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## EARCHING FOR A PATH: A BIBLIOMETRIC STUDY ON INNOVATION AND TECHNOLOGICAL CAPABILITIES

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### ABSTRACT

Innovation is recognized as a matter of survival and success to firms and technological capabilities can lead to an innovative behavior by using technological resources and competences. The literature about technological capability and innovation is vast, counting on several approaches and a large number of researchers involved within. Based on this, our aim is to use a bibliometrics approach to map out the authors, institutions, journals and the evolution of the publication as well, to provide the path needed to build a theoretical framework about the theme. We held this research on the Scopus database using a standard search protocol to perform the selection of the sample. Our results indicate an emerging field of study and a large number of papers and citations concentrated in few journals. Most cited authors are related to seminal works on the subject and most cited papers are ones from late 90's and early 2000.

**Keywords:** Innovation, Technological Capabilities, Bibliometric Study on Innovation, Seminal works.

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## INTRODUCTION

From the works of Joseph Alois Schumpeter until today, innovation is recognized as the process of renovation of the firm, ensuring its survival and success. In addition, with a constantly fluctuating environment the firm requires technological innovation and managerial response to remain competitive (WANG et al., 2008). Thus, the way the firm uses its technological resources and competences, the ability to combine/recombine components, methods, processes and techniques to offer products and services, i.e. technological capability (AFUAH, 2002) plays a central role on the innovation process.

Reviewing the literature on technological capabilities, since early 80's until today, we can find many definitions of the concept. The diversity of the concept is confirmed by several authors, which recognize that there are numerous empirical and theoretical contributions in the literature about innovation and technological capabilities, resulting in a large number of definitions and approaches (JIN; VON ZEDTWITZ, 2008; REICHERT et al., 2011; GONZALES; CUNHA, 2012) that depends on the aim of the researchers (JIN; VON ZEDTWITZ, 2008).

Other important point in studies involving technological capabilities is that it seems to be following some new trends. Some possibilities are that innovation comes not only from technological capability but also from the complement of different kinds of capabilities (WANG et al., 2008; ALVES et al., 2011; ARGYRES, 2011). The innovative behavior rests on a meta-capability called innovation capability that seems to be a result of complementary capabilities (technological development, operations, management and transaction) (ZAWISLAK et al., 2012). It is not an easy task to work with all these definitions, which comes from a large amount of fields and authors.

Therefore, our main goal is to map out the authors, institutions, journals and the evolution of the publication about Innovation and Technological Capabilities. We may think about this article as a guide to whoever want to study these themes and this study may provide the path needed to build a deeply theoretical framework about the subject.

To achieve our objectives we proceed with a Bibliometrics approach on the terms Innovation and Technological Capabilities. According to Glanzel (2003), bibliometrics has become a standard tool of science policy and research

management in the last decades. All significant compilations of science indicators heavily rely on publication and citation statistics and other, more sophisticated bibliometrics techniques.

In addition, the author point out that many extensive bibliometrics studies of important science fields appeared during the last two decades. The aim of these studies was to measure national research performance in the international context or to describe the development of a science field with the help of bibliometrics means, which is the case of this study.

## CONCEPTS

Once that we have our goals clear, it is necessary to set the borders of our study. Thus, we use this chapter to establish, briefly, the definition of the concepts of Innovation and technological capabilities.

### Innovation

In a constantly changing environment in which the search to increase and maintain the competitive advantage of firms is constant innovation has become a matter of survival, not just of differentiation. Innovate has become cost to continue the market (KLINE; ROSENBERG, 1986). In this context, innovation emerges as the fundamental process of renovation of the firm, to modify the way it offers and delivers its goods and services.

Schumpeter in 1912 was the precursor to the understanding of innovation as a stimulus for economic development and as a factor of success of firms, an approach that was later followed by several authors. For the author, innovations emerge when the firm represented by the figure of the entrepreneur or, in the current context for the R&D department associated, discovers new ways of combining the factors of production that generate extraordinary profits to the firm. In a broader sense, the author states that what keeps the economy going is the release of new products, new production methods, new forms of organization and new markets (SCHUMPETER, 1942).

Currently, the concept of innovation is associated with changes in processes and products in order to solve problems of production and marketing, through the implementation and transformation of scientific and technical knowledge, always aiming to profit (FREEMAN, 1994). Zawislak (2008) supports this view by stating that innovation is defined as "any and all of

the firm's organizational change through the application of new knowledge (...) results recognized as superior, i.e. that are generating profit."

