INTERNAL AND EXTERNAL RELATIONS-BASED KNOWLEDGE AS ANTECEDENTS OF RADICAL INNOVATION: AN EMPIRICAL STUDY

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Abstract

The present paper tries to provide a new insight into intellectual capital classification by theoretically and empirically differentiating relations-based knowledge into social capital and relational capital. Additionally, taking into account the key role played by radical innovation to compete in the context defined by the “Knowledge-based Economy”, we empirically investigate the possible effect of both relations-based intellectual capital components on the development of this kind of innovation by firms. Thus, from a sample of 251 Spanish high and medium-high tech firms, empirical findings show that relations-based intellectual capital can be separated into social and relational capital, with social capital as main component, and both elements have a significantly positive influence on radical innovation developed by firms in our sample, although those relationships maintained with external agents seem to have a higher impact.

EL CONOCIMIENTO BASADO EN LAS RELACIONES INTERNAS Y EXTERNAS COMO ANTECEDENTE DE LA INNOVACIÓN RADICAL: UN ESTUDIO EMPÍRICO

Resumen

La presente investigación trata de proporcionar una nueva comprensión sobre la clasificación de capital intelectual mediante la diferenciación teórica y empírica del conocimiento basado en las relaciones: capital social y capital relacional. Asimismo, teniendo en cuenta el importante papel adquirido por la innovación radical para competir en la actual Sociedad del Conocimiento, se analiza empiricamente el posible efecto de ambos componentes de capital intelectual sobre el desarrollo de este tipo de innovación. A partir de una muestra de 251 empresas españolas de alta y media-alta tecnología, los resultados muestran que dentro del capital intelectual basado en relaciones se pueden distinguir dos clases de capitales -siendo el capital social el componente clave-, y que ambos elementos tienen una influencia positiva y significativa sobre la innovación radical. Concretamente, son las relaciones externas las que tienen un mayor impacto sobre aquellas innovaciones con un elevado grado de novedad por proporcionar conocimiento diverso y heterogéneo.

*Palabras clave:* Capital Social, Capital Relacional, Conocimiento basado en las Relaciones, Innovación Radical
Introduction

Different authors (e.g.: Grant, 1996; Dean & Kretschmer, 2007) claim that we are in what they call “Knowledge-based Economy”. This assumption implies that, due to the important process of socioeconomic change, a new environment has emerged in which economic globalization, technological revolution, increasing primacy of services, shortening life cycle of products or changes in customers’ needs and demand patterns, among others, are some of the major factors to take into account.

In this new global and dynamic competitive landscape, information and knowledge, as inputs of firm’s production process, are considered as key elements for firms’ profitability and survival, in a greater extent that traditional production factors such as land, capital or labour (Tseng & Goo, 2005; Dean & Kretschmer, 2007; Khamseh & Jolly, 2008; Mu et al., 2008). Additionally, technological innovation also plays a key role for firm success and, ultimately, for survival, because it leads to continuous strategic renewal (Danneels, 2002) and to adaptation to market changes (Stieglitz & Heine, 2007), both necessary to achieve a competitive advantage in dynamic contexts (Teece et al., 1997). Therefore, it can be claimed that “knowledge and innovation are the dominating resources in the contemporary Knowledge-based Economy” (Tseng & Goo, 2005: 187).

Knowledge-based resources (intangible resources and capabilities) have been analyzed by different theoretical approaches, such as the Resource-based View (Wernerfelt, 1984; Barney, 1991), Knowledge-based View (Kogut & Zander, 1992; Nonaka, 1994; Grant & Baden-Fuller, 2004), or Dynamic Capabilities Perspective (Teece et al., 1997; Eisenhardt & Martin, 2000). This paper, however, is focused on an Intellectual Capital-based View of competitive advantage (Reed et al., 2006). This approach helps to overcome the gap between the conceptual thinking of the resource-based view and the necessary practical approach for its adoption by managers and practitioners (Kong, 2008).

In this way, our research carries out an analysis of intangible factors within a slightly treated perspective by previous empirical research, trying to shed more light on a issue that still requires a thorough theoretical and empirical development (Cabrita & Bontis, 2008), as it is the intellectual capital owned by firms.

