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Innovation Capabilities: Uma análise de co-citações

Innovation Capabilities: An analysis of co-citations

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Objetivo do estudo
Investigar o campo de capacidades de inovação, seus autores, principais estudos, para situar novos pesquisadores e ajuda-los a direcionar pesquisas futuras, fortalecendo a teoria e o campo.

Relevância/originalidade
O estudo apoia aqueles que querem conhecer a área de capacidades de inovação e a partir daí desenvolver novos estudos, relações ou aplicações.

Metodologia/abordagem
Foi feita uma análise bibliométrica de co-citação entre autores, partindo de 10.874 resultados de busca com os termos "innovati* capabilit*" na base Web of Science, analisados dados bibliométricos selecionando os artigos nos 10% mais citados para uma análise de co-citação por meio de uma análise fatorial exploratória.

Principais resultados
O resultado foram seis fatores em clusters de estudos agrupados como: Competição/Capacidades Dinâmicas/Inovação; Inovação Aberta/Redes de Aprendizagem; Metodologia/Desempenho/Orientação de Mercado; Ambidextria; Desenvolvimento tecnológico e Inércia organizacional; e Inovação a nível Nacional/Setorial.

Contribuições teóricas/metodológicas
A contribuição teórica do estudo advém do mapeamento atualizado do campo para entendimento inicial e exploração a partir deste estudo bibliométrico. A metodologia de bibliometria de co-citação com análise fatorial exploratória é validada e descrita para replicação e atualizações futuras.

Contribuições sociais/para a gestão
Para a gestão fica o mapeamento das capacidades de inovação como leitura básica no suporte a tomada de decisões e informação geral da visão teórica frente a aplicação do conhecimento.

Palavras-chave: Capacidades de inovação, Bibliometria de co-citação, Maturidade em gerenciamento de portfólio de projet, Capacidades dinâmicas

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Study purpose
Investigate the innovation capabilities field, its authors, main studies to situate new scholars and help directing further investigations strengthening the theory and the field.

Relevance / originality
The study helps the ones who want to better know Innovation Capabilities area and from there develop further research, new relationships or applications.

Methodology / approach
I performed a bibliometric authors co-citation analysis starting from 10,874 search results for the terms "innovati* capabilit*" at Web of Science base, analysed bibliometric data selecting the top 10% most cited papers for a co-citation analysis through exploratory factorial analysis.

Main results
The result were six factors clustering studies as Competition/Dynamic Capabilities/Innovation; Open Innovation/Learning Networks; Methodology/Performance/Market Orientation; Ambidexterity; Technology Development and Organizational Inertia; and Innovation at a National/Sector Level.

Theoretical / methodological contributions
Theoretical contribution is derived from the field update mapping for an initial understanding of the area and further exploration from this bibliometric study. Co-citation bibliometry with exploratory factorial analysis is validated and described for replication and future updates.

Social / management contributions
Mapping of innovation capabilities is the management contribution as a basic reading to support decion making porcesses and as general information on the theoritical view in face of knowledge application.

Keywords: Innovation capabilities, Co-citation bibliometry, Resource Based View, Dynamic capabilities

1 Introduction

Understanding innovation capabilities of an organisation is important to figure out its current state and how to further develop those capabilities. Organisations develop its strategies seeking sustainable competitive advantages to win the market and obtain higher profits, not only surviving but leading the market. Innovation capabilities can be an enabler for the attainment of these sustainable competitive advantages (Camisón & Villar-López, 2014).

This work seeks to understand current state-of-the-art research about innovation capabilities. To do so, I carry an exploratory and descriptive research of the topic in Web of Science database, focusing on the most cited articles and then proceed a co-citation bibliometric analysis to lay the foundation for the further research recommendations.

According to RBV, a capability refers to the deployment and reconfiguration of resources to improve productivity and achieve strategic goals (Makadok, 2001). A capability is a lower-order functional, operational or technological capability (Ortega, 2010). Technological IC is identified as one of the most important sources of competitive advantage (Coombs & Bierly III, 2006, 2001) owing to its causal ambiguity (González-Alvarez & Nieto-Antolín, 2005). Specifically, technological IC is the ability to perform any relevant technical function or volume activity within the firm, including the ability to develop new products and processes, and to operate facilities effectively (Teece et al., 1997). Innovative capability can be defined as an organisation's ability to develop new products and/or markets, through aligning strategic innovative orientation with innovative behaviours and (Wang & Ahmed, 2007).

Early innovation capability research started in the 80's. But in the 90's the subject got bigger and publications jumped from tens to hundreds. This is in line with globalisation and the changes at the market and perception of innovation needs at the companies. So, this work aims to answer who are the most influential authors on innovation capability? As a primary objective this paper aims to map current state of research on the topic and provide insights for further development on both research and shed light on practical trends for the area.