The innovation process that generates new products or services is largely recognized in the literature as one of the most visible types of innovation and as a source of competitive advantage (CHRISTENSEN, 1999; COOPER, 2001). However, the firm's innovations include other junctures, such as:

- a. Introduction of a new product or service in the market or the transformation of an existing asset;
- b. Introduction of a new production method, previously unknown by the industry, or a new way of handling a product commercially;
- c. Opening of a new market for the industry in question, existing or not;
- d. Capture of a new source of raw materials or new suppliers;
- e. Establishment of a new form of organization of the industry, changing the positions of existing domain (SCHUMPETER, 1985).

Briefly, according to Schumpeter (1912), to generate value, translated here as superior performance in the market, the firm must create something different, but that should be recognized by the market as such. For this, the firm must understand an internal effort of creating, transforming the knowledge available in a technological change, which necessarily must be the transaction value, thereby generating extraordinary profits. This internal effort of managing existing knowledge and the search for new knowledge that can enable technological change is what provides firms with technological capabilities.

### Technological capabilities

According to Afuah (2002), every firm has a set of specific technological resources (e.g., patents, stock of knowledge, licenses, etc.) that can be used to offer products with specific characteristics. The technological capabilities come from "its ability to use these resources to combine/recombine components, linkages between the components, methods, processes and techniques, and underpinning core concepts to offer products" (AFUAH, 2002, p.172). Furthermore, technological capability is related to the improvement of existing technologies, development of new knowledge and abilities (JIN; VON ZEDTWITZ, 2008).

Thus, every firm possess some technological capabilities that are embedded with its resources and

competences, and the technological knowledge involved is not equally distributed among firms, nor is easily imitated by or transferred across them (LALL, 1992). For these processes learning plays a central role (FIGUEIREDO, 2002), and the firm needs to employ skills, effort and investment to master new technologies (LALL, 1992).

Since the firm is a repository of knowledge (WINTER, 1991), it need to be acquired for the firm to accumulate capabilities, what may occur through entering learning processes (FIGUEIREDO, 2002). Therefore, technological learning is the process of building and accumulating technological capability, and takes place through the conversion between tacit and explicit knowledge (KIM, 2000). However, capabilities cannot be bought but only transferred between firms (FIGUEIREDO, 2002).

Kim (1997) states that capabilities transfer can be done by two ways: formal or informal. Formal ways include the acquisition of licenses, patents and other forms of commercial assignment for intellectual property licenses, and informal mechanisms are represented by looking for the state of art, observation, sample products, etc. (KIM, 1997).

Other characteristic of technological capabilities often cited in the literature is its source of competitive advantage. Technological capabilities provide firms to acquire, develop and better use technologies to achieve competitive advantage (ACUR et al., 2010). The authors propose that firms with superior technological capabilities are more prone to be innovative and that behavior lead to a positive impact on their performance. For being an intangible asset, this capability is very difficult to imitate, what makes it a valuable resource to the firm and source of competitive advantage. Figueiredo (2009) states that even it does not appear on balance sheets, the capabilities can define the distinctive performance of a firm.

Although exists some common characteristics to technological capabilities, there are several approaches on the literature that conceptualize it. Tello-Gamarra and Zawislak (2013) lists some authors: (DESAI, 1984; KATZ, 1984; NELSON, 1991; LALL, 1992; BELL; PAVITT, 1995; KIM, 1999; AFUAH, 2002; FIGUEIREDO, 2002; MADANMOHAN et al., 2004; COOMBS; BIERLY, 2006; GOMEL; SBRAGIA, 2006; JONKER et al., 2006; GARCIA-MUIÑA; NAVAS-LOPEZ, 2007; JIN; VON ZEDTWITZ, 2008; ACUR et al., 2010; REICHERT et al., 2011; GONZALES; CUNHA, 2012).

## METHOD

### Why bibliometrics?

To achieve the objective of this study we proceed a bibliometrics study within a reliable library, searching for an overview of the evolution, most cited authors, publishers and fields of study.