Intellectual capital, defined as a set of intangible resources and capabilities related to different categories of knowledge, which can provide a firm competitive advantage, has been studied by several authors who have tried to identify its components (e.g.: Edvinsson & Sullivan, 1996; Bontis, 1998; Subramaniam & Youndt, 2005; Cabrita & Bontis, 2008). In this sense, most studies propose a classification on this concept based on three elements: human capital (knowledge, skills, experience, motivation, etc. embedded in firm’s employees), structural capital (methods, capabilities, routines, procedures, etc. embedded in the organization), and relational capital (knowledge, capabilities, procedures, etc. embedded in the organization which arises from the relationships maintained with external agents).

Nevertheless, there is not consensus on the concepts considered within a relations-based intellectual capital component. Works such as Youndt et al. (2004); Subramaniam and Youndt (2005), Reed et al. (2006) or Carlucci and Schiuma (2007) do not differentiate between the relationships maintained by individuals within the organization from those maintained with other agents at institutional level by the firm. Also, several authors focused on intellectual capital do not consider those personal relationships among employees within the firm (Brooking, 1996; Edvinsson & Sullivan, 1996; Roos & Roos, 1997; Bontis, 1998; Edvinsson & Malone, 1999; Sveiby, 2000;
Leliaert et al., 2003; Hayton, 2005; Kong, 2008). Even some authors as Wu et al. (2008), instead of not considering social capital as a component of intellectual capital, recognize its relevance as interacting factor with other intellectual capital components.

By contrast, from a knowledge creation point of view, and taking into account innovation as main objective, relationships arising around the organization are increasing its relevance in recent times (Tsai & Ghoshal, 1998; Chang, 2003; Laursen & Salter, 2006; Wu et al., 2008; Zheng, 2010; Alguezaui & Filieri, 2010). Accordingly, it is interesting to distinguish between the different intellectual capital endowments required to achieve different kinds of innovation, which constitutes an under research issue in current literature (Subramaniam & Youndt, 2005; Wu et al., 2008).

Therefore, the present study, based on the social capital stream (Nahapiet & Ghoshal, 1998; Adler & Kwon, 2002; Zheng, 2010) and considering individually its analysis (Bolino et al., 2002, Zheng, 2010), tries to provide a new insight into intellectual capital classification. So, knowledge derived from institutional relationships between the firm and other actors will be considered within relational capital. On the other hand, knowledge arising from personal and informal relationships maintained among firm's employees will be considered as social capital. This distinction is necessary because two such different kinds of relationships should not be understood as one single component of intellectual capital.

In addition, taking into account the key role played by technological innovation in the so-called "Knowledge-based Economy", the present paper attempts to add some empirical evidence on the possible effect of inter and intra-organizational relationships on radical innovation. In this sense, as recognized in recent literature, mere improvement of current products, services or production processes is not enough to ensure firm's viability in such environments (Rosenkopf & Nerkar, 2001). To avoid the threat of obsolescence associated with this type of contexts, organizations must develop innovations with a higher degree of novelty (Benner & Tushman, 2003; Jansen et al., 2006). However, in spite of many theoretical discussions on the effect of radical innovation, the origins of this kind of innovation have so far received much less attention by researchers (Schoenmakers & Duysters, 2010). Our research tries to fill this gap empirically analyzing the role of firm’s relationships-based intellectual capital as determinants of innovation radicalness (the degree of novelty incorporated in an innovation).

The paper is structured as follows. First, we offer a deeper explanation of intellectual capital as well as the key concepts considered in the study (social capital, relational capital and radical innovation). Secondly, we present the proposed hypotheses to be tested. After that, we explain the measurement of variables and methodology followed to carry out our empirical analysis. Then, we present the empirical findings using data from 251 Spanish high and medium-high tech firms. We conclude with a discussion of the results, implications, and future research directions.

**Theoretical Background**

New theoretical approaches have emerged in order to analyze the causes of business success from internal organizational factors. In this sense, the Intellectual Capital-based View arises to overcome some limitations associated to the Resource-based View regarding measurement of its core concepts (Priem & Butler, 2001). This problem is especially remarkable in the case of intangible resources, which meet certain requirements that make them to have a higher potential in achieving a competitive advantage (Hall, 1993).
According to Reed et al., (2006), broadly, such limitations are the following: lack of specificity about the required resources to accumulate in order to achieve a competitive advantage; it does not provide a clear definition of competitive advantage; and it has some tautological problems. Therefore, by focusing on the Intellectual Capital-based View, this research tries to overcome some of those problems by identifying and measuring organizational intangible resources and capabilities which can lead to achieve a competitive advantage by firms.

