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Knowledge-based human resource management practices, intellectual capital and innovation☆

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ABSTRACT

This paper proposes a conceptual model in which a human resource management (HRM) system of explicitly knowledge-based HRM practices impacts a firm's intellectual capital, producing higher innovation performance. We have empirically tested this idea in a survey dataset of 180 Spanish companies using structural equation modelling (SEM) based on partial least squares (PLS). The results show that intellectual capital positively mediates the relationship between knowledge-based HRM practices and innovation performance and illustrate the pivotal role of human capital in this relationship: knowledge-based HRM practices impact structural and relational capital partially through human capital, and human capital affects innovation performance by enhancing structural and relational capital.

1. Introduction

Innovation in organizations is, first and foremost, a human issue. Since it is people who develop and implement ideas, innovation will depend on effective human resource management (HRM). It will also depend on knowledge, since any innovation implies the development of new knowledge as both an input (e.g. new ideas, concepts, prototypes, etc.) and an outcome (i.e. the novelty produced). Thus, both HRM and knowledge are key enablers of innovation in firms. In this paper, we address the production of innovation from the perspective of HRM and the pools of knowledge it produces for the company.

While authors in the past (e.g. Kang, Snell, & Swart, 2012; Minbaeva, 2013; Minbaeva, Foss, & Snell, 2009; Swart & Kinnie, 2013) have identified the integration of HRM and the knowledge-perspective as a crucial issue with significant potential, it still remains underdeveloped. In particular, there is a paucity of work addressing both HRM and knowledge as antecedents of corporate innovation. While many previous studies have examined the impact on innovation of HRM (e.g., Gil-Marqués & Moreno-Luzón, 2013; Jiménez-Jiménez & Sanz-Valle, 2005; Lau & Ngo, 2004; Laursen & Foss, 2003; Saá-Pérez & Díaz-Díaz, 2010; Shipton, West, Dawson, Birdi, & Patterson, 2006) and intellectual capital (IC) (e.g. Leitner, 2011; Menor, Kristal, & Rosenzweig, 2007; Pizarro-Moreno, Real, & De la Rosa, 2011; Subramaniam & Youndt, 2005; Wu, Lin, & Hsu, 2007), few studies have empirically analyzed the interplay between IC and HRM vis-à-vis innovation (Cabello-Medina, López-Cabrales, & Valle-Cabrera, 2011; De Winne & Sels, 2010; Donate, Peña, & Sánchez de Pablo, 2016; Jiang, Wang, & Zhao, 2012; López-Cabrales, Pérez-Luño, & Valle-Cabrera, 2009; Wang & Chen, 2013). Moreover, the HRM practices considered in these studies tend to be insufficiently adapted for the purpose of enhancing companies' knowledge processes.

This scarcity of research highlights the need for further studies on the relationships between HRM, IC and innovation performance. The present paper aims to fill this gap. Specifically, we have built a conceptual model that 1) identifies key IC elements for innovation, 2) suggests key knowledge-based HRM practices and 3) examines the impact of knowledge-based HRM on IC and innovation. We argue that innovation in firms is largely enabled by knowledge-based HRM practices (cf. Inkinen, Kianto, & Vanhala, 2015; López-Cabrales et al., 2009; Minbaeva, 2013), including the handling of recruitment, the extent to which training and development systems focus on knowledge-related development aspects and how appraisal and compensation systems support employees' knowledge-based behaviors. We suggest that all these HRM practices impact a firm's IC level, which reflects the firm's intangible value-generating properties, including its employees' skills and motivation, external relationships, and knowledge contained in

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information systems, documents and databases. These IC elements, in turn, affect the firm's innovation performance. Overall, HRM contributes to innovation by enhancing the organizational knowledge base and stimulating knowledge creation (e.g., De Winne & Sels, 2010; López-Cabrales et al., 2009; Shipton et al., 2006).

We have empirically tested the proposed conceptual model in a survey dataset of 180 Spanish companies using structural equation modelling (SEM) based on partial least squares (PLS). Our results contribute to a better understanding of the role of HRM in advancing innovation from a knowledge-based perspective, thereby adding to the fields of strategic HRM, IC and innovation management.

