AN EMPIRICAL ANALYSIS OF THE INFLUENCE OF HUMAN CAPITAL ON PRODUCT INNOVATION PERFORMANCE

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Abstract: The authors build on the resource-based view of the firm, new product development and intellectual capital perspectives to analyse the influence of human capital on product innovation performance at Portuguese innovative SMEs. By conducting a questionnaire within a network of Portuguese innovative SMEs and performing both a partial least squares and a regression analysis of the data, this study aims to clarify if human capital at the firm level influences its product innovation performance, and also if such influence is equally relevant among the distinct human capital elements that are considered for the purpose of this study.

The findings indicate that human capital does have a significant and positive relationship with product innovation performance in Portuguese innovative SMEs. Moreover, the results also indicate that not all human capital elements have a significant impact on such performance. “Commitment to the product innovation process” stands out as the only human capital factor that significantly affects product innovation performance.

At a time when intellectual capital and product innovation management are both considered to be major determinants of sustainable competitive advantage, and consequently critical to gain a competitive edge (and even survive) in today’s unstable business environment, this study contributes to acknowledge the relevance of intellectual capital management, and human capital management in particular, to achieve better product innovation performance in innovative SMEs.

Keywords: Intellectual capital, human capital, product innovation, new product development, Portugal, Innovative SMEs

1. Introduction

The perception regarding the fundamental basis of competitive power has changed significantly in the last decades, accompanying the radical changes witnessed in the global business environment (Johanson et al, 1999). Resources of “intangible” characteristics, as opposed to the traditional “land, labour and financial capital”, have emerged has critical success factors to corporations. At
the same time, innovation has materialized as one of the most crucial drivers of long term development.

The general purpose of this research is to study interaction effects between intangible assets and innovation at the firm level. Specifically, we will analyse the influence of human capital on product innovation performance at innovative small and medium enterprises (SMEs).

1.1. Human capital

The intellectual capital stream of research emerged in the mid-nineties as a natural ramification of the resource and knowledge-based views of the firm, focusing on understanding the implications of those theories for the daily management of corporations. More precisely, the intellectual capital perspective seeks to analyze the intangible assets’ contribution to an organization (Roos et al., 2001), as a means to better understand what constitutes the value of the business and to manage more successfully those elements that effectively generate value (Petty and Guthrie, 2000).

For the purpose of this study, we will define intellectual capital as the combination of an organization’s human, organizational and relational resources and activities (European Commission, 2006). Intellectual capital is thus a multidimensional concept. In fact, it is nowadays generally accepted that the main components of intellectual capital can be structured into three dimensions: human capital, structural capital and relational capital (Curado et al. 2011). This article will focus on the human capital component of intellectual capital.

Human capital represents the capital associated to the individual, that is, the capital that resides in the members of the organization and generates value to the company. Brooking (1996) calls this component “human assets”, including elements such as collective skills, creative abilities, problem-solving competencies and leadership. Edvinsson and Malone (1997) describe this component as including all individual capabilities, knowledge, skills and experience of employees and managers. They consider human capital to be a critical factor to the firm, adding that the absence of an adequate human dimension will negatively restrain all value-creation activities. Bontis (1998) argues that human capital is important because it represents the firm’s main source of innovation and strategic renovation.

Bueno and Salmador (2000) define human capital as the accumulated value of the principles, knowledge, capacities and abilities of the people within the organization. Human capital is also identified with the knowledge that companies lose when their employees abandon it, and, for this reason, it is the most difficult capital to retain (Roos and Roos, 1997).
1.2. Product innovation

Innovation, in a broad sense, is in the heart of economic change. The vision of innovation as the main driver of long term development is today widely accepted (Leiponen, 2005). At the firm level, innovation is nowadays considered to be inevitable: driven by a variety of forces (including globalization, technological evolution and demography), the economic environment is changing rapidly. To succeed in such a context, or even to remain viable, corporations must respond with innovation (Govindarajan and Trimble, 2005).

In the Oslo Manual (OECD, 2005), innovation is defined as the implementation of a new or significantly improved product (good or service) or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations. Different types of innovation are also distinguished: product innovation, process innovation, marketing innovation and organizational innovation.

Among these distinct types of innovation, product innovation, due to its higher visibility in the relationship between companies and consumers, stands out as an element of particular importance to any business. Companies must develop new products, at least on occasion, to maintain or gain competitive advantages, and their ability to create new products has been linked to performance and even long-term survival (De Jong and Vermeuler, 2006; Linzalone, 2008).