As it has been mentioned in the previous section, it is usually considered that intellectual capital consists of three elements: human capital, structural capital and relational capital, which refer to individual, organizational and inter-organizational knowledge, respectively. However, the growing number of studies analyzing the concept of social capital in recent times (Dean & Kretschmer, 2007; Zheng, 2010; Alguezau & Filieri, 2010) and its inclusion in some works focused on intellectual capital where different relationships are considered (Subramaniam & Youndt, 2005; Carlucci & Schiuma, 2007) lead us to integrate it within this view in order to pay attention to that knowledge related to social and informal relationships maintained between employees within organizational boundaries, so separating them from those relationships maintained by the firm with other agents.

Therefore, taking into account that relationships and/or networks are considered as one of the most promising areas within the Resource-based View (Acedo et al., 2006), and due to the great interest acquired by relationships in achieving innovation both at institutional (Damanpour, 1991; Chang, 2003, Grant & Baden-Fuller, 2004; Laursen & Salter, 2006) as well as at personal level (Tsai & Ghoshal, 1998; Nahapiet & Ghoshal, 1998; Swart, 2006; Wu et al., 2008; Zheng, 2010), the present paper is focused on firm’s relational and social capital. In this sense, in order to deepen both concepts, a comprehensive literature review was carried out attempting to specify the issues involved in each one of them.

Regarding relational capital, authors studying it within the logic of intellectual capital stress the value derived from external relationships (Brooking, 1996; Sveiby, 2000; Youndt et al., 2004), underlying the important role played by those relationships maintained with customers. So, authors such as Roos and Roos (1997), Bontis (1998), Edvinsson and Malone (1999) or Leliaert et al. (2003), called “customer capital” to those knowledge derived from relationships maintained by the firm with other external agents, except in the last two mentioned works that only include relationships with customers. Some authors also include reputation within this kind of intellectual capital based on the argument that it constitutes how the firm is perceived by those external agents (Sveiby, 2000; Hayton, 2005).

Accordingly, relational capital can be defined as the set of knowledge obtained by the firm derived from relationships with other agents of its environment (as customers, suppliers, or allies) which brings the necessary knowledge base to carry out its activity more efficiently.

With regard to social capital, this study adopts the emerging perspective of social capital, also considering proposals from other studies focused on intellectual capital. So, taking into account the ideas arising from works such as Nahapiet and Ghoshal (1998), who laid the foundations for further studies based on this perspective, or Adler and Kwon (2002), who reviewed the concept of social capital, our research seeks to include this concept within intellectual capital classification as well as to sort and homogenize the different underlying ideas that have been developed around it with the aim of shedding some light to the lack of consensus in academic literature.
Before presenting the significance of social capital, it is necessary to take into account two aspects. On the one hand, social capital can be analyzed at different levels: individuals, teams, organizations, communities and countries (Bolino et al., 2002; Zheng, 2010). On the other hand, it may include both formal and informal relationships (Nahapiet & Ghoshal, 1998; Bolino et al., 2002; Alquezau & Filieri, 2010; Zheng, 2010). Based on a more sociological point of view, as Fukuyama (1997), who defines social capital as a certain set of informal values or norms shared by members of a group which allow them to promote cooperation, the present paper is focused on those informal relationships held at individual level within the firm. Thus we include issues such as friendship (a primary feature highlighted by Alder & Kwon, 2002), complicity, affinity, goodwill or confidence arising among individuals.

Based on the previous reasoning, social capital can be defined as the set of informal and personal relationships maintained by employees within the firm, and not predetermined by it, which allows improving knowledge base and, therefore, objectives achievement.

Once both intellectual capital components have been defined, the next step consists into analyze technological innovation. This issue has been addressed by several authors over time (e.g.: Schumpeter, 1912; Myers & Marquis, 1969; Nonaka, 1994; EC, 1995; Subramaniam & Youndt, 2005; OECD, 2006; Song & Thieme, 2009). However, despite the large number of studies examining this concept, due to the growing dynamism and uncertainty characterizing current environments, innovation has renewed its interest as a key source in adapting to market change (Stieglitz & Heine, 2007) and therefore in organizational success.

So, innovation should be considered as the main instrument to compete by many firms, especially by those operating in technology-based industries. Broadly, innovation process can be understood as a complex activity in which current and new knowledge is applied for commercial ends (Galende, 2006; Escribano et al., 2009). In fact, some authors consider innovation as the most knowledge-intensive organizational process that depends not only on the individual members, but also on the collective knowledge of a firm (Adamides & Karacapilidis, 2006).