2. Theoretical background

2.1. Intellectual capital and innovation

In recent decades, management literature has used the concept of IC to understand how knowledge functions as a key value-creating asset for organizations. IC refers to 'the possession of the knowledge, applied experience, organizational technology, customer relationships and professional skills that provide a company with a competitive edge in the market' (Edvinsson & Malone, 1997). In other words, IC is the sum of all of the intangible and knowledge-related resources an organization uses to create value. Attempts to understand and conceptualize IC have yielded many frameworks (e.g. Edvinsson & Malone, 1997; Nahapiet & Ghoshal, 1998; Roos, Edvinsson, & Roos, 1998; Stewart, 1997; Subramaniam & Youndt, 2005; Sveiby, 1997), which tend to divide IC into three main categories: human capital, structural capital and relational capital, which are related with knowledge embedded in individuals; organizational structures, processes and systems; and relationships and networks.

Human capital includes an organization's employees and their attributes, such as their knowledge, experience, commitment and motivation (Bontis, 1998; Edvinsson & Malone, 1997; Stewart, 1997). The firm does not own or even control human capital in the strict sense, since it 'walks out' the company's door each night or when employees change jobs (e.g. Grant, 1996; Roos et al., 1998; Spender, 1996). However, authors in the field consider that human capital is the most significant element of IC, because a firm can accomplish nothing—including innovation—without it. As Subramaniam and Youndt (2005, p. 451) argue, '[a] critical portion of the knowledge and skills required for innovation resides with and is used by individuals.' Since developing new knowledge requires some level of existing knowledge (De Winne & Sels, 2010), employees' skills and expertise are important predictors of organizational innovation. Creative and knowledgeable employees are more likely to develop new and innovative ideas (Anand, Gardner, & Morris, 2007) or to question existing ways of conduct and act as organizational change agents (Amabile, 1997).

Structural capital, sometimes called organizational capital, comprises 'all the non-human storehouses' of knowledge within organizations (Bontis, Keow, & Richardson, 2000, p. 88), accumulated and distributed through organizational structures, processes, systems and manuals (Subramaniam & Youndt, 2005; Youndt & Snell, 2004). It is the knowledge that stays with a firm when staff leaves (Roos et al., 1998; Youndt & Snell, 2004). This stock of institutionalized knowledge and codified experience can increase innovation because the production of new products, processes or methods usually involves combining and applying different pieces of existing knowledge (Fleming & Sorenson, 2004). Hence, having developed an "organizational memory" (Walsh & Ungson, 1991) will help companies to find out and combine all the relevant bits of knowledge that they have generated or acquired in the past, and that they need to produce the expected innovation. Established structures, norms and routines support the systematic documentation and retention of knowledge that organizations can use to continuously produce and test new ideas (Hargadon & Sutton, 1999; Nonaka & Takeuchi, 1995). Information and communication technologies also facilitate innovation by enabling there to be information search, retrieval, storage, transfer, analysis and dissemination (Alavi & Leidner, 2001). In sum, structural capital supports innovation by providing a (collective) infrastructure for knowledge development activities within an organization.

Relational capital, also sometimes called (external) social capital, refers to the value and knowledge embedded in and available through relationships with customers, suppliers, institutions and other external agents (Bontis, 1998; Edvinsson & Malone, 1997; Nahapiet & Ghoshal, 1998; Sveiby, 1997). Relational capital contributes to innovation because not all of the knowledge necessary to innovate is located within a firm's boundaries. External relationships can help firms innovate by introducing solutions that exist elsewhere or combining knowledge from different external sources (Hargadon & Sutton, 1999). In fact, according to Hargadon (2003), the majority of breakthrough innovations involve transplanting ideas from one industry to another. Relational capital also offers influence, control and power and produces mutual solidarity, which can increase the chance of co-creation (Adler & Kwon, 2002). Involving 'outsiders', such as clients, in development activities, also encourages continuous experimentation (Sutton & Kelley, 1997). Overall, inter-organizational collaboration is likely to facilitate knowledge sharing and interactive learning and, thus, increase innovation (Pérez-Luño, Medina, Lavado, & Rodríguez, 2011).

2.2. Enhancing IC and innovation through knowledge-based HRM practices

Given the human nature of knowledge and innovation, HRM practices could substantially enhance a company's IC and capability to innovate. Indeed, recruiting and selection, training and development, and performance evaluation and compensation are all major determinants of organizational behavior and effectiveness (e.g. Bowen & Ostroff, 2004; Delaney & Huselid, 1996). In line with Minbaeva (2013) and Minbaeva et al. (2009), we argue that in order to enhance innovation as a knowledge-based process, managers must customize traditional HRM practices in order to advance knowledge sharing and creation in the firm. Knowledge-based HRM includes those HRM practices purposefully designed to enhance knowledge processes within an organization. The following sections outline the nature of traditional HRM practices from a knowledge-based perspective.