This paper is divided as follows: as it is a bibliometric co-citation study literature review is implicit within results analysis as the papers are analysed and its clusters described. So, I start with an explanation of the methodology used; proceed to results analysis; discussions and conclusions; and cited references.

2 Methodological Procedures

In this study we intend to identify the basis of research being published on innovation capabilities. Assuming that bibliographic citations are acceptable proxy for the actual influence of various information sources on a research project (Culnan, 1986), a bibliometric descriptive research is well suited to identify topics like most common themes, main research groups, journals, methods and authors in a given area. Co-citation analysis, therefore, can provide an objective and quantitative means to meet our goals. Citations can be considered more potent concept symbols than words because a high citation rate represents peer recognition (Small, 2003). Since the highly cited documents represent the key concepts, methods, or ideas shared by the citing documents in a field, then the co-citation patterns can be used to map out in great detail the relationships between these key ideas (Small, 1973).

Franklin and Johnston (1988) suggested that co-citation could identify coherent research problem areas by classifying and grouping current scientific papers through their common referencing to clusters of highly cited and highly co-cited works. Co-citation analysis can be held at multiple levels, being them document, author and journal co-citation analysis. Small (1973) introduced document co-citation analysis, evaluating the network created when

documents are linked according to their joint citations by subsequent documents. Author co-citation analysis, by contrast, uses authors instead of documents to map prominent authors within a selected field (White, 1990; White & Griffith, 1981). McCain (1991) introduced journal co-citation analysis, which treats representative journals of each field as the units of analysis (Sugimoto et al., 2008). This work carried an author's co-citation analysis.

Co-citation patterns change as new papers continually appear in the clusters due to their increasing citation or co-citation and old papers drop out. Through studying these changing structures, the co-citation method provide a mean to monitor the development of scientific fields and to assess the degree of interrelationship among specialties (Small, 1973). The co-citation method is based on a frequency count that two documents or authors are cited in pairs in the same work (Small, 1973). Its goal is to identify groups of closely related documents or authors which can be considered as the same "research line" (Price & De Solla, 1965).

2.1. Selection of source documents

To obtain a collection of representative research papers on innovation capabilities, I retrieved data from the Web of Science database. This particular database was chosen because it is one of the world's leading citation database and enjoys a great reputation; its citation database is abundant in covering high impact journals; it is highly regarded and receives great popularity from researchers; it provides a systematic and objective means to trace related information efficiently (Hsiao & Yang, 2011).

The search keywords used were "innovati* capabilit*" so as to capture variations like innovation capability and innovation capabilities. This procedure resulted in a list of 10,874 documents between 1945-2019 (i.e. without restriction of period at Web of Science) collected in search conducted in august 2019. In order to ensure that only influential articles with a significant impact were selected I considered the 10% most cited documents for analysis, according to Lotka law which states that a small number of papers hold the most significant amount of citations (Lotka, 1926), resulting in 1,001 articles with at least 49 citations each.

2.2. Retrieval of co-citation matrix

After the retrieving of source documents, the next stage was to perform a co-citation matrix based on the above 1,001 most cited documents between 1945-2019 according to Quevedo-Silva, Santos, Brandão, & Vils (2016) orientations using VOSViewer, Bibexcel and Excel software. Although it was possible to prepare a 1,001 x 1,001 co-citation matrix, just out of curiosity, running a preliminary exploratory factorial analysis in it with SPSS software generated 57 factors. It would be impractical work with that many factors and the insights generated by this dispersion could be useless for the purpose of this work. So, again, the 10% most cited articles were selected, generating a 101 x 101 co-citation matrix. With this document prepared by Bibexcel and Excel software I proceeded an exploratory factor analysis.

Factor analysis allows the study of the quality of data reduction in more dimensions with precise numbers, and it is commonly used in co-citation analysis (Leydesdorff & Vaughan, 2006; Nerur et al., 2007; White & McCain, 1998). With an orthogonal (Varimax) rotation of the extracted factors, factor analysis produces the uncorrelated factors. Most documents have high loadings on only one factor; thus, each factor reveals the underlying subject matter. The amount of variance explained by a factor may represent its contribution to the conceptual foundation of the field (McCain, 1990). Documents in specialized areas tend to cite some researchers' concepts and be co-cited by others within the field (McCain, 1990). Therefore, those documents are prone to load on the same factor. Each subfield corresponding to the extracted factor represents an intellectual specialty that is defined by authors who load highly on that subfield/factor (Nerur et al., 2007).