One of the most common criteria to classify innovation involves its degree of novelty, ranging from incremental to radical innovations. Incremental innovations consist of minor changes or plain adjustments to existing products or technology and are built on firm’s current technological capabilities, whereas radical innovations imply the development of a highly novel or unique product/service or production process and are based on changes in firm’s technological trajectory and associated organizational competencies (Tidd, 2001; Benner & Tushman, 2003).

Based on the argument that environmental dynamism is competence-destroying (Teece et al., 1997; Uotila et al., 2009), Benner and Tushman stated that “the ability to develop new technological capabilities rapidly is especially critical in environments characterized by rapid innovation and change” (2003: 249). In the same way, Jansen et al. pointed out that “dynamic environments make current products and services obsolete and require that new ones be developed” (2006: 1664). In other words, firm’s current knowledge and technology, while valuable in that they can provide competitive advantage at present, do not ensure that the firm would be able to maintain its competitive advantage in the face of rapid external changes (O’Reilly & Tushman, 2008).
So, to reduce this threat of obsolescence, organizations must introduce more radical innovations that depart from existing products/services, production processes or markets. Organizations that pursue such innovation can capitalize on changing circumstances through creating opportunities for above-normal return by targeting premium market segments and creating new niches (Levinthal & March, 1993).

Nevertheless, despite its relevance and the great number of theoretical discussions and empirical analyses about the effect of this kind of innovation, the origins of radical innovation constitutes a under research issue in current literature (Schoenmakers & Duysters, 2010). In the following sections we try to fill this gap by theoretically proposing and empirically analyzing the role of relations-based knowledge in achieving radical innovation by firms.

**Hypotheses**

**Relational capital as a source of radical innovation**

There are few studies relating the degree of novelty of innovations and the relational capital. Among them, we can mention Damanpour (1991), who found that external communication was positively associated with radical innovation. This is because the exchange of inter-organizational information enriches the organizational knowledge and encourages the creation of new ideas. According to this evidence, we can consider that firms, in order to increase their capacity to develop discontinuous or radical innovations, must create new networks with customers, suppliers, allies and other partners.

Thus, Nieto and Santamaría (2007) pointed out that the links with customers, suppliers and research organizations have a positive influence on the probability of developing radical product innovation, being greater and more meaningful the relationship with suppliers, since it helps the development of new products and improve quality. Specifically, Song and Thieme (2009), contrary to what they expected, found that relationships with suppliers, in the market development stage, have a significantly positive influence on radical innovation (in a greater extent than on incremental innovation). These authors argued that the results were due to the fact that in new markets, the suppliers can be an important source of market information because of their experience in the application of new technologies to other markets.

In the same vein, Díaz et al. (2006), taking as the dependent variable the “innovation capability” to develop new or significantly improved products and processes, also found that the relationships with customers and suppliers (partnerships), universities, participation in technology development companies, joint ventures and European Union projects, have a positive effect on the probability of developing radical innovation, having customers and suppliers relationships the greatest importance on innovation capability.

Similar argumentation is provided by Simon et al. (2007) for which the relationships with universities, government laboratories and external research institutions play a complementary role enriching firm’s internal resources, sharing the risk and facilitating the innovation process. According to Chang (2003), companies involved in various types of cooperative arrangements can introduce a greater level of innovation, that is, a radical innovation.

Thus, it can be argued that collaboration with more than one agent has a positive effect on the probability of carrying out a radical innovation. Being more likely for
radical product innovation that for incremental product innovation (Nieto & Santamaría, 2007). In other words, much greater diversity of knowledge derived from heterogeneous relationships with various stakeholders, like research networks, public research institutions or universities (Landry et al., 2002; Baba & Walsh, 2010), the better position to achieve a greater number of radical innovations.

Therefore, based on the arguments above, we suggest the following hypothesis:

**Hypothesis 1**: Relational capital has a positive influence on radical innovation

#### Social capital as a source of radical innovation

Generally speaking, it can be argued that social capital affects innovative activity (Tsai & Ghoshal, 1998). According to Fukuyama (2000, in Kaasa, 2009), innovative activity depends on the spread of information. For that reason, those activities inside the firm that enhance person to person communications (Poolton & Barclay, 1998) and personal relationships (e.g. meetings between senior staff and non management staff in their private time), play an important role and are a critical variable for innovation.