For this reason, this article will focus on product innovation, defined in the Oslo Manual (OECD, 2005) as the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses.

The search for systematic product innovation is usually materialized at the firm level through a new product development process, consisting on a series of stages and activities (either sequential or simultaneous) that are conducted in order to conceive, design and launch new products.

1.3. Research goals

Several studies have succeeded in trying to empirically demonstrate that intangible assets, and human capital elements in particular, are positively and significantly associated with the firms’ innovative capabilities (e.g. Canibaño et al., 1999; Del Canto and González, 1999; Chen et al., 2004; Subramanian and Youndt, 2005; European Commission, 2006; Linzalone, 2008; Wu et al., 2008; Santos Rodrigues et al., 2010; Bueno et al., 2010). Nevertheless, rarely were those investigations specifically oriented at assessing the impact of intangible assets on product innovation performance. Similarly, several authors from the product innovation field have analyzed the critical success factors of new product development (e.g. Montoya-Weiss and Calantone, 1994; Abetti, 2000; Bullinger et al., 2004; Cooper et al., 2004, 2004a, 2004b; Kandemir et al., 2006; Shum and Lin, 2007), but they seldom focused on the specific impact of intellectual
capital components on that success. In other words, although there are some clues suggesting that intangible assets, and intellectual capital components in particular, do influence product innovation success, few studies have tried to directly investigate this link. Additionally, most investigations on these subjects are conducted among large companies, and rarely on small and medium ones. In fact, in what concerns intellectual capital research, little attention has been focused on the specific case of SMEs, and even less on innovative SMEs. Small and medium companies have different characteristics from the larger companies that are usually studied in this context (Tovstiga and Tulugurova, 2007; Cohen and Kaimenakis, 2007).

In order to fill these gaps, the main purpose of this study is:

• to analyze if the existence of human capital elements at innovative SMEs influences its product innovation performance, and
• to analyze if such influence is equally relevant among the distinct human capital elements we will identify.

2. Human capital and product innovation: theoretical model

While searching for clues to establish the link between human capital and product innovation, we came across several studies suggesting that a strong competence basis benefits innovative firms, and particularly that the need for qualified employees is not restricted to the research and development department (Leiponen, 2005): the modern perspective of innovation emphasises the importance of information sharing and participation of different firm units on the innovation process, including marketing, production, research, design and development. On the other hand, firms with lower levels of internal knowledge find it more difficult to internalize the knowledge that comes from external cooperation in an effective way.

Other studies investigated the relative importance of some firm-specific competencies to their level of technological innovation (Souitaris, 2002). The most important determinants that were empirically identified included the proportion of university graduates and engineers in the staff, the proportion of staff with managerial responsibilities and the proportion of professional staff with previous experience.

Baldwin and Johnson (1996) argue that the most innovative firms offer more formal and informal continuous training and have more innovative human resource policies, implicitly recognizing the relevance of human capital to their performance. In fact, the knowledge specificity and the speed of change associated to innovation demand a permanent growth in the competence levels of employees, high degrees of motivation and their participation in the decision process. The authors empirically validate that human resources competencies, especially those of managers, are a key element for innovation success. Other studies (e.g. Hayton,
2005) seem to confirm this perspective: cognitive resources, along with experience and values, were found to have a significant influence on the way managers understand and interpret organizational stimuli, and thus on their problem-solving capabilities. Considering their influence (through their decision power) in product innovation processes, the existence of these elements of human capital at the managerial level (and, by extrapolation, at the project team leadership level) will probably have an impact on the firm’s product innovation capabilities.

Empirical support was also found for the notion that individual characteristics such as education, intelligence and cognitive resources are associated to higher levels of creativity and openness to innovative ideas (Hayton, 2005), and consequently to the efficiency and level of success of human resource management practices oriented at promoting innovation. In fact, “sophisticated” human resources management, that drives people into exploratory learning (that is, to maximizing their own ability to create, transfer and implement knowledge), has been related to the improvement of the innovative capabilities of firms (Shipton et al., 2005). Such guidance also contributes to the development of cooperation skills, thus easing the flow and transfer of knowledge within the firm. And, the more motivated and opened to new ideas the employees are, the more efficient these practices will be, which emphasizes the importance of having people with skills and attitudes that are compatible to the product innovation goals of the firm. Santos Rodrigues et al. (2010) also confirmed that innovative behaviours among employees have an impact on the innovativeness of firms.