3 Results

A total of 10,874 papers were obtained through Web of Science database search. Following the orientations from Quevedo-Silva, Santos, Brandão & Vils (2016) the Web of Science output file was prepared with assistance of Bibexcel open source software. The top 101 most cited authors (top 10%) were selected to be analysed because, as warned by Quevedo-Silva et al. (2016), it generates a 101 lines per 101 columns co-citation matrix and the addition of more authors make it more difficult to analyse the data and draw any conclusion because of the dispersion of data including increasingly less relevant authors to the analysis. The co-citation matrix was then submitted to the exploratory factor analysis using SPSS statistical software.

One recommended practice for dataset generation is to discard methodology papers as they are highly cited but do not directly relate with the theory being studied. Nevertheless, I decided to keep methodology works to check on which factors they would load and investigate on how the researches of those factors are being held. So, I could obtain not only a theoretical panorama of the field but also get a grasp the methods that are being used to explore the field.

The dataset generates all communalities above 0.500. The total variance explained is of 86.306%, which can be considered high for social sciences according to Hair, Black, Babin, & Anderson (2014). The respective rotated component matrix consisted of nine factors and is presented at the appendix. Some authors presented cross factorial loading, in those cases the higher one was considered initially to decide to which factor this author should pertain. In this step all authors from factor 7 were transferred to factor 1 because they had higher factorial loading there. Then the Cronbach's Alpha (CA) for each factor was calculated to validate them as presented in Table 1. Factor 9, compounded by two papers from the same author (Cohen), presented a value for CA smaller than 0.700. According to Hair et al. (2014) values smaller than 0.600 for CA are inadequate for social sciences, so this factor is invalid. It is also worth of note that, despite factor 8 presented an AC higher than 0.700 it is compounded by three works from the same author also (Teece), so I discarded this factor for the theme analysis following.

Finally, the titles and abstracts from each factor were analysed to determine a common theme to define the factor as presented in Table 1. The first and larger cluster consists of 30 papers which are the theoretical basis from RBV theory and dynamic capabilities theory. The second cluster has themes of innovation and learning, with papers seeking understanding about the aspects of innovation management and how the organisations can learn and adapt to the market. The third cluster, with 19 papers, basically investigates organisation performance and which factors influence it. A fourth cluster with 10 papers addresses specific innovation issue of organisations ambidexterity, or to what extent should the organisations explore new innovative possibilities and, at the same time, explore current opportunities and products; and also, internationalisation of the organisations. A smaller fifth cluster of 5 papers pertains to competitiveness subject. The last validated factor consists of 4 papers treating knowledge and economy theories. So, I obtained six factors, namely: Competition/Dynamic Capabilities/Innovation; Open Innovation/Learning Networks; Methodology/Performance/Market Orientation; Ambidexterity; Technology Development and Organizational Inertia; and Innovation at a National/Sector Level.

Table 1: The nine initial factors from the exploratory factor analysis and its respective Cronbach's Alpha and items number

Factor name	Cronbach's Alpha	N of Items
Competition/Dynamic Capabilities/Innovation	0.970038	30
Open Innovation/Learning Networks	0.975304	28
Methodology/Performance/Market Orientation	0.97341	19
Ambidexterity	0.934298	10
Technology Development and Organizational Inertia	0.929266	5
Innovation at a National/Sector Level	0.878113	4
Factor 7	-	-
Teece	0.779134	3
Cohen	0.486903	2

3.1. Competition/Dynamic Capabilities/Innovation

Table 2: Articles and factor loads for competition/dynamic capabilities/innovation

Articles	Loads	Articles	Loads
Amit R, 1993, Strategic Manage J, V14, P33	.848	Pavitt K, 1984, Res Policy, V13, P343	.527
Barney J, 1991, J Manage, V17, P99	.622	Penrose E, 1959, Theory Growth Firm	.856
Christensen C, 1997, Innovators Dilemma N	.602	Peteraf M, 1993, Strategic Manage J, V14, P179	.869
Cyert R, 1963, Behav Theory Firm	.540	Porter M, 1980, Competitive Strategy	.864
Danneels E, 2002, Strategic Manage J, V23, P1095	.598	Porter M, 1985, Competitive Advantag	.811
Dierickx I, 1989, Manage Sci, V35, P1504	.825	Porter M, 1990, Competitive Advantag	.685
Eisenhardt K, 2000, Strategic Manage J, V21, P1105	.693	Prahalad C, 1990, Harvard Bus Rev, V68, P79	.842
Eisenhardt K, 2007, Acad Manage J, V50, P25	.577	Schumpeter J, 1934, Theory Ec Dev	.711
Grant R, 1991, Calif Manage Rev, V33, P114	.809	Schumpeter J, 1942, Capitalism Socialism	.650
Helfat C, 2003, Strategic Manage J, V24, P997	.783	Wang C, 2007, Int J Manag Rev, V9, P31	.660
Helfat Constance E, 2007, Dynamic Capabilities	.723	Wernerfelt B, 1984, Strategic Manage J, V5, P171	.821
Henderson R, 1990, Admin Sci Quart, V35, P9	.556	Williamson O, 1975, Markets Hierarchies	.793
Henderson R, 1994, Strategic Manage J, V15, P63	.616	Winter S, 2003, Strategic Manage J, V24, P991	.739
Leonardbarton D, 1992, Strategic Manage J, V13, P111	.579	Zahra S, 2006, J Manage Stud, V43, P917	.668
Nelson R, 1982, Evolutionary Theory	.630	Zollo M, 2002, Organ Sci, V13, P339	.680