Taking these assertions as a starting point, some scholars have tried to enrich the relationship between social capital and radical innovation. In this sense, we can mention different contributions ranging from some that highlight the role of organizational communication to others that emphasize the importance of the creative ideas within the firm on radical innovation.

Un and Cuervo-Cazurra (2004) highlighted the importance of personal relationships within the organizational communication. From their point of view, organizational communication has a positive effect on new product development. More specifically, they make a difference between new product development and product modification, so, indirectly, they are connecting organizational communication and radical innovation.

According to Subramaniam and Youndt (2005), social capital has a positive influence on the capability to carry out radical innovations. Emphasizing the role played by the relationships within the company, these authors highlighted the fact that social capital has a direct and highly significant effect on innovation. According to these authors, the connection of different creative ideas and thoughts may result in radical innovations.

Using a similar approach and referring to these creative ideas, or more specifically to the level of creativity within the organization, Carmona-Lavado et al. (2010) argued that the information exchange associated to social capital encourages the questioning of prevailing norms and leads to the emergence of new ways of thinking. According to this, social capital is appropriate to handle situations in which the information has a high degree of uncertainty, where radical innovation is more likely to happen. Furthermore, given that uncertainty associated to radical innovation, high quality relationships among people within the firm (social capital), could support the decision making process, characterized by its complexity in this kind of situation.

Therefore, based on the reflections above, we suggest the following hypothesis:

**Hypothesis 2**: Social capital has a positive influence on radical innovation

#### Methodology
Sample and data

According to Rouse and Daellenbach (1999), this study focused on a homogeneous industry with the aim to avoid different effects derived from environmental factors. In addition, due to the fact that those firms based on knowledge have a strong dependence on intellectual capital (Johnson et al., 2002), and specifically the importance of R&D intensity as indicator of technology-intensive manufacturing sectors (Huergo, 2006), high and medium-high technology manufacturing companies were selected to carry out our analysis.

On the other hand, in order to achieve a sufficiently diverse stock of relational and social capital, firms with fifty or more employees were considered. Thus, from the SABI database1, we obtained a total number of 1270 Spanish firms.

Data were collected from a questionnaire (7-point Likert scale, see appendix) designed by us with the objective to attain those unique and valuable competences of the firm, which can lead to competitive advantage (King & Zeithaml, 2003), being not included in secondary sources (Penrose, 1959).

In this sense, senior managers were the respondents in order to achieve relevant information, since that kind of managers has a thorough of knowledge of the firm and their competitors. The questionnaire was administered as a telephone survey to clarify any problem, obtaining finally a total of 251 valid questionnaires, which represent a response rate of 17.07% with a sampling error of +/- 5.5% for a 95% confidence level. Those data were collected between January and June of 2009.

Table 1 shows the technical resume of the empirical study.

Table 1. Research Outline

<table>
<thead>
<tr>
<th>Research focus</th>
<th>Relations-based knowledge and radical innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criteria defining sample</td>
<td>High and medium-high technology manufacturing firms From industries CNAE-93: 24, 29, 30, 31, 32, 33, 34 &amp; 35 Operating in Spain 50 employees or bigger Included in SABI database</td>
</tr>
<tr>
<td>Population</td>
<td>1,270 firms</td>
</tr>
<tr>
<td>Sample (response rate)</td>
<td>251 firms (17.07%)</td>
</tr>
<tr>
<td>Sampling Technique</td>
<td>Random algorithm of Pascal’s language</td>
</tr>
<tr>
<td>Sampling error</td>
<td>+/- 5.5%</td>
</tr>
<tr>
<td>Method for data gathering</td>
<td>Survey</td>
</tr>
<tr>
<td>Respondents</td>
<td>Senior Managers</td>
</tr>
<tr>
<td>Process for data gathering</td>
<td>Phone questionnaire</td>
</tr>
<tr>
<td>Fieldwork implementation</td>
<td>From January 2009 to June 2009</td>
</tr>
<tr>
<td>Statistical software used</td>
<td>SPSS 17.0 for Windows</td>
</tr>
</tbody>
</table>

1 “Sistema de Análisis de Balances Ibéricos” (SABI) is an economic-financial database which includes around 550,000 Spanish firms and 67,000 Portuguese firms. Each record includes the following information: contact, activity description, national and international economic activities codes (in this article CNAE-93 is used), corporate body, number of employees, profit and loss account and set-up date.
Measurement of variables

From a wide review of the literature, we designed the two main constructs of our research (relational capital and social capital), and we considered radical innovation as dependent variable. In this way, 15 questions were considered in order to measure our variables: 6 questions referred to relational capital, 6 to social capital, and 3 to radical innovation.

