "R&D others", "capabilities others" or "investment others". This reinforces the fact that the dimensions that form this cluster are generic *"key words"* in the research regarding innovation. Furthermore, the dimensions "technology others" and "management others" stand out due to their high relative importance.

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Graph 2. Weighting of each area in the innovation construct

*Cluster 3. Emerging areas.* They have a current interest (Aj) above average, albeit its relative importance ($IRj_2$) is below average. They are "emerging" because they have been more widely utilised by researchers over the second five-year period but still do not have a relevant output, they are not yet consolidated. There are 74 dimensions in this cluster (24% of the 303 dimensions), among which "service industries", "disruptive innovation", "transformational leadership", "R&D investment/R&D investments" and "exploitation" stand out due to their high relevance. Their relative growth has been between 6 and 9 times higher than the average of the areas within the innovation construct.

*Cluster 4. Consolidated and future areas.* They have a current interest (Aj) and a relative importance ($IRj_2$) above average. They have had strong relevance in the scientific literature concerning innovation and also points to continue to do so in the future. It is the cluster with fewer dimensions: 13 (5% of the total selected dimensions). "Innovation policy", "social networks/social network" and "open innovation" are those with major current interest.

"Open innovation" is the dimension where a greater importance in the future is foreseen, given that it is current (its current interest is nine times the average value) and moreover its relative importance places it beyond the introductory stages of a new area. The number of papers about "Open Innovation" is 1.5 times higher than the average.

Open innovation is a paradigm introduced by Henry Chesbrough in 2003, thus it is a new-born area which makes its relative importance even more relevant. Open innovation *"is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology."* [16].

After analysing the scientific output about business management innovation in the first decade of the XXI century, we can confirm that among the 13,433 areas of research addressed by scientists in 9,368 papers, open innovation is the most unique area that pushes towards the progress of the innovation construct. Open innovation has been the most growing dimension in the last decade, in addition to appearing in a large number of papers when compared to other dimensions analysed. Open innovation is a hot topic in the current scientific output.

# 5. References


[1] J.A. Schumpeter, *The theory of economic development*. Harvard University Press, Boston,1934

[2] OECD, *Oslo Manual Guidelines For Collecting And Interpreting Innovation Data, 3er* edition, France, 2005

[3] R. Florida et al. What makes companies green? Organizational and geographic factors in the adoption of environmental practices, *Economic Geography.* 2001, **77** (3): 209-224.

[4] G.C. O'Connor and C.M McDermott, The human side of radical innovation, *Journal of Engineering and Technology Management*. 2004, **21** (1-2): 11-30

[5] M.D.J. Clements and A.J. Sense. Socially shaping supply chain integration through learning, *International Journal of Technology Management.* 2010, **51** (1): 92-105

[6] R. Varadarajan. Fortune at the bottom of the innovation pyramid: The strategic logic of incremental innovations, *Business Horizons*. 2009, **52** (1): 21-29

[7] Y.L. Liu and C.R. Shumway, Induced Innovation in US Agriculture: Time-series, Direct Econometric, and Nonparametric Tests, *American Journal of Agricultural Economics.* 2009, **91** (1): 224-236

[8] H.W. Chesbrough, and A.R. Garman. How Open Innovation Can Help You Cope in Lean Times, *Harvard Business Review*, 2009, **87** (12): 68

[9] M.C. Belis-Bergouignan and R. Levy. Sharing a common resource in a sustainable development context: The case of a wood innovation system. *Technological Forecasting And Social Change*, 2010, **77** (7): 1126-1138

[10] E. Engelen et al. Reconceptualizing financial innovation: frame, conjuncture and bricolage, *Economy And Society*. 2010, **39** (1): 33-63

[11] I. Gil-Leiva and A. Alonso-Arroyo. La relación entre las palabras clave aportadas por autores de artículos de revista y su indización en las bases de datos ISOC, IME e ICYT, *Rev. Esp. Doc. Cient.,* 2005, **28** (1): 62-79

[12] R.P. Dant and J.R.Brown. A journal of retailing retrospective based on ISI Web of Knowledge, *Journal of Retailing*. 2009, **85** (4): 527–531

[13] Z.L. He et al. Research collaboration and research output: A longitudinal study of 65 biomedical scientists in a New Zealand university, *Research Policy*. 2009, 38: 306-317

[14] C.L.Chang et al. What makes a great journal great in economics? The singer not the song. *Journal of economics surveys*. 2011, **25** (2): 326-361

[15] R.K. Pillania. The state of research on technological uncertainties, social uncertainties and emerging markets: A multidisciplinary literature review, *Technological Forecasting & Social Change*. 2011, 78: 1158–1163.

[16] H. Chesbrough. Open Innovation: The New Imperative for Creating and Profiting from Technology, *Harvard Business Review Press*, Boston, 2003