In this cluster, consisting of 30 papers, some of the highest impact factor papers were grouped, those works are seminal or part of theoretical basis for the subject in hand. A first group on competition research is comprised of three main themes: Resource Based View (RBV), Dynamic Capabilities (DC) and External Forces. Penrose (1959), Wernerfelt (1984), Peteraf (1993) and Barney (1991) are the basis of RBV, Eisenhardt (2000) as the basis of DC (complementing Teece (1997) which came as a different factor). DC developed from RBV and takes an internal point of view of the firm in competing. Porter (1980, 1985 and 1990) works on competitive forces, on the other hand, look for external factors in competition and are included in the factor. Schumpeter (1934 and 1942) and Prahalad (1990) are seminal papers on innovation and innovation management.

A second group of papers consists in researches from RBV competition and DC point of view. From RBV works on sustainable competitive advantage like Dierickx & Cool (1989) was developed. Amit & Schoemaker (1993) on the same line researched strategic assets and

organizational rent. Grant (1991) elaborate on implications of RBV for strategy formulation at the firms. Helfat et al. (2007) and Helfat & Peteraf (2003) bridges RBV and dynamic capabilities elaborating on dynamic RBV. Yet on capabilities, Leonard-Barton (1992) develop on core capabilities and core rigidities for new product management. Wang & Ahmed (2007) proposes a research agenda for dynamic capabilities. Winter (2003) work is about understanding dynamic capabilities. Zahra, Sapienza, & Davidsson (2006) links entrepreneurship and dynamic capabilities. Zollo & Winter (2002) theorizes on learning and evolution of dynamic capabilities.

Finally, a third group in the factor points innovation applications of competences. Christensen (1997) is a book called "Innovators Dilemma", on management of disruptive technological change, topic of the ambidexterity factor following. Daneels (2002) wrote about the dynamics of product innovation and firm competences. Henderson (1994) and Henderson & Clark (1990) wrote about architectural innovation and competence measurement.

3.2. Open Innovation/Learning Networks

Table 3: Articles and factor loads for open innovation/learning networks

Articles	Loads	Articles	Loads
Ahuja G, 2000, Admin Sci Quart, V45, P425	.877	Laursen K, 2006, Strategic Manage J, V27, P131	.619
Burt R, 1992, Structural Holes Soc	.866	Mowery D, 1996, Strategic Manage J, V17, P77	.853
Chesbrough H, 2003, Open Innovation New	.558	Nahapiet J, 1998, Acad Manage Rev, V23, P242	.757
Dyer J, 1998, Acad Manage Rev, V23, P660	.670	Nonaka I, 1994, Organ Sci, V5, P14	.696
Granovetter M, 1973, Am J Sociol, V78, P1360	.866	Nonaka I, 1995, Knowledge Creating C	.680
Granovetter M, 1985, Am J Sociol, V91, P481	.735	Powell W, 1996, Admin Sci Quart, V41, P116	.780
Grant R, 1996, Organ Sci, V7, P375	.617	Subramaniam M, 2005, Acad Manage J, V48, P450	.564
Grant R, 1996, Strategic Manage J, V17, P109	.639	Szulanski G, 1996, Strategic Manage J, V17, P27	.816
Hansen M, 1999, Admin Sci Quart, V44, P82	.921	Tsai W, 1998, Acad Manage J, V41, P464	.816
Huber G, 1991, Organ Sci, V2, P88	.631	Tsai W, 2001, Acad Manage J, V44, P996	.801
Jansen J, 2005, Acad Manage J, V48, P999	.658	Uzzi B, 1997, Admin Sci Quart, V42, P35	.842
Kogut B, 1992, Organ Sci, V3, P383	.620	Von Hippel E, 1988, Sources Innovation	.628
Lane P, 1998, Strategic Manage J, V19, P461	.801	Zahra S, 2002, Acad Manage Rev, V27, P185	.647
Lane P, 2006, Acad Manage Rev, V31, P833	.634	Zander U, 1995, Organ Sci, V6, P76	.782