Regarding relational capital (see appendix), we obtained information about customers relating to valuable information on market needs and tendencies, and the join development of solutions (Yli-Renko et al., 2001; Tippins & Sohi, 2003; Chen et al., 2004; Youndt et al., 2004; Subramanian & Youndt, 2005; Reed et al., 2006); about suppliers, the improvement of products and processes quality and design, and the join development of solutions (Chen et al., 2004; Youndt et al., 2004; Subramanian & Youndt, 2005; Reed et al., 2006); and about allies, the improvement of products and processes quality and design, and the join development of solutions (Youndt et al., 2004; Subramanian & Youndt, 2005; Reed et al., 2006).

With respect to social capital (see appendix), we obtained information relating to informal exchange of ideas about new product development, constructive discussions, good close relationships, advice and support, shared knowledge and experience, and mutual help (Tsai & Ghoshal, 1998; Yli-Renko et al., 2001; Rodan & Galunic, 2004; Zárraga & Bonache, 2005; Wu et al., 2008).

Radical innovation was measured considering the number of innovations completely new, obsolete or drastically changes in previous ones, and percentage of sales on radical innovations (Tsai & Ghoshal, 1998; Souitaris, 2002; Chen et al., 2004; Wang & Ahmed, 2004; Hayton, 2005; Subramaniam & Youndt, 2005).

Finally, due to the fact that a firm’s size and age, as well as industry to which a firm belongs, may influence innovation, they are considered as control variables (based on Subramaniam & Youndt, 2005; Reed et al., 2006; among others). Accordingly, size was measured by means of employees of the firm; age was measured from the date of the firm’s establishment, and an industry dummy was included to assess if firms were either high or medium-high technology manufacturing firms (0 = otherwise).

Results

In order to test our hypotheses, two exploratory factor analyses were conducted. The first one included the 12 items referred to relations-based knowledge, and the second one included the 3 items used to measure radical innovation. The objective was to identify the two kind of relations-based knowledge (relational and social capital), and to develop the variable “radical innovation”, respectively. Then, linear regression analyses were carried out (using SPSS 17.0).

Regarding exploratory factor analysis for relations-based knowledge (see Table 2), the main indexes showed the appropriateness of using this analysis (Hair et al., 2004), since the KMO index had a value higher than .6 (.903); the Bartlett’s test was significant a level less than .05 (.000); and the matrix determinant had a value of 0. Moreover, using varimax orthogonal rotation, all items had a load higher than .6, and were included on the right factor, finding the two factors presented in the theoretical background within relations-based knowledge: social and relational capital. In addition,
Cronbach’s Alpha coefficients were higher than .7 (.925 and .866, respectively), confirming that the measures utilized were valid and internally consistent (Hair et al., 2004). Finally, the percentage of accumulated explained variance for both factors was 67.23, being higher than the proposed value for social science: 60%.

Table 2. Exploratory Factor Analysis for Social and Relational Capital

<table>
<thead>
<tr>
<th>Item</th>
<th>Social Capital</th>
<th>Relational Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>RC1</td>
<td>.159</td>
<td>.705</td>
</tr>
<tr>
<td>RC2</td>
<td>.263</td>
<td>.638</td>
</tr>
<tr>
<td>RC3</td>
<td>.186</td>
<td>.775</td>
</tr>
<tr>
<td>RC4</td>
<td>.225</td>
<td>.832</td>
</tr>
<tr>
<td>RC5</td>
<td>.227</td>
<td>.772</td>
</tr>
<tr>
<td>RC6</td>
<td>.242</td>
<td>.762</td>
</tr>
<tr>
<td>SC1</td>
<td>.755</td>
<td>.259</td>
</tr>
<tr>
<td>SC2</td>
<td>.823</td>
<td>.218</td>
</tr>
<tr>
<td>SC3</td>
<td>.764</td>
<td>.293</td>
</tr>
<tr>
<td>SC4</td>
<td>.879</td>
<td>.248</td>
</tr>
<tr>
<td>SC5</td>
<td>.822</td>
<td>.147</td>
</tr>
<tr>
<td>SC6</td>
<td>.877</td>
<td>.272</td>
</tr>
</tbody>
</table>

| Cronbach alpha | .925 | .866 |
| Explained variance | 51.69% | 15.54% |
| Accumulated | 51.69% | 67.23% |

Extraction method: Principal components.
Rotation method: Varimax normalization with Kaiser.
Rotation has converged after 3 iterations.