Today, bibliometrics is one of the rare truly interdisciplinary research fields to extend to almost all scientific fields. Bibliometrics methodology comprises components from mathematics, social sciences, natural sciences, engineering and even life sciences. It can be defined as the analysis of the scientific outcome published, for example by a researcher, a research team, an institution or country. It can further be specified by scientific discipline. The scientific outcome can be in a number of forms such as books, book chapters, a journal article, a contribution in a newspaper etc. One can label this strand of analysis the counting of publications. This provides information on quantity, but it does not provides it a relative use nor does it tell anything about the scientific use or impact. (THANUSKODI, 2010)

As it is rather difficult to obtain a picture of all scientific outcome, bibliometricians tend to use a dedicated database. For more than 40 years, the main database for analyzing the scientific performance of researchers was the Science Citation Index (SCI), starting in 1963, and the Social Science Citation Index (SSCI), starting in 1973. The Arts & Humanities Citation Index followed in 1978. All indexes were developed and maintained by the Institute for Scientific Information (ISI), which is now owned by Thomson Reuters. The main idea behind such an index is to collect citations of scientific articles. The database thus contains several thousand journals, and provides citation counts between these journals. The more a journal is cited, the higher its scientific impact.

### Data sources

Hence we have our methodology chosen we had to set the population of the study, the terms Technological capabilities and Innovation are used among many fields, so our main scope was to choose a library that covers different fields. In this sense, we found Scopus as a database that can cover this diversity, besides having the largest amount of paper collection in the whole world.

Scopus is database owned by Elsevier and is considered the largest abstract and citation database of peer-reviewed research literature. According to its website, Scopus is provided with tools to offer a quick, easy and comprehensive resource to support research needs in the scientific, technical, medical and social sciences fields as well as arts and humanities. Considering November 2012, Scopus has in its files more than 20.500 titles form more than 5000 international publishers, what means about 49 million records since 1823. Approximately 2 million new records are added every year via daily updates.

### Assignment criteria

To perform the analysis we first assumed several rules to the sample gathering, these rules were<sup>5</sup>:

a) Search Protocol: Scopus allows us to create and use our parameters to within their search engine. We established a simple parameter that made possible to search the terms “innovation” and “technological capabilities”, only and just when used together, in the same paper, since we do not want to consider papers where only one of both are used, for this, we already have books and seminal authors. We also exclude conference papers, reviews, essays and undefined documents.

b) References published in newsletters were not consider as scientific literature, so, we have them excluded from the sample.<sup>6</sup>

c) All references were considered independent on their year of publication and impact of the journal.

Thus, we had our final sample, composed by 310 papers published between 1984 and 2014.

### Possible sources of error

While efforts were made to avoid errors by combining both manual and computerized procedures, the quality of the original data cannot be guaranteed if the main sources of failures are still data input errors. If volume/page numbers are omitted and irregular and cryptic journal abbreviations are used, an assignment to the correct reference-type category is made impossible. Another factor lies in the standards used by certain journals. It