The second factor groups 28 papers. Among them one common theme are collaboration networks and external sources of innovation for companies, like open innovation. Mowery, Oxley & Silverman (1996) examined interfirm knowledge transfers within strategic alliances, using a new measure of changes in alliance partners' technological capabilities, based on the citation patterns of their patent portfolios. Dyer & Singh (1998) adopt a relational view on cooperative strategy and sources of interorganizational competitive advantage offer a view that suggests that a firm's critical resources may span firm boundaries and may be embedded in

interfirm resources and routines. Four potential sources of interorganizational competitive advantage: (1) relation-specific assets, (2) knowledge-sharing routines, (3) complementary resources/capabilities, and (4) effective governance (Dyer & Singh, 1998). Nahapiet & Ghoshal (1998) wrote about social capital, intellectual capital, and the organizational advantage as theory of the firm have begun to emphasize the sources and conditions of what has been described as "the organizational advantage", rather than focus on the causes and consequences of market failure. Hansen (1999) work is about the search-transfer problem, developing on the role of weak ties in sharing knowledge across organization subunits, he combines the concept of weak ties from social network research and the notion of complex knowledge to explain the role of weak ties in sharing knowledge across organization subunits in a multiunit organization. Ahuja (2000) did a longitudinal study on collaboration networks, structural holes, and innovation. To assess the effects of a firm's network of relations on innovation, this paper elaborates a theoretical framework that relates three aspects of a firm's ego network—direct ties, indirect ties, and structural holes (disconnections between a firm's partners)—to the firm's subsequent innovation output (Ahuja, 2000).

Chesbrough (2003) is a book on open innovation and how it's a new imperative for creating and profiting from technology. Laursen & Salter (2006) also wrote about open for innovation, specifically the role of openness in explaining innovation performance among UK manufacturing firms, the paper links search strategy to innovative performance, finding that searching widely and deeply is curvilinearly (taking an inverted U-shape) related to performance. Von Hippel (2007) presents a book on the sources of innovation.

Nonaka (1994) proposes a dynamic theory of organizational knowledge creation, a new paradigm for managing the dynamic aspects of organizational knowledge creating processes. Later he publishes Nonaka & Takeuchi (1995) book The Knowledge Creation. Powell, Koput & Smith-Doerr (1996) explore networks of learning in biotechnology. Subramaniam & Youndt (2005) did a longitudinal, multiple-informant study of 93 organizations and concluded that organizational capital positively influenced incremental innovative capability, while human capital interacted with social capital to positively influence radical innovative capability.

Szulanski (1996) researched impediments to the transfer of best practice within the firm, the internal stickiness, in a data set consisting of 271 observations of 122 best-practice transfers in eight companies. Contrary to conventional wisdom that blames primarily motivational factors, the study findings show the major barriers to internal knowledge transfer to be knowledge-related factors such as the recipient's lack of absorptive capacity, causal ambiguity, and an arduous relationship between the source and the recipient (Szulanski, 1996). Tsai (2001) investigated the role of intrafirm networks, social interaction, a manifestation of the structural dimension of social capital, and trust, a manifestation of its relational dimension, were significantly related to the extent of interunit resource exchange, which in turn had a significant effect on product innovation. Tsai (2001B) analysed effects of network position and absorptive capacity on business unit innovation and performance in data from 24 business units in a petrochemical company and 36 business units in a food-manufacturing company show that the interaction between absorptive capacity and network position has significant, positive effects on business unit innovation and performance. Uzzi (1997) contributed on the paradox of embeddedness. Zander & Kogut (1995) did an empirical test on knowledge and the speed of the transfer and imitation of organizational capabilities. Burt (1992) is an article published in a book on the social structure of competition. Granovetter (1985) addressed the problem of embeddedness investigating the extent to which economic action is embedded in structures of social relations, in modern industrial society opposing to the neoclassic view of economy.

Another group of studies theme is learning and capabilities, getting to knowledge-based theory. Huber (1991) research on organizational learning articulated four constructs related to

organizational learning (knowledge acquisition, information distribution, information interpretation, and organizational memory). Kogut & Zander (1992) investigated further on the knowledge of the firm, combinative capabilities, and the replication of technology. Grant (1996) argues that organizational capabilities rather than served markets becoming the primary basis upon which firms establish their long-term strategies. So he develops a knowledge-based theory of organizational capability and draws upon research into competitive dynamics, the resource-based view of the firm, organizational capabilities, and organizational learning. Grant (1996B) theorises on a knowledge-based theory of the firm. Expanding on Resource Based View, Grant (1996B) explore the coordination mechanisms through which firms integrate the specialist knowledge of their members.