On the other hand, we also obtained satisfactory results with respect to radical innovation exploratory factor analysis (see Table 3). In this way, the value of KMO index was .631, the Bartlett’s test was significant (.000), and the matrix determinant value was .334. Furthermore, using varimax orthogonal rotation, the three items had a load higher than .6, indicating that variable “radical innovation” is single-dimensional. The required reliability level was shown, obtaining a Cronbach’s alpha value of .793, and its percentage of explained variance was 70.96.

Table 3. Exploratory Factor Analysis for Radical Innovation

<table>
<thead>
<tr>
<th>Item</th>
<th>Radical Innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAD1</td>
<td>.860</td>
</tr>
<tr>
<td>RAD2</td>
<td>.748</td>
</tr>
<tr>
<td>RAD3</td>
<td>.911</td>
</tr>
</tbody>
</table>

| Cronbach alpha | .793 |
| Explained variance | 70.96% |

Extraction method: Principal components.
Rotation method: Varimax normalization with Kaiser.
Rotation has converged after 3 iterations.

The next step was to design two regression models in order to analyze the influence of each kind of relations-based knowledge on radical innovation (see Table 5). We paid attention to the normality of dependent variable, obtaining satisfactory results using Q-Q graphs and Kolmogorov-Smirnov test, and to the possible multicollinearity through correlations matrix, not finding problems among used variables (see Table 4). Then, according to multiple linear regression rules, Durbin-Watson’s values were close to 2, so residues are independent, and statistician F values showed a linear significant relation between radical innovation and each type of relations-based knowledge: relational and social capital, showing the statistical validity of the proposed models.

Table 4. Means, Standard Deviations, and Correlations
Thus, as it can be seen in model 2 (see Table 5), both types of knowledge have a positive and significant statistical influence on radical innovation, supporting our two hypotheses. Moreover, relational capital has a higher coefficient (.341) than social capital one (.276), and both explain a relevance percentage of radical innovation variance (29.3). Finally, any control variables had a significant role in radical innovation.

Table 5. Regression Analysis

<table>
<thead>
<tr>
<th></th>
<th>Radical Innovation</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Model 1</td>
</tr>
<tr>
<td>Control Variables</td>
<td></td>
</tr>
<tr>
<td>Firm Age</td>
<td>.3</td>
</tr>
<tr>
<td>Firm Size (Log)</td>
<td>.004</td>
</tr>
<tr>
<td>High-tech Industry</td>
<td>.43</td>
</tr>
<tr>
<td>Hypothesized variables</td>
<td></td>
</tr>
<tr>
<td>Social Capital</td>
<td>.276***</td>
</tr>
<tr>
<td>Relational Capital</td>
<td>.341***</td>
</tr>
<tr>
<td>R2</td>
<td>.003</td>
</tr>
<tr>
<td>? R2</td>
<td>.290***</td>
</tr>
<tr>
<td>F-statistic</td>
<td>.227</td>
</tr>
<tr>
<td>Durbin-Watson</td>
<td>2.073</td>
</tr>
</tbody>
</table>

Notes. All correlations above |.086| are significant at ? < .10. n = 251.

Discussion and Conclusion

The objective of this study was to theoretically and empirically examine organizations' relations-based knowledge in order to explore the existence of different concepts within this construct. In doing so, we have focused on an Intellectual Capital-based View of competitive advantage, whose research has only begun to explore components and dimensions. Additionally, although literature has been mainly devoted to investigate the outcomes of radical innovation, its antecedents have been largely ignored. Thus, this empirical study assessed relational capital and social capital and examined the link between both dimensions of a firm’s relations-based knowledge and radical innovation achievement.

The paper contributes to research on intellectual capital and knowledge management in several ways. We first want to highlight the contribution of our research to the field of intellectual capital. By means of differentiating among relational and social capital as important elements of the relations-based knowledge, and using an innovative approach that has not received much attention in the literature, we attempt to add value to Subramanian and Youndt's (2005) work, showing empirical evidence of the clear distinction among firm internal and external relationships and their different impact on radical innovation.
Our results show that relations-based knowledge is mostly explained by internal informal relationships among employees. This suggests that firms tend to look inside themselves instead of span their boundaries when searching new knowledge. Nevertheless, the fact that institutional external relationships have the highest impact on radical innovation highlights that this tendency should not be adequate in technology-intensive industries, where rapid technological changes emerging from the environment could lead to obsolescence quickly. In this sense, from a knowledge-management and learning perspectives, our results are consistent with the “myopia of learning” argument developed by Levinthal and March (1993). That is, firms tend to search new solutions within their related knowledge areas (i.e.: within their own boundaries). This reasoning is also supported by recent empirical results suggesting that established companies tend to systematically overemphasize knowledge exploitation to the detriment of knowledge exploration (Uotila et al., 2009).