2.2.1. Knowledge-based recruitment

Recruitment 'includes those practices and activities carried out by the organization with the primary purpose of identifying and attracting potential employees' (i.e. human capital; Breaugh & Starke, 2000, p. 45), while selection refers to 'the task of predicting which applicant will be the most successful in meeting the demands of the job, and/or be the best fit with the work group and culture of the organization' (Torrington, Hall, Taylor, & Atkinson, 2014, p. 133). These activities affect knowledge creation because they determine the knowledge brought into an organization (De Winne & Sels, 2010). Subramaniam and Youndt (2005) showed that organizational innovation depends on an organization's knowledge base, which is rooted in the recruitment of talented people (Jiang et al., 2012). According to Lepak and Snell (1999, 2002), recruiters should select employees based on their potential rather than their current knowledge, skills or experience, since individuals with high potential are more likely to be capable of learning the knowledge necessary for innovation (Jiang et al., 2012). Furthermore, since learning takes place primarily in a collaborative context (e.g. Nonaka & Takeuchi, 1995), knowledge-based recruitment should consider a candidate's ability to collaborate. In short, knowledge-based recruitment involves a strong and explicit focus on choosing candidates with relevant knowledge, learning and networking capabilities.

2.2.2. Knowledge-based training

As Robbins, Judge, and Campbell (2010) point out, competent employees do not remain competent forever. Skills deteriorate and can

become obsolete. By designing and implementing training and development activities, organizations can optimize the fit between employees' present and requisite knowledge and skills, thereby contributing to knowledge creation (De Winne & Sels, 2010) and improvement of human capital (Cabello-Medina et al., 2011). Training can also enhance employees' creative thought processes and task domain expertise (Jiang et al., 2012; Lau & Ngo, 2004). In short, knowledge-based training and development involve regularly developing the depth and breadth of employees' knowledge and expertise, personalizing training to fit particular needs and, finally, ensuring continuous employee development.

2.2.3. Knowledge-based performance assessment

performance evaluation can be an extremely relevant mechanism for guiding employee behavior. Managers should consciously and explicitly include performance criteria related to knowledge processes (i.e. knowledge sharing, creation and application) in order to enhance them. In particular, performance appraisal should focus on development and feedback (Lepak & Snell, 1999, 2002). Feedback helps to identify gaps between performance and targets (Shipton et al., 2006), thereby motivating employees to work creatively (Jiang et al., 2012). Moreover, appraisals that focus on learning and growth may help employees gain the confidence necessary to seize opportunities for higher-level learning (Jiang et al., 2012; Stiles, Gratton, Truss, Hope-Hailey, & McGovern, 1997). In short, knowledge-based performance appraisals assess employees according to their contributions to organizations' knowledge processes: knowledge sharing, creation and application (e.g. Alavi & Leidner, 2001).

2.2.4. Knowledge-based compensation

Compensation policies can also promote knowledge handling inside organizations. Managers could use both tangible (e.g. bonuses and one-off rewards) and intangible incentives (e.g. status and recognition) to motivate employees to share, create and apply knowledge (Andreeva & Kianto, 2012; Scarbrough, 2003). Several previous studies (e.g. Andreeva & Kianto, 2012; Chen & Huang, 2009; Kamhawi, 2012) have demonstrated that incentive systems are important mechanisms for motivating employees to take the time needed to share knowledge and generate new ideas. In short, knowledge-based compensation implies rewarding employees according to their contributions to the key knowledge processes of knowledge sharing, creation and application.

Previous research has acknowledged that HRM practices may have a stronger impact on organizational performance when they are applied jointly, rather than in isolation (Bowen & Ostroff, 2004; Donate et al., 2016; Jiménez-Jiménez & Sanz-Valle, 2005; Laursen & Foss, 2003; Minbaeva, 2013). Accordingly, over the past two decades, SHRM literature has shifted from a practice-oriented perspective to a bundle-oriented one (Wang & Chen, 2013; Youndt & Snell, 2004). Following this line of thought, we assume a bundle-oriented approach to HRM (Delery & Doty, 1996) and consider knowledge-based HRM as a bundle of separate but interrelated HRM practices designed to attract, retain and motivate employees to share, create and utilize knowledge. Based on this premise, we assume that pursuing knowledge-based HRM practices in a coherent bundle is likely to exert a stronger promoting influence on building IC and innovation than implementing only single supportive practices (Laursen & Foss, 2003).