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5(TITLE-ABS-KEY("innovation") AND TITLE-ABS-KEY("technological capabilities")) AND (LIMIT-TO(DOCTYPE, "ar")) AND (LIMIT-TO(SRCTYPE, "j"))
```

may happen that some journals use different types of citation index, making difficult to create a standard to analyze.

**Analysis aspects**

Therefore, to this paper version, we used these softwares to prepare the sample to the analysis: *Endnote X7*, *Procite 5.0* and *Mendeley*. To perform the tests we used R software, *Ucinet 6.0*, *MS Excel*, *IBM SPSS 21* and *Citespace*.

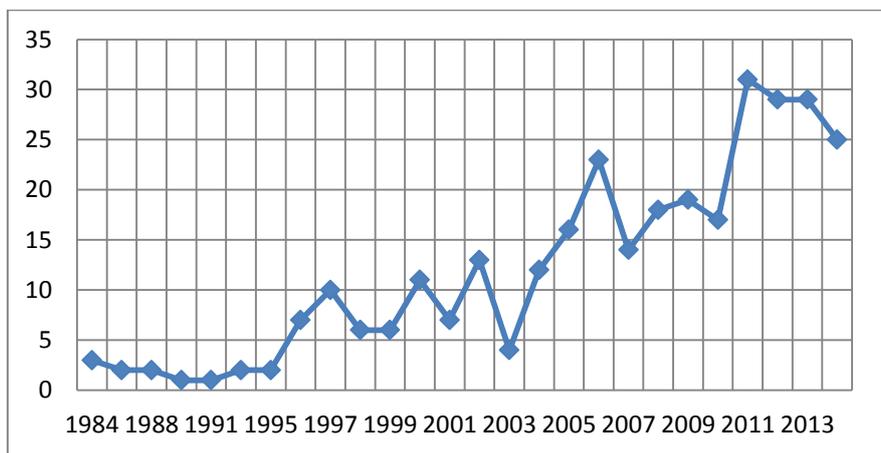
Descriptive statistic was used to analyze the evolution of the papers, most cited journals, authors and nationality.

**FINDINGS**

The first time the terms and Technological Innovation Capabilities articles appeared simultaneously in was in 1984, in the Scopus database. In the eleven years after the appearance of the terms worked simultaneously, the production of articles was low. The first production peak appeared only in 1997, when the publication reached 15 articles.

Since 1997, the number of publications was alternating ups and downs until 2006, when it reached the highest peak at that moment. After that, between the 2007 and 2010 there were few publications, until in 2011 the number of publications reached its highest peak. From 2012 to nowadays, the movement is gradually stabling.

**Figure 01: Number of Papers published using the terms Innovation and Technological Capabilities per year, total amount: 310.**



Considering the number of papers published using the term Innovation and Technological Capabilities together, the results show that the first three positions are occupied by Research Policy, International Journal of Technology Management and Technological Forecasting and Social Change, respectively.

These three journals represent around 15% of all publications in the subject for the studied library, which compared to the other journals figuring Table 01 can be considered a representative result.

One journal that appears on the list with very similar results is Science, Technology and Society, that stands in fourth position with 12 papers published.

Regards its similarity with the third position results, it can be included as one of the most representative journals. Another perceived point is that of publishers per country. The distribution was United Kingdom (6), Netherlands (2), United States (1) and India (1).<sup>7</sup>

<sup>7</sup>We have to add a note that the main country of publisher could be not the same as its origin institution; this could be a subject of study to future research.

**Table 01: Number of Papers published using the terms Innovation and Technological Capabilities per journal, top 10. Total amount: 310.**

R#	SOURCE TITLE	N	%
1	ResearchPolicy (NL)	18	5.8
2	International Journal of Technology Management (UK)	14	4.51
3	Technological Forecasting and Social Change (US)	13	4.19
4	Science Technology and Society (IN)	12	3.87
5	Technovation (UK)	8	2.58
6	Technology Analysis and Strategic Management (UK)	8	2.58
7	Strategic Management Journal (UK)	7	2.28
8	Science and Public Policy (UK)	6	1.94
9	World Development (NL)	6	1.94
10	European Planning Studies (UK)	5	1.61
	Others	212	68.08
	<b>Total</b>	<b>310</b>	<b>100</b>

Analyzing the number of citations per journal, Research Policy still remains on the first position, with 1772 citations. In a different way from the number of articles per journal results, another journals figure among the most cited, like Strategic Management Journal, with 1719 citations in this library. Other journals figuring the first positions was Harvard Business Review and Technological Forecasting and Social Change.

Considering **Tables 01 and 02**, Research Policy seems to be the top journal when it refers to Innovation and Technological Capability, indicating that it can be a reliable source on the subject. Besides that, as the number of citations better represent the reach of the journal on its field than number of papers published, Strategic Management Journal and Harvard Business Review also must be considered top journals when referring to technological capabilities and innovation.

**Table 02: Number of citations of papers using the terms Innovation and Technological Capabilities per journal, top 10, total amount of citations: 6648**

R#	SOURCE TITLE	N	%
1	Research Policy	1772	26,65
2	Strategic Management Journal	1719	25,86
3	Harvard Business Review	354	5,32
4	Technological Forecasting and Social Change	323	4,86
5	Journal of Economic Behavior and Organization	204	3,07
6	Technovation	181	2,72
7	Government Information Quarterly	147	2,21
8	Industry and Innovation	147	2,21
9	Journal of Product Innovation Management	112	1,68
10	World Development	110	1,65
	Others	1579	23,75
	<b>Total</b>	<b>6648</b>	<b>100</b>

Among the authors who have published articles that relate the terms simultaneously stand out Figueiredo, P.N. (6), Choung, J. Y. (5) and Zander, I., with four papers published, respectively. No author has published more than 2% of all publications

related to the topics, demonstrating that there are a large number of authors researching the issues and consequently the publications are spread among a large amount of authors (**Table 03**).