A group of works on absorptive capabilities was captured by this factor. Jansen, Van Den Bosch & Volberda (2006) work on managing potential and realized absorptive capacity explored how organizational antecedents affect potential and realized absorptive capacity. Lane & Lubatkin (1998) studied relative absorptive capacity and interorganizational learning, reconceptualizing the firm-level construct absorptive capacity as a learning dyad-level construct, relative absorptive capacity. Zahra & George (2002) did a review, reconceptualization, and extension of absorptive capacity through key dimensions of absorptive capacity and offer a reconceptualization of this construct. Building upon the dynamic capabilities view of the firm, we distinguish between a firm's potential and realized capacity, then advancing a model outlining the conditions when the firm's potential and realized capacities can differentially influence the creation and sustenance of its competitive advantage (Zahra & George, 2002). Lane, Koka & Pathak (2006) did a critical review and rejuvenation of the construct absorptive capacity through 289 papers from 14 journals to assess how the construct has been utilized, examine the key papers in the field, and identify the substantive contributions to the broader literature using a thematic analysis.

3.3. Methodology/Performance/Market Orientation

Table 4: Articles and factor loads for methodology/performance/market orientation

Articles	Loads	Articles	Loads
Anderson J, 1988, Psychol Bull, V103, P411	.870	Hurley R, 1998, J Marketing, V62, P42	.912
Armstrong J, 1977, J Marketing Res, V14, P396	.864	Jaworski B, 1993, J Marketing, V57, P53	.888
Bagozzi R, 1988, J Acad Market Sci, V16, P74	.907	Kohli A, 1990, J Marketing, V54, P1	.818
Baron R, 1986, J Pers Soc Psychol, V51, P1173	.839	Lumpkin G, 1996, Acad Manage Rev, V21, P135	.859
Calantone R, 2002, Ind Market Manag, V31, P515	.887	Narver J, 1990, J Marketing, V54, P20	.825
Churchill G, 1979, J Marketing Res, V16, P64	.897	Nunnally J, 1978, Psychometric Theory	.885
Damanpour F, 1991, Acad Manage J, V34, P555	.746	Podsakoff P, 1986, J Manage, V12, P531	.830
Day G, 1994, J Marketing, V58, P37	.815	Podsakoff P, 2003, J Appl Psychol, V88, P879	.793
Fornell C, 1981, J Marketing Res, V18, P39	.733	Slater S, 1995, J Marketing, V59, P63	.873

In this factor between the 18 papers some methodology articles loaded. It is interesting to notice how psychology journals and methods influenced the subject in applied social sciences. Anderson & Gerbing (1988) describe the use of structural equation modelling in practice for theory testing and development. Bagozzi & Yi (1988) also worked on criteria for evaluating structural equation models with latent variables. Armstrong & Overton (1977)

worked on valid predictions for the direction of nonresponse bias obtained from subjective estimates and extrapolations in an analysis of mail survey data from published studies. Baron & Kenny (1986) distinguish between the properties of moderator and mediator variables at a different level. Churchill (1979) argue for better measures of the variables with which marketers work. Fornell & Larcker (1981) examined the statistical tests used in the analysis of structural equation models with unobservable variables and measurement error. Nunnally (1978) is a book on psychometric theory. Podsakoff, MacKenzie, Lee, & Podsakoff, (2003) and Podsakoff & Organ (1986) develop on problems of self-reporting and biases in behavioural research methods and how to remedy those problems.

In a second group of articles in this factor research on innovation and its influence in firm performance. Damanpour (1991) holds a meta-analysis of the relationships between organizational innovation and thirteen of its potential determinants resulted in statistically significant associations for nine. Damanpour (1991) also did moderator analyses which indicated that the type of organization and their scope are effective moderators of the focal relationships than the type of innovation and the stage of adoption. Calantone, Cavusgil, & Zhao (2002) studied learning orientation, firm innovation capability, and firm performance. Learning orientation comprises of four factors: commitment to learning, shared vision, open-mindedness, and intraorganizational knowledge sharing (Calantone et al., 2002). Calantone et al. (2002) tested a framework using data from US industries, learning orientation was conceptualized as a second-order construct, authors examined its effect on firm innovativeness, which in turn affects firm performance. Lumpkin & Dess (1996) worked on entrepreneurial orientation construct to propose a contingency framework for investigating the relationship between entrepreneurial orientation and firm performance.