3. Research hypotheses

Our research model analyzes the influence of knowledge-based HRM practices on IC (i.e. human capital, structural capital and relational capital) and innovation. This is consistent with the resource-based view of HRM (Wright, McMahon, & McWilliams, 1994). According to this approach, although HRM practices are not sources of sustained competitive advantage in themselves (since it is virtually impossible for them to be rare, inimitable and non-substitutable), they are still relevant for the purpose of developing a company's human capital (Wright et al., 1994) and other knowledge-related resources. In fact, it is these resources that have the potential to be rare, inimitable and non-substitutable, and hence be the source of competitive advantage.

Any attempt to assess the influence of knowledge-based HRM practices on IC must involve an analysis of the relationships among IC components. As Bontis (1998) points out, for an organization to exert leverage over its knowledge base, there must exist a constant interplay among human, structural and relational capital. Empirical studies carried out by several authors in different countries and industries (e.g. Bontis, 1998; Bontis et al., 2000; Cabrita & Bontis, 2008; Chen, Liu, Chu, & Hsiao, 2014; Costa, Fernández, & Dorrego, 2014; Wu et al., 2007) show that human capital is a key antecedent of both structural and relational capital. In other words, human capital (i.e. employees' knowledge, skills and motivation) triggers the development of structural and relational capital and affects the extent to which they are developed. This suggests that knowledge-based HRM practices could affect IC components both directly and indirectly. Since human capital is one of the pillars of structural and relational capital, any improvement in human capital due to the application of knowledge-based HRM practices should benefit structural and relational capital as well. Thus, we put forward the following hypotheses:

H1. Human capital positively mediates the relationship between knowledge-based HRM practices and structural capital.

H2. Human capital positively mediates the relationship between knowledge-based HRM practices and relational capital.

This hierarchical relationship among IC components should also affect how they influence innovation. As previously suggested, human capital can affect innovation performance both directly and indirectly by enhancing structural and relational capital. However, past studies on the IC-innovation relationship have largely overlooked the role of human capital as a precursor to structural and relational capital.

Some studies analyze the impact of IC components on innovation without considering their mediating or moderating relationships. For example, in their study of US manufacturing firms, Menor et al. (2007) find that the covariation of human capital, structural capital and supply chain integration constitutes an important antecedent of process flexibility and product innovation. Later, in their study of Spanish professional service firms, Martín de Castro, Alama-Salazar, Navas-López, and López-Sáez (2009) find that human capital, structural capital and relational capital exert a positive and significant influence on innovation when taken in isolation. However, when they analyze them together, only structural and relational sub-factors significantly affect innovation performance, suggesting that both structural and relational capital may mediate the relationship between human capital and innovation.

Wu et al.'s (2007) study of a group of Taiwanese electronic and information technology firms is one of the few studies that analyzes the role of human capital as a precursor to structural and relational capital in the relationship between IC and innovation performance. In keeping with their expectations, they find that structural and relational capital positively mediate the relationship between human capital and innovation. Chen et al. (2014) and Costa et al. (2014) also obtained similar results. Based on these findings and the theoretical foundations previously outlined, we formulate the following hypotheses:

H3. Structural capital positively mediates the relationship between human capital and innovation performance.

H4. Relational capital positively mediates the relationship between human capital and innovation performance.

The same hierarchical relationship among IC components should affect how knowledge-based HRM practices influence innovation through IC. On the one hand, HRM practices could affect innovation through their impact on human capital and the subsequent influence of

the latter on both structural and relational capital (as tested in research hypotheses H1 through H4). On the other hand, knowledge-based HRM practices could affect innovation through their direct influence on both structural and relational capital.

Abundant research exists that analyzes the direct influence of HRM practices on innovation performance (e.g. Gil-Marqués & Moreno-Luzón, 2013; Jiménez-Jiménez & Sanz-Valle, 2005; Lau & Ngo, 2004; Laursen & Foss, 2003; Saá-Pérez & Díaz-Díaz, 2010). However, only one study includes both HRM practices and IC components. Wang and Chen (2013) adopt a 'bundle' approach to HRM in order to analyze the influence of high-performance work systems (including comprehensive staffing, extensive training, knowledge- and skill-based reward systems, teamwork and employee participation) on IC and innovation in a sample of 164 Chinese firms. In their hypothesis formulation, Wang and Chen (2013) do not consider the role of human capital as an antecedent of organizational or structural capital and social or relational capital; instead, they treat all IC components as being at the same level. However, their findings that human capital has no significant direct influence on incremental or radical innovation suggest that this precursor role may actually exist. On the contrary, they also find that organizational capital mediates the relationship between high-performance work systems and incremental innovation, whereas social capital mediates the relationships between these systems and both incremental and radical innovation.