**Table 03: Authors with more papers using the terms Innovation and Technological Capabilities.**

Authors	N	%
Figueiredo, P.N.	6	1,94
Choung, J.Y.	5	1,61
Zander, I.	4	1,29
Bala Subrahmanya, M.H.	4	1,29
Bessant, J.	3	0,97
Diez, J.R.	3	0,97
Hwang, H.R.	3	0,97
Berger, M.	3	0,97
Wignaraja, G.	3	0,97
Wonglimpiyarat, J.	3	0,97
Others	273	88,06
Total	310	100

In **Table 04**, we found a list of the top cited authors in the final sample of articles. The first place ranking, occupied by authors Nelson, R. R (14,25%) and Pavitt, K. (13,60%), followed closely by Lall, S., that is cited in nearly 13% of the total articles.

A big part of papers use at least the first three places in the ranking, which shows that perhaps the majority of research within the theme of innovation and technological capabilities, are following the same line of knowledge construction. There is also a predominance of American and British authors, which reinforces this understanding.

**Table 04: Top cited authors in the sample.**

Rank	AUTHOR NAME		Nationality	N	%
1	Nelson, R. R.		EUA	65	14,25
2	Pavitt, K.		UK	62	13,60
3	Lall, S.		India	59	12,94
4	Bell, M.		UK	55	12,06
5	Freeman, C.		UK	42	9,21
6	Kim, L.		South Korea	39	8,55
7	Hobday, M.		UK	37	8,11
8	Teece, D. J.	Bessant, J.	EUA - UK	36	7,89
9	Rosenberg, N.	Dosi, G.	EUA - Italy	31	6,80
10	Figueiredo, P. N.		Brazil	30	6,58

Table 05: Most cited papers.

Publication Year	Document Title	Authors	Journal Title	Citations	%
2001	Internal capabilities, external networks, and performance: A study on technology-based ventures	Lee, C., Lee, K., Pennings, J.M.	Strategic Management Journal	549	8,26
2000	Innovation in project-based, service-enhanced firms: The construction of complex products and systems	Gann, D.M., Salter, A.J.	Research Policy	411	6,18
1995	Explaining the attacker's advantage: Technological paradigms, organizational dynamics, and the value network	Christensen, C.M., Rosenbloom, R.S.	Research Policy	374	5,63
1996	Local search and the evolution of technological capabilities	Stuart, T.E., Podolny, J.M.	Strategic Management Journal	364	5,48
1997	Spark innovation through empathic design.	Leonard, D., Rayport, J.F.	Harvard business review	258	3,88
2002	Determinants of innovation capability in small electronics and software firms in southeast England	Romijn, H., Albaladejo, M.	Research Policy	222	3,34
1994	Evaluating technological information and utilizing it. Scientific knowledge, technological capability, and external linkages in biotechnology	Arora, A., Gambardella, A.	Journal of Economic Behavior and Organization	204	3,07
2004	Where do resources come from? The role of idiosyncratic situations	Ahuja, G., Katila, R.	Strategic Management Journal	181	2,72
2002	Innovation, collaboration and SMEs internal research capacities	Bougrain, F., Haudeville, B.	Research Policy	157	2,36
2001	Gauging e-government: A report on implementing services among American cities	Kaylor, C., Deshazo, R., Van Eck, D.	Government Information Quarterly	147	2,21
			Others	3781	56,87
			Total	6648	100,00%

In **Table 05**, we found a list of the 10 most cited papers of the final sample. The 10 most cited articles are divided in two periods, 1994-1997 and 2000-2004, which were the first two periods of growth in the number of publications. The most cited article, "Internal capabilities, external networks, and performance: A study on technology-based ventures" author C. Lee, K. Lee and J.M.Pennings, published in 2001, has a percentage of 8.26% of citations, which represents a significant sample of the total citations that the articles within the sample have.

Other information that may reveal the way that production related to the topics studied here is following the publication date of the most cited articles. Among the top 4 rated, representing 25.55% of the total citations (significant percentage), we have an average of 15 years since its publication, which shows that the construction of knowledge about the topics innovation and technological capabilities are still attached to that produced a long time, the initiators of this research field.

### Hot Topics

To reveal an overview of the hot topics and new trends about the two themes listed here, we performed an analysis of the most cited recent articles published in the last three years. In the analysis of these articles we realized that research on innovation and technological capabilities also

converge towards other themes, ranging from the traditional approach directed to the firm to issues that links innovation or technological capabilities to more social or environmental subjects on the other extreme. Table 06 lists these selected papers.

**Table 06: Top 10 cited papers of the last four years.**

Publication Year	Document Title	Authors	Journal Title	Citations
2011	The role of foreign technology and indigenous innovation in the emerging economies: Technological change and catching-up	Fu, X., Pietrobelli, C., Soete, L.	World Development	41
2011	A framework for mapping industrial emergence	Phaal, R., O'Sullivan, E., Routley, M., Ford, S., Probert, D.	Technological Forecasting and Social Change	33
2011	Schumacher meets Schumpeter: Appropriate technology below the radar	Kaplinsky, R.	Research Policy	24
2014	Organizational innovation as an enabler of technological innovation capabilities and firm performance	Camisón, C., Villar-López, A.	Journal of Business Research	20