Other studies (Cooper, 2004a; Shum and Lin, 2007) stress the importance of all employees understanding and being committed to the role of innovation in achieving the firm’s strategic goals, and sharing the firm’s vision regarding innovation. The effort of leaders to communicate these elements internally is therefore of vital importance.

We thus find some evidence that employees’ competencies, values, attitudes and skills seem to be very relevant factors on the innovative capabilities of firms. It is reasonable to admit that this relation also applies to product innovation performance. In fact, product innovation is to a great extent a knowledge absorption and creation process. But organizations cannot create knowledge for themselves, without the initiative of individuals. Firms must have people that know how (and want to) select, integrate, share and enrich information to create understanding and true knowledge, and turn it into innovation. In that sense, apart from “formal” competencies like education, other personal characteristics like one’s values, attitudes and skills seem to be equally critical for product innovation success.

We will thus hypothesize that:

- Hypothesis 1: human capital is positively associated with product innovation performance at innovative SMEs

Simultaneously, just as intellectual capital is a multidimensional concept that exists at different levels of an organization (individual, organizational and relational), so each one of its components (human, structural and relational capital),
when individually considered, contains a multitude of distinct elements. When presenting the rationale for our conviction that human capital affects product innovation performance, we mentioned such diverse elements as competencies, values, attitudes or skills. This leads us to another interrogation: does every human capital element we identified have the same relative importance to product innovation success? Although it is not easy to find previous empirical investigations to support this assumption, it seems reasonable to admit that the distinct elements that comprise human capital do not have a homogeneous impact on product innovation performance.

We will thus also hypothesize that:

- Hypothesis 2: the distinct elements that comprise human capital affect product innovation performance at innovative SMEs differently

Having presented the investigation hypothesis, Figure 1 encapsulates the theoretical model we intend to test:

**Figure 1. Theoretical model**

3. Research methodology

In order to empirically examine the influence of human capital on product innovation performance at innovative SMEs, and once presented the theoretical background that inspired this research, we will now focus on the research methodology that guided our field work.

3.1. Variable definition and measurement

As previously stated, we found various indications that some employees’ characteristics positively contribute to the firm’s ability to innovate, and therefore to its product innovation success. We chose to structure those characteristics into three human capital elements: competencies; values and attitudes; and capabilities (incorporating the results of our own research and also studies from Baldwin & Johnson, 1996; Abetti, 2000; Souitaris, 2002; IADE, 2003; Cooper et al., 2004; Leiponen, 2005; Hayton, 2005; Shipton et al., 2005).
• **Competencies** represent the formal education and professional experience of managers and employees, as well as their specific competencies in what concerns product innovation activities. We relied on four indicators to measure this element:
  • Top managers and technical staff possess high education levels and specialized training
  • Top managers and technical staff possess professional experience in different activities
  • Top managers and technical staff possess (among them) an heterogeneous academic education
  • Employees possess specific competencies that are adequate to the firm’s product innovation goals

• **Values and attitudes** relate to the orientation towards cooperation and knowledge sharing, risk assumption and creativity, and also to the degree of commitment to the firm’s values and strategy. We relied on the following indicators to measure this element:
  • Employees cooperate and share knowledge
  • Employees take risks, are enterprising and creative
  • Employees show interest and participate on idea generation activities
  • Employees are committed to the firm’s strategy

• **Capabilities** represent employees’ learning and team work abilities and their leadership skills, as well as their understanding of the internal product innovation process. This element was measured using the following indicators:
  • Employees participate on training initiatives related to innovation and successfully apply the knowledge they acquire
  • Employees often develop team work
  • Leaders strive to communicate the role of innovation on the firm’s strategy
  • Employees know and understand the firm’s new product development process

In what concerns the measurement of product innovation performance, a growing number of studies is relying on the use of the so-called “impact indicators”, which measure the impact of product innovation on enterprise performance by assessing the financial and economic significance of product innovation to the firm. With that in mind, we chose the following indicators to measure product innovation performance (Souitaris, 2002; Cooper, 2004; OECD, 2005; Shum and Lin, 2007):
  • Proportion of projects entering development stage that became commercial successes (met or exceeded sales goals) in the past three years;
  • Percentage of current sales revenue derived from new products introduced in the past three years;
• Proportion of projects hitting their launch dates on time and on budget.