A third group of articles are based on market orientation. Kohli & Jaworski (1990) developed a framework for understanding the implementation of the marketing concept, theorizing market orientation from 35 years research in the marketing literature, work in related disciplines, and 62 field interviews with managers. Narver & Slater (1990) point that for more than three decades (since the 70's so) research and practice observe that business performance is affected by market orientation, the authors report the development of a valid measure of market orientation and analyse its effect on a business's profitability from a sample of 140 business units they found a substantial positive effect of a market orientation on the profitability of businesses. Jaworski & Kohli (1993) researched market orientation and how it is related to top management emphasis on the orientation, risk aversion of top managers, interdepartmental conflict and connectedness, centralization, and reward system orientation. Day (1994) found that the most distinctive features of market-driven organizations are their mastery of the market sensing and customer linking capabilities. Slater & Narver (1995) claim that as important as market orientation and entrepreneurship are, they must be complemented by an appropriate climate to produce a "learning organization". Hurley & Hult (1998) developed a conceptual framework for incorporating constructs from innovation in market orientation research, testing relationships in this conceptual framework among a sample of 9648 employees from 56 organizations in a large agency of the U.S. federal government. Higher levels of innovativeness in the firms' culture are associated with a greater capacity for adaptation and innovation; and are associated with cultures that emphasize learning, development, and participative decision making (Hurley & Hult, 1998).

3.4. Ambidexterity

Table 5: Articles and factor loads for ambidexterity

Articles	**Loads**	**Articles**	**Loads**

Benner M, 2003, Acad Manage Rev, V28, P238	.856	Katila R, 2002, Acad Manage J, V45, P1183	.692
Gibson C, 2004, Acad Manage J, V47, P209	.899	Levinthal D, 1993, Strategic Manage J, V14, P95	.693
Gupta A, 2006, Acad Manage J, V49, P693	.902	March J, 1991, Organ Sci, V2, P71	.503
He Z, 2004, Organ Sci, V15, P481	.867	Rosenkopf L, 2001, Strategic Manage J, V22, P287	.578
Jansen J, 2006, Manage Sci, V52, P1661	.842	Tushman M, 1996, Calif Manage Rev, V38, P8	.865

From the ten articles at this factor, six have exploration and exploitation at their titles, including the seminal work by Stanford professor March (1991), who firstly pointed the risk on focusing only in exploring new possibilities or exploiting existing resources. Two articles have them indirectly with only exploration term (Rosenkopf & Nerkar, 2001) or ambidextrous organisation (Tushman & O'Reilly III, 1996) at the title. The other two articles, Katila & Ahuja (2002) and Levinthal & March (1993) are, respectively, about new product development and the myopia of learning. Both articles also get to the point of exploration/exploitation. Another point to be noticed is that four articles are from the Academy of Management Journal, a high impact well cited journal.

A first group of articles in this factor related organisational learning and exploration/exploitation. Levinthal & March (1993) stresses the limitations of organisational learning, while calling the development of new knowledge as exploration, they argue that exploitation of current competencies from companies tend to be overinvested, concluding that the imperfections of learning are not so great as to require abandoning attempts to improve the learning capabilities of organizations, but that those imperfections suggest a certain conservatism in expectations. March (1991) also bridges organisational learning and exploration/exploitation, examining complications of allocating resources between the two options and arguing that adaptive processes, which refines exploitation more rapidly than exploration, are likely to become effective in the short run but self-destructive in the long run. Katila & Ahuja (2002) investigated the global robotics industry for problem search and solving on new products creation, concluding that search efforts vary in two distinct dimensions: search depth (frequency of existing knowledge reuse), and search scope (firm exploration of new knowledge).

Rosenkopf & Nerkar (2001) held a patent study on optical disk technology, and concluded that exploration that does not span organizational boundaries consistently generates lower impact on subsequent technological evolution. The six with exploration and exploitation at their titles basically investigate on ambidexterity and related aspects like moderations and antecedents. Tushman & O'Reilly III (1996) reinforces the importance of managers and organizations being able to implement both incremental and revolutionary change states (ambidextrous) and that managers face problems in overcoming inertia and implementing innovation and change. Tushman & O'Reilly III (1996) also explore why is this problem such an enduring one and; why is anything but incremental change often so difficult for the most successful organizations; and why are the patterns of success and failure so prevalent across industries and over time. Benner & Tushman (2003) argue that dynamic capabilities provides companies with the ambidexterity to navigate the exploration/exploitation dilemma. Gibson & Birkinshaw (2004) also investigated contextual ambidexterity facilitation through a combination of stretch, discipline, support, and trust; and also, ambidexterity mediating the relationship between these contextual features and performance. He & Wong (2004) recognises exploration and exploitation as approaches for organisational learning but argue that there is little direct evidence of the positive effect of ambidexterity on firm performance, so they