2011	Entry into new niches: The effects of firm age and the expansion of technological capabilities on innovative output and impact	Kotha, R., Zheng, Y., George, G.	Strategic Management Journal	20
2012	Appropriate intellectual property protection and economic growth in countries at different levels of development	Kim, Y. K., Lee, K., Park, W. G., Choo, K.	Research Policy	19
2011	The co-evolution of firm-centered knowledge networks and capabilities in late industrializing countries: The case of Petrobras in the offshore oil innovation system in Brazil	Dantas, E., Bell, M.	World Development	16
2011	Innovation and internationalization as growth strategies: The role of	Kyläheiko, K., Jantunen, A.,	International Business Review	13

	technological capabilities and appropriability	Puumalainen, K., Saarenketo, S., Tuppura, A.		
<b>2012</b>	Innovation Capability: From technology development to transaction capability	Zawislak, P. A., Alves, A. C., Tello-Gamarra, J., Barbieux, D., Reichert, F. M.	Journal of Technology Management and Innovation	10
<b>2012</b>	An empirical examination of the development of a solar innovation system in the United Arab Emirates	Vidican, G., McElvaney, L., Samulewicz, D., Al-Saleh, Y.	Energy for Sustainable Development	10

Starting with traditional (but not at all outdated) approaches, Camisón and Villar-López (2014) bring to discussion the organizational innovation (i.e. the introduction of new organizational methods for business management) and try to reveal its connections to technological innovation capability.

Based on a survey performed on 144 Spanish firms, the authors conclude that organizational innovation favors technological innovation capability, mainly on product and process innovation. The results also indicate that both organizational innovation and technological capabilities can lead to superior firm performance (CAMISÓN; VILLAR-LÓPEZ, 2014).

In a similar way, Zawislak et al. (2012) also shows that other characteristics of the firm, beyond technological development, are important to its innovation capability. As the title indicates, the authors come up with the idea that the innovation capability of the firm comes from different types of capabilities that may complement each other. These capabilities are technology development, operations, management and transaction, and are divided in two groups, the technology driven capabilities (the first two) and business driven capabilities (management and transaction). Based on the four capabilities, Zawislak et al. (2012, p. 21) make three propositions about it, "1. Every firm has all four capabilities. None of them are null. 2. To be innovative, at least one of the firm's capabilities must be predominant. 3. Any firm, when born, is primarily technological or transaction, in a second stage, operational or managerial."

Some of the implications of technological capabilities and innovation to the firm are explored by others cited papers. Khota, Zheng and George (2011) state that firm's age can influence on the innovative activities that result from entering new technological niches. The results show that younger firms tend to benefit from the impact delivered by innovative activities while older firms are able to

generate more output from those activities (KHOTA; ZHENG; GEORGE, 2011). When entry on new niches corresponds to the internationalization of the firm, Kyläheiko et al. (2011) shows that technological capabilities can have a positive and significant impact on that effort and also on innovation.

Going beyond the firm, Phaal et al. (2011) offers a framework for mapping science and technology-based industrial emergence, which brings a full perspective over several stages of that process, such the phases related to the conversion of scientific knowledge to technological capability. The framework reveals an important tool for managers and policy makers to improve strategy development.

Other authors that explore the role of knowledge and its management to technological capabilities and innovation are Kim et al. (2012). They investigate the role of property protection in innovation and economic growth, finding that patent protection is determinant to innovation in developed countries, and that form of protection contributes to economic growth. For developing countries the scene is different, patents doesn't have the same effect and utility models (a minor form of intellectual property rights) takes its place in determining innovation and growth (KIM et al., 2012).

Developing countries, and in some cases the BRICS, are a recurrent subject on recent published papers referring to technological capabilities and innovation. Fu, Pietrobelli and Soete (2011) discuss on the role of foreign innovation and indigenous efforts designed to enhance technological change and industrialization in developing countries. On that subject they conclude that although foreign technologies created in developed countries may seem a good idea, Northern technology tends not to be appropriate to major Southern realities, requiring efforts to develop indigenous innovation as well (FU; PIETROBELLI; SOETE, 2011). Furthermore, the authors highlight the need for modern and adequate institutional and governance structures on the part of

developing countries, so indigenous innovation become a reality.