3.2. Sample definition and data collection

As in most studies concerning intellectual capital and product innovation, this research was conducted at the firm level. The theoretical population was established as “small and medium Portuguese innovative firms”, with no restrictions in terms of industry sectors, in order to increase the potential number of cases considered and thus raise the interpretative consistency of the research.

The decision to analyze innovative firms was based on their adequacy to the kind of research we intended to conduct. We understand the concept of “innovative firms” as those that:

• Are widely recognized for their innovation practices;
• Possess a structure that is compatible with the existence of a formalized new product development process;
• Are intensive in knowledge assets and resources (as suggested by Nonaka and Takeuchi, 1995; Hall and Andriani, 2002; Abou-Zeid and Cheng, 2004).

Firms that do not fill into these criteria or where there is little innovation activity tend to find that participating in such researches represents a disproportionate burden, and the non-response rates tend to be higher for those units (OECD, 2005).

The decision to focus the study on SMEs was based on a number of reasons. On one hand, SMEs represent the overwhelming majority of Portuguese and European firms (INE, 2010; European Commission, 2010). On the other hand, SMEs generally have a smaller financial capacity and less market power than larger companies, and so are more dependent on innovative dynamics (European Commission, 2006; Vaona and Pianta, 2008). Even if their individual ability to have an impact on their industry is small, the strategic decisions regarding their orientation towards a higher level of intensity in knowledge assets is under their control, and that could be an important catalyst for product innovation success (Thornhill, 2006). Additionally, most SMEs cannot assume the financial risk of conducting a large portfolio of new product projects (European Commission, 2006), which again emphasizes the importance of identifying those factors that are most critical to the success of product innovation initiatives.

Considering these criteria, we chose a network of Portuguese innovative SMEs, COTEC’s “Rede PME Inovação”, as being the best possible sample for our theoretical population. COTEC is a non-profit association supported by the Portuguese Government and the institutions of the National Innovation System, aimed at promoting the competitiveness of companies established in Portugal, through the development and the diffusion of a culture and practice of innovation as well as of “resident” knowledge. Among its initiatives, COTEC endorses an
expanding innovative SMEs network ("Rede PME Inovação") based in Portugal, which comprises innovative SMEs that, having applied for membership, fulfill a set of specific criteria and enjoy a minimal score on COTEC’s “innovation scoring”. At the date of the research, this network comprised 100 firms from 19 different sectors, with a total of around 7729 employees and 782 million euros of total turnover.

In order to empirically examine the hypothesized relationships, and once the research constructs were operationalized and the target population and its sample was established, a preliminary version of the questionnaire was designed. A 5-point Likert scale was used in human capital related indicators (ranging from “strongly disagree” to “strongly agree”), and a choice of percentage intervals was used in product innovation performance items. A pilot study with four firms and an expert interview were conducted, to ensure the reliability and validity of the questionnaire, and some items were refined through this purification process.

The data collection took place from July 2008 to January 2009, via e-mail, involving all 100 companies. The request included a description of the study, stating its usefulness and social value, and a statement of confidentiality. The questionnaire was directed to the CEO of each firm, as suggested by the Oslo Manual (OECD, 2005), as the key informant that better knows the subject of the research and who is most available to communicate it to the researcher. Follow-up telephone calls were made to each firm explaining the purpose of the research, and a few questionnaires were taken in person. 72 responses were received, for a response rate of 72%. As every response was valid, 72 was our effective sample size.

4. Data analysis and results

This section is dedicated to the empirical findings of the research. Once all questionnaires were received, we proceeded to the treatment and analysis of the data, making use of distinct statistical techniques.

4.1. Reliability analysis

A preliminary analysis of the data for processing and purification purposes was conducted, using SPSS software. The existence of abnormal behaviour was studied through the analysis of frequency tables and descriptive statistic measures, as well as through a joint purification by classifying the data into clusters, using k-averages. As a consequence, two cases were considered to be incoherent, revealing an odd behaviour within the set of data, and were therefore excluded.