As Rosenkopf and Nekar pointed out, in organizational learning “boundaries matter; here it is not only the boundary that separates the organization from its environment, but it is also internal boundaries that have arisen to organize various technological subunits” (2001: 289) within the organization. Our results suggest that firms in our sample do not have difficulties in to carry out internal boundary-spanning through developing their social capital, which plays an important role in achieving radical innovation. By contrast, it seems clear that they fail in performing a more important task for innovation radicalness, as external boundary-spanning.

So, because of all technological knowledge cannot be developed solely within the firm (not even relevant knowledge), managers of technology-intensive firms should overcome this external knowledge aversion, trying to enhance their organizations’ relational capital through promoting relationships with a wide range of external agents. Based on our results, this would lead to develop innovations with a higher degree of novelty, which is a key issue in order to avoid the threat of obsolescence associated with this type of contexts.

Nevertheless, some limitations must be considered. Firstly, we collected subjective, primary data, so it would be interesting to consider objective data, as well, and combine them. Secondly, the findings of this empirical research cannot be generalised to all types of industries, since our sample only drew on high and medium-high technology manufacturing sectors. For this reason, implications for managerial practice may only be obtained for these industries. Finally, the dynamic nature of factors which affect firms has not been taken into account to reflect how firms and activities change over time. This is a consequence of using a cross-sectional survey instead of carrying out a longitudinal study.

More empirical contributions are needed in order to explain the influence of social and relational capital on other types of technological innovation. Previous papers have highlighted partial aspects such as the positive influence of relational capital in the development of incremental product innovation (Nieto & Santamaría, 2007) or the significant effect of social capital on incremental innovation (Subramanian & Youndt, 2005), but a whole model showing the influence of both (social and relational capital) on incremental innovation is still missing. Our study may be useful for further developments in this research arena.

A complete picture of the relationships between relational and social capital on incremental innovation would be, to our understanding, an important contribution to the field of intellectual capital. Such a global picture would be useful to make comparative analysis with the relationships presented in this paper, and would provide new insights
in order to understand the different role played by firm’s internal and external relationships depending whether we refer to incremental or radical innovation.

Additionally, other approaches to the same phenomenon could enrich the literature. Applying this kind of analysis to different industries or linking the social/relational capital to firm performance would provide interesting research avenues on the topic.

References


EC (1995), Green paper on innovation, Brussels.


Schumpeter, J.A. (1912), Teoría del desenvolvimiento económico (3ª edición), Fondo de Cultura Económica, México.


Appendix. Measures and Items

All items were measured on a seven-point Likert scale (1=strongly disagree and 7=strongly agree)

**Social Capital**
In my company, there are employees and/or teams who build informal network relationships in order to exchange idea and information about new product development (SC1)

In my company, there are employees and/or teams who discuss to each other in a constructive way when things go wrong (SC2)

In my company, there are employees and/or teams among which there are good close relations (SC3)

In my company, there are employees and/or teams who exchange advice and provide support (SC4)

In my company, there are employees and/or teams who are not reluctant to share their knowledge and experience (SC5)

In my company, there are employees and/or teams who help each other in order to generate new ideas and/or enhance your ability to do your daily job (SC6)

**Relational Capital**
We obtain from our customers’ portfolio much of our valuable information on the market needs and tendencies (RC1)

Employees of our company work jointly with customers in order to develop solutions (RC2)

Employees of our company work jointly with suppliers in order to develop solutions (RC3)

In the last years, my company is improving products and processes quality and design through relationships with our suppliers (RC4)

Employees of our company work jointly with allies in order to develop solutions (RC5)

In the last years, my company is improving products and processes quality and design through relationships with our allies (RC6)

**Radical Innovation**
In general, the number of completely new innovations developed by my company in the last three years is higher than my competitors’ one (RAD1)

My company develops innovations that turn into obsolete or drastically change prevailing/existing ones (RAD2)

The percentage of sales on radical innovations (completely new) introduced in the last three years is higher than my competitors’ one (RAD3)