Dantas and Bell (2011) explore the evolution of knowledge networks in the context of emerging economies, in this case, Brazil. Focusing on innovation systems, they study the co-evolution of firm's capabilities according to the sequence that the network changes its type. As networks can improve firm's capabilities, these same capabilities are responsible to enable or constraint the forms that were possible to existent networks (DANTAS; BELL, 2011).

Vidican et al. (2012) study sectoral innovation systems to, more specifically the emergence of a solar energy sector in the United Arab Emirates, which has limited industrial and technological capabilities. Reinforcing what was proposed by Fu, Pietrobelli and Soete (2011), Vidican et al. (2012) claim that in the first moment of the innovation system there is a need of foreign technology in order

## CONCLUSION

With the analysis of results is possible to notice a certain tendency of evolution of this emerging field. Emerging, because the publications within the two terms only grown starting in the years of 1995-1996. The papers on the subjects were on a growing tendency, since our analysis demonstrated this tendency through Figure 1, in which the peak for works on this subject occurred in 2011. However, the actual tendency is the fall of the publications.

In relation to the number of papers and citations per journal, Research Policy stands at the top, followed by journals as International Journal of Technology Management, Technological Forecasting and Social Change, Science Technology and Society and Technovation. The top positions sustained by these journals may indicate reliable sources of information concerning Innovation and Technological Capabilities when combined. For those who want to publish in this field, these journals seems to have a good reach on scientific community.

The large distribution of authors in the number of papers published indicates a large amount of people working on the subject and a possible diversity of approaches, since it depends on the author's aims. Considering the top cited authors this diversity is diminished, since about a half of the citations belongs to the top authors, which are Nelson, Pavitt, Lall and Bell. These authors, as we can see, are consider responsible for some of the seminal works on the subject. Considering the ten most cited papers, it can

to improve indigenous knowledge, but next phase involves an effort to build local capabilities, thus breaking the dependency created early. Also, to improve the success of the innovation systems created and the solar energy sector, networks for knowledge transfer and creation must be strengthened, and institutional structures must be supportive (VIDICAN et al., 2012).

Different from the previous approaches, Kaplinsky (2011) discuss on the role of innovation from and for low-income regions. Besides arguing in favor of the need and importance of innovations to poor people, Kaplinsky (2011) suggest that some countries that live under these conditions have plenty of technological capabilities, like China and India, and new trajectories of innovation are emerging from them. The author concludes that these capabilities and innovations may become a source of technological change, not only for the South, but affecting North to.

be distributed in two periods related to those peaks of production demonstrated in Figure 01. The first four papers in citations have around 15 years old or more, which means that the production since them, in the field, could be relate to these works.

Our study has its recognized limitations. First, is the lack of a library that covers all the journals that compose a field of study, which means that, no matter how good is the search algorithm, it will not cover all the papers about the chosen subject, and that is why such an extend delimitation of the sample was made. The second limitation is also related to the sample, once that, due to the lack of a properly data basis, we were not able to analyze the dissertations and thesis which work within the terms of this study.

Finally, the third limitation is time, since the libraries not just do not cover all the time, since the beginning of the studies about the subjects, (once that we do not have how to know the very first paper touching the subject), and the lack of a standard, concerning to the analysis.

As possibilities to future researches, we strongly suggest a systematic review on the terms and a paper that make a comparison between more libraries, making possible a wider scope of the research allowing the discovery of other factors that may not have been encompassed with this current research. This will also, provide to check the amount of publication impact, to verify which library have more influence in the scientific field.

Researcher may find useful for future studies to combine Technological Capabilities with other subjects besides Innovation, like Transactional Capabilities or Innovation Capabilities, trying to find some new research trends. Other effort that can be

made is a full study of capabilities and innovation, what we may call a “landscape of capabilities”, aiming to identify the role of capabilities in innovative behavior from its first appearance until today.

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