A chi-square test proved the geographical representativeness of the sample, as the calculated actual chi-square value of 2.21 was lower than the critical chi-square value of 12.59 for 6 degrees of freedom, at a 0.05 level of significance.
Cronbach’s α coefficients of the constructs were calculated. This method can be defined as the correlation one expects to obtain between the scale used and a hypothetical scale of the same universe, with the same number of items, measuring the same characteristics. It produces values ranging from zero to one. The closer the value is to one, the more reliable is the construct. Cronbach’s α coefficient for “human capital” was 0.827, and Cronbach’s α coefficient for “product innovation performance” was 0.746. Generally, the minimum threshold of Cronbach’s α coefficient is 0.7 (Hair et al., 1998). Therefore, this study was considered to be acceptable in what concerns reliability.

4.2. Partial Least Squares analysis and results

The first step of the study was to empirically test the relation between human capital and product innovation performance, with Hypothesis 1 predicting that human capital is positively associated with product innovation performance at innovative SMEs. In order to test our assumption, a partial least squares (PLS) analysis was conducted, using SmartPLS version 2.0.

Originally proposed by Herman Wold, the PLS method is a structural equation modelling technique, usually described as an example of “second generation multivariate analysis”. The PLS method was designed to reflect the theoretical and empirical conditions of social and behavioural sciences, where it is common to find situations where theory is weak and there isn’t much solid information available (Wold, 1979). The underlying mathematic and statistic procedures are rigorous and robust, creating optimal predictive linear relations between variables, but the model is flexible in the sense that it does not make assumptions concerning measuring levels, data distribution and sample size.

The PLS model is based on theoretical constructs or latent variables, with the exogenous constructs (in our case, human capital) representing the predictive variables of the endogenous constructs (in this case, product innovation performance). Such constructs are observed from their respective measurement indicators, which can be specified by the researcher as reflective or formative (Cepeda and Roldán, 2004). Reflective indicators are expressed as a function of the construct (the indicators form the construct); formative indicators represent a construct that is expressed as a function of its indicators (the indicators are a manifestation of the construct). In our case, all indicators were specified as reflective.

In this research, another decisive argument to use PLS as an investigation methodology was the sample size: this study had a potential maximum of 100 cases, which is below the usual threshold recommended for other structural equation modelling techniques. PLS is less sensitive to sample size, so it allows working with smaller samples. In fact, Chin (1998) suggests that sample size can be equal to the larger of the following criteria: 1) ten times the largest number of indicators on the most complex formative construct, or 2) ten times the largest
number of independent latent variables that affect a dependent latent variable. In our case, the second condition applies, as we have no formative indicators. As our model uses only one independent latent variable affecting a dependent latent variable, 1x10=10. Our sample size is 70.

Using PLS in intellectual capital related research is not new. Nick Bontis, one of the most distinguished authors in this field, pioneered the use of PLS in several empirical studies (e.g. Bontis, 1998; Bontis et al., 2000). More recently, several studies in the intellectual capital stream also used PLS for parameters estimation (e.g. Cabrita and Vaz, 2006; Tovstiga and Tulugurova, 2007; Cabrita and Bontis, 2008; Sharabati et al., 2010).

Our measurement model consists of the relationship between the two constructs and their measurement indicators. We used three methods to assess the adequacy of the measurement:

- individual items reliability (by examining their respective loadings, or simple correlations between the measurement items and their construct);
- constructs reliability (by analyzing the composite reliability, a measure recommended by Fornell and Larcker (1981), similar to Cronbach’s α but preferred in this context because it estimates consistency based on actual construct loadings);
- convergent validity (by calculating the average variance extracted (AVE), a measure designed by Fornell and Larcker (1981) that indicates the amount of variance captured by a construct from its measurement indicators in relation to the amount of variance due to its measurement error. Its values should be greater than 0.5, indicating that over 50% of the construct variance comes from its indicators).

We examined the factor loadings to assess individual items reliability. A rule of thumb in this situation is to accept those items with loadings over 0.7 (Cepeda and Roilden, 2004), but it is common to find studies where some measurement items reveal loadings under that limit, especially when new indicators or scales are used. That is the recommendation of Barclay et al. (1995) and Chin (1998), accepting loadings that equal 0.4. In our case, we decided to establish a 0.4 cut-off, eliminating all items presenting loadings under this threshold. The subsequent loadings calculations are presented on Table 1:
Table 1. Loadings for Measurement Indicators