examined a sample of 206 manufacturing firms and found evidence consistent with the ambidexterity hypothesis by showing that the interaction between explorative and exploitative innovation strategies is positively related to sales growth rate. Gupta, Smith, & Shalley (2006) argue that still there are ambiguities in the definition of exploration and exploitation and addresses four questions like their meaning whether if must all organizations strive for balance, or specialization between the two for long-run success. Jansen, Van Den Bosch, & Volberda (2006) state that antecedents and consequences of explorative and exploitative activities remains rather unclear, they focus on the apparent differences of exploration and exploitation and implications for using formal and informal coordination mechanisms; and how environmental aspects moderate the effectiveness of exploratory and exploitative innovation. Results indicate that centralization negatively affects exploratory innovation, whereas formalization positively influences exploitative innovation (Jansen et al., 2006).

3.5. Technology Development and Organizational Inertia

Table 6: Articles and factor loads for technology development and organizational inertia

Articles	**Loads**
Levitt B, March J, 1988, Annu Rev Sociol, V14, P319	.509
Tushman M, 1986, Admin Sci Quart, V31, P439	.576
Tripsas M, 2000, Strategic Manage J, V21, P1147	.576
Dosi G, 1982, Res Policy, V11, P147	.600
Christensen C, 1996, Strategic Manage J, V17, P197	.712

At these five papers factor most studies address points on technological development and issues like organizational inertia and threats coming from new technology being developed by other companies. Apart form Levitt & March (1988), all the other studies developed models and frameworks to help companies recognise innovation related threats and respond accordingly. Nevertheless, organizational learning is also a source of response for innovation related threats and can help firms to compete.

Levitt & March (1988) wrote about organizational learning and leave an open path for the study of organizational learning as a form of intelligence. Tushman & Anderson (1986) investigated microcomputer, cement and airline industries to theorise on patterns of technological change and the impact of competence-destroying discontinuities (technology breakthroughs) caused by new firms' technology, versus competence-enhancing discontinuities caused by existing firms on competitive environment conditions. Tripsas (1997) held an in-depth case study of Polaroid company shift from analog to digital imaging to understand how managerial cognition affects the adaptive intelligence of organizations. Dosi (1982) developed a model which tries to account for both continuous changes and discontinuities in technological innovation, establishing a general framework to account factors and define the process of selection of new technological paradigms among a greater set of notionally possible ones. Christensen & Bower (1996) present a model, based on the disk drive industry, that charts the process through which the demands of a firm's customers shape the allocation of resources in technological innovation.

3.6. Innovation at a National/Sector Level

Table 7: Articles and factor loads for innovation at a national/sector level

Articles	Loads
Pavitt K, 1984, Res Policy, V13, P343	.599
Nelson R R, 1993, National Innovation Systems	.703
Lundvall B, 1992, National Innovation Systems	.711
Lall S, 1992, World Dev, V20, P165	.794

This factor comprises of four articles on innovation studies about a higher level like a nation or a sector. Nelson and Lundval wrote articles for a book called "National Innovation Systems: A Comparative Analysis" the book is divided in part I: large high-income countries, II: smaller high-income countries, III: Lower income countries and IV: National Innovation Systems. Nelson was the coordinator of the book and Lundvall contributed to part IV (Nelson, 1993). Lall (1992) also studied technological capabilities at national levels and at the firms level as well, setting a framework to explain the growth of national capabilities. Pavitt (1984) objective was to describe and explain sectoral patterns of technical change based on data from 2000 innovations in Britain since 1945. Those sectoral patterns where explained in a three-part taxonomy based on firms: (1) supplier dominated; (2) production intensive; (3) science based.

4 Discussion and Conclusions

This research indicates the validity of author co-citation as a technique to map current state-of-the-art of a given field. On innovation capabilities currently six authors co-citation clusters were identified and statistically validated. So, the aim of this research was achieved. The first, more obvious one, operates on the theoretical basis of the subject and is consolidated. The other factors point a huge weight in innovation management related topics like in Open Innovation/Learning Networks and Ambidexterity factors. There is also a great deal of attention devoted to performance and competition related topics like in Competition and Market Orientation factors. A third main theme, and less obvious one, is about learning and knowledge in Learning Networks.

Further research should investigate those clusters to operationalise the construct of innovation capabilities and conduct quantitative research as scholars indicate that qualitative case studies were already conducted to explore the topic (Wang & Ahmed, 2007). A starting point would be to analyse all current published and validated scale for innovation capabilities in order to build a stronger compounded scale. Or to create a new one according to DeVellis (2016) scale development procedures.

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