Based on the above results and the theoretical underpinnings previously outlined, we maintain that knowledge-based HRM practices can affect innovation through both the influence they exert on human capital and the subsequent influence of the latter on both structural and relational capital (hypotheses H1 through H4), as well as through these practices' direct influence on structural and relational capital. According to this additional possibility, we formulate the following two additional research hypotheses:

H5. Structural capital positively mediates the relationship between knowledge-based HRM practices and innovation performance.

H6. Relational capital positively mediates the relationship between knowledge-based HRM practices and innovation performance.

Fig. 1 shows the overarching conceptual model assumed in this research.

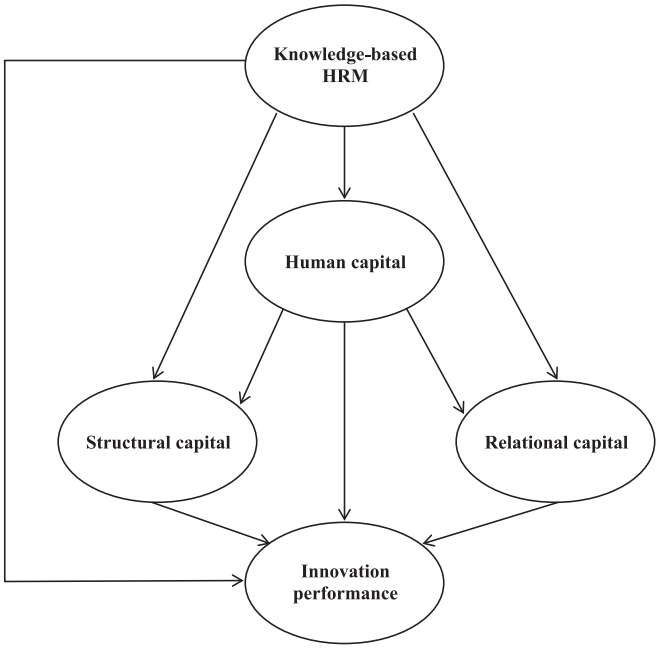

Fig. 1. Research model.

4. Research method

4.1. Sample and data collection

We tested the research hypotheses using structured survey data gathered in Spain in 2014 by means of the key informant technique. The target population comprised Spanish companies with at least 100 employees, identified through the SABI database. The search identified 1289 firms that met the established criteria and made financial and economic data available. Of these, we contacted 700 to request their participation in the research, with a focus on preserving the industry and size proportions of the initial population. We emphasized confidentiality and promised a summary of the results to all respondents. Of the 700 companies contacted, 180 completed the survey, yielding a response rate of 25.71% (180/700).

We administered the questionnaires via phone interviews, although some companies preferred to receive and respond to the questionnaire form by email. Regarding respondents' profiles, 89.44% of participants held responsible positions in their firms as managing directors (3.89%), human resource managers (67.22%) or heads of other departments (18.33%). The remaining 10.56% of participants were employees who did not hold positions of responsibility, but were knowledgeable about the topics being studied.

The obtained sample size (180) was sufficiently large to conduct a statistical study based on the PLS SEM approach (Chin, 2001), which in this case required a minimum sample size of 100 (i.e. ten times the number of variables in the most complex regression, which contained ten independent variables: four knowledge-based HRM practices, three IC components and three control variables).

Since we gathered data regarding all dependent and independent variables from a single key informant in each company, there was a risk that they could suffer from 'common method bias' (Podsakoff, Podsakoff, MacKenzie, & Lee, 2003). To determine the extent of method variance in the dataset, we conducted a Harman's one-factor test (Podsakoff & Organ, 1986). The 31.68% variance explained by a single factor suggests that common method bias was not a likely contaminant in this study.

4.2. Measures

The research model comprised eight first-order constructs or latent variables. Of these, four were related to knowledge-based HRM (recruiting and selection, training and development and performance assessment and compensation), three represented IC stocks (human capital, structural capital and relational capital) and one represented innovation performance.

Since this research treats knowledge-