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Human Capital</th>
<th>Product Innovation Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIP1</td>
<td>0.8330</td>
<td></td>
</tr>
<tr>
<td>PIP2</td>
<td>0.7859</td>
<td></td>
</tr>
<tr>
<td>PIP3</td>
<td>0.8205</td>
<td></td>
</tr>
<tr>
<td>HC4</td>
<td>0.7830</td>
<td></td>
</tr>
<tr>
<td>HC5</td>
<td>0.7584</td>
<td></td>
</tr>
<tr>
<td>HC10</td>
<td>0.5683</td>
<td></td>
</tr>
<tr>
<td>HC11</td>
<td>0.7098</td>
<td></td>
</tr>
<tr>
<td>HC12</td>
<td>0.7379</td>
<td></td>
</tr>
</tbody>
</table>

The next step was to assess the construct reliability. Composite reliability values for both constructs are over 0.8, as shown on Table 2, which exceeds the strictest parameters associated to a good internal consistency. Finally, convergent validity was tested, by examining AVE. Both constructs reveal AVE values over the 0.5 threshold, as also shown on Table 2:

Table 2. Composite Reliability and AVE

<table>
<thead>
<tr>
<th></th>
<th>Composite Reliability</th>
<th>AVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human Capital</td>
<td>0.8383</td>
<td>0.5119</td>
</tr>
<tr>
<td>Product Innovation Performance</td>
<td>0.8539</td>
<td>0.6610</td>
</tr>
</tbody>
</table>

To assess the statistical significance of the path coefficients, a bootstrapping analysis was performed. This nonparametric test of significance generates a high number of random samples from the general data, re-calculating the coefficients using each one of these random samples. This technique allows the calculation of t-Student values, and the correspondent p-values.

The resulting structural model is shown on Figure 2:

Figure 2. PLS Structural Model

The model examines the influence of human capital on product innovation performance. The relationship appears as significant, with p-value under 0.05 and path coefficient over 0.2, thus validating Hypothesis 1.
4.3. Regression analysis and results

The second step of the study was to empirically test if all human capital elements we identified have the same relative importance to product innovation performance, with Hypothesis 2 predicting that the distinct elements that comprise human capital affect product innovation performance at innovative SMEs differently. In order to test this assumption, we started by reducing the data, using a principal components factor analysis. This technique explores the observed variables for patterns of correlations that can be combined into a set of common factors. The internal structure of the factors obtained through this method will allow us to analyze which elements the respondents think are related. Subsequently, we will be able to study if the relations between human capital and product innovation performance are attributable to the whole human capital construct, or only to some of the elements that form it. Following Chin and Marcolin’s (1995) recommendation to confirm the characteristics of the construct’s set of indicators in the context of the theory in which they are being used, we conducted this analysis considering a priori all the measurement items initially established (regardless of the exclusion decisions taken in the context of the PLS analysis).

In what concerns the selection of the number of factors that better describe the data, there is no absolute rule as to how many factors to retain, and some degree of subjectivity is admitted on that assessment (Hair et al., 1998). Our decision resulted from the combination of three commonly used criteria: the analysis of the cumulative total variance explained (that should always be over 50%), the Kaiser criterion (factors with explained variance, or initial eigenvalues, over 1), and the visual analysis of the scree plot. Factors were submitted to an orthogonal Varimax rotation, with Kaiser Normalization, which simplifies the interpretation of the results as it produces a solution where values close to one (in absolute value) indicate positive association between the variable and the factor, and values close to zero indicate absence of association. Geometrically this corresponds to a rotation of the factorial axis, not affecting the structure of the data.

To confirm that the elements were factorable, we used Bartlett’s sphericity test and the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy. The first test verifies whether the correlation matrix between the original items is an identity matrix. The second test measures sampling adequacy by comparing the partial correlation between the items involved. The closer to one the results are, the closer to zero will partial correlations be, meaning that the specifications of each item are small in relation to the overall data. Values are usually considered to be acceptable if greater than 0.6 (Hair et al., 1998).

In what concerns human capital, KMO’s measure of sampling adequacy was 0.789, signalling an acceptable quality of correlation between variables. Bartlett’s test resulted in a 0.000 level of significance, dismissing the hypothesis that the
correlation matrix is the identity matrix. These results allowed us to proceed with factor analysis for human capital. Three factors were extracted under the established criteria, as presented in Table 3, obtained through a Varimax rotation with Kaiser normalization that converged in 5 iterations. These factors account for 56,805% of cumulative variance explained. All item loadings are over 0.5, which is typically considered as a high significance level.

Table 3. Factor analysis results for human capital

<table>
<thead>
<tr>
<th>Factor</th>
<th>Item description</th>
<th>Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor 1: Commitment to the product innovation process</td>
<td>Employees know and understand the firm’s new product development process</td>
<td>.871</td>
</tr>
<tr>
<td></td>
<td>Leaders strive to communicate the role of innovation on the firm’s strategy</td>
<td>.681</td>
</tr>
<tr>
<td></td>
<td>Employees are committed to the firm’s strategy</td>
<td>.603</td>
</tr>
<tr>
<td></td>
<td>Employees cooperate and share knowledge</td>
<td>.560</td>
</tr>
<tr>
<td></td>
<td>Employees possess specific competencies that are adequate to the firm’s product innovation goals</td>
<td>.547</td>
</tr>
<tr>
<td>Variance explained</td>
<td>35,806</td>
<td></td>
</tr>
<tr>
<td>Cumulative variance explained</td>
<td>35,806</td>
<td></td>
</tr>
<tr>
<td>Factor 2: Capabilities, values and attitudes</td>
<td>Employees often develop team work</td>
<td>.664</td>
</tr>
<tr>
<td></td>
<td>Employees take risks, are enterprising and creative</td>
<td>.659</td>
</tr>
<tr>
<td></td>
<td>Top managers and technical staff possess high education levels and specialized training</td>
<td>.622</td>
</tr>
<tr>
<td></td>
<td>Employees participate on training initiatives related to innovation and successfully apply the knowledge they acquire</td>
<td>.602</td>
</tr>
<tr>
<td></td>
<td>Employees show interest and participate on idea generation activities</td>
<td>.537</td>
</tr>
<tr>
<td>Variance explained</td>
<td>12,151</td>
<td></td>
</tr>
<tr>
<td>Cumulative variance explained</td>
<td>47,957</td>
<td></td>
</tr>
<tr>
<td>Factor 3: Top Managers’ competencies</td>
<td>Top managers and technical staff possess professional experience in different activities</td>
<td>.830</td>
</tr>
<tr>
<td></td>
<td>Top managers and technical staff possess (among them) an heterogeneous academic education</td>
<td>.704</td>
</tr>
<tr>
<td>Variance explained</td>
<td>8,848</td>
<td></td>
</tr>
<tr>
<td>Cumulative variance explained</td>
<td>56,805</td>
<td></td>
</tr>
</tbody>
</table>

According to the characteristics of the items, we labeled these three factors as follows:

- **Factor 1: “Commitment to the product innovation process”,** representing the effort to communicate the importance of product innovation within the company, and the way employees interpret that effort, through their understanding, approach and commitment towards the product innovation process;
- **Factor 2: “Capabilities, values and attitudes”,** representing the employees’ capabilities and their values and attitudes, at several levels, regarding the
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firm’s product innovation efforts;
• Factor 3: “Top Managers’ competencies”, which refers to the experience and education heterogeneity of top managers and technical staff.

In what concerns product innovation performance, KMO’s measure of sampling adequacy was 0.653, signalling a reasonable quality of correlation between variables. Bartlett’s test resulted in a 0.000 level of significance, dismissing the hypothesis that the correlation matrix is the identity matrix. These results allowed us to proceed with factor analysis for product innovation performance. One single factor was extracted under the established criteria, as presented in Table 4, which accounts for 66,657% of cumulative variance explained. Therefore, we aggregated the three items into one single measure for product innovation performance. Again, all item loadings are over 0.5.

Table 4. Factor analysis results for product innovation performance

<table>
<thead>
<tr>
<th>Factor</th>
<th>%</th>
<th>Item description</th>
<th>Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor 1: Product Innovation Performance</td>
<td></td>
<td>Proportion of projects entering development stage that become commercial successes (meet or exceed sales goals) in the past three years, 0.871</td>
<td>0.871</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Proportion of projects hitting their launch dates on time and on budget, 0.811</td>
<td>0.811</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Percentage of current sales revenue derived from new products introduced in the past three years, 0.764</td>
<td>0.764</td>
</tr>
<tr>
<td>Variance explained</td>
<td>66,657</td>
<td>Cumulative variance explained</td>
<td>66,657</td>
</tr>
</tbody>
</table>

In order to assess if all human capital elements we identified have the same relative importance to product innovation performance, we then performed a multiple linear regression on the data resulting from our factor analysis. The results are contained on Figure 3.

Figure 3. Regression analysis

> Number on top is the path coefficient (β), t-value in brackets
> Significance levels: *p<0.05; **p<0.01; ***p<0.001 (2-tailed).
This model seeks to analyze the influence of human capital elements on product innovation performance, testing the hypothesis that the distinct elements that comprise human capital affect product innovation performance at innovative SMEs differently. The results show strong differences in the significance and relevance of the coefficients, confirming that not all human capital elements have a relevant influence on product innovation, and thus validating our Hypothesis 2. In fact, only the element we called “Commitment to the product innovation process” reveals a significant impact on product innovation performance.

5. Discussion, limitations and directions for future research

The objective of this study was to analyze the influence of human capital on product innovation in innovative SMEs. We hypothesized that human capital is positively associated with product innovation performance, and also that the distinct elements that comprise human capital affect product innovation performance differently. We ran a PLS analysis and a linear regression analysis to test this assumptions, which were validated by the results. Not only human capital as a whole showed a positive and significant impact on product innovation performance, but only one of the elements that comprise it revealed such an impact. That element was identified as the “Commitment to the product innovation process”, representing the effort to communicate the importance of product innovation within the company, and the way employees interpret that effort, through their understanding, approach and commitment towards the product innovation process. Other human capital manifestations were also included on this element, such as the employees’ ability to cooperate and share knowledge and the adequacy of their competencies to the firm’s product innovation goals. In general, these results are consistent with some fragmented research results published recently in similar contexts (e. g. Shipton et al., 2005, Hayton et al., 2005), and allow us to conclude that the better the innovative SMEs’ product innovation strategy is communicated and assimilated among employees, and the more competent and available to share knowledge they are, the more successful those firm’s product innovation efforts will be. Other capabilities, values and attitudes of employees, as well as top managers’ competencies, did not show a significant effect on product innovation performance.

Our results offer some important contributions for the intellectual capital and product innovation fields. First and foremost, we must recall that intellectual capital is still a relatively new subject, far from a maturity stage (more so if we consider the analysis of its relationships with product innovation performance in the context of innovative SMEs). For this reason, we think this study contributes to the “second stage” of intellectual capital research, as suggested by Petty and Guthrie (2000), by producing new evidence on which to build additional research. Moreover, we add a supplementary aspect of particular interest, which
is the empirical analysis of the differentiated impact of human capital elements on product innovation. Bontis (2001) states that there is still a long way to go in order to clarify the best intellectual capital proxy measures. Intellectual capital models in firms still include a wide range of very distinct measurement items, often complex and too numerous, and typically weighed in an undifferentiated manner. We believe this study contributes to clarify which human capital elements are the most important to product innovation success.

As for practitioners, we think the main contribution of our study is to offer some clues on how to address the problem of managing human capital to increase product innovation performance. Communication and overall understanding and commitment towards product innovation strategy seem to be key factors to consider.

There are some limitations on this research that need to be addressed. The first one relates to the characteristics and size of the population being studied, COTEC’s “Rede PME Inovação”. In view of the criteria selection in place for this network, we have no doubts that these companies represent some of the most successful Portuguese innovative SMEs. However, we cannot state without reservations that these firms are representative of all Portuguese innovative SMEs, so the generalization of our results must be cautious. Conducting further research within a larger population would be useful to confirm the generalization of our results to all innovative SMEs.

Another important issue to consider regards the decision to analyse the influence of only one intellectual capital component on product innovation. Several studies (e.g. Bontis, 1998; Bontis et al., 2000; Chen et al., 2004; Cabrita and Vaz, 2006; Cabrita and Bontis, 2008; Santos Rodrigues et al., 2010) found that intellectual capital components reveal strong path dependencies among themselves, when measuring their combined influence on organizational phenomena. Low $R^2$ readings on our models suggest the convenience to consider other intellectual capital components (namely structural capital and relational capital). In the future we will investigate the impact of all dimensions of intellectual capital on product innovation performance. In fact, we are already conducting such a research, which will soon allow us to address this matter more thoroughly.

6. References


IADE (2003): “Metodología para Elaboración de Indicadores de Capital Intelectual”, Documentos Intellectus nº 4, Centro de Investigación sobre la Sociedad del Conocimiento - Universidad Autónoma de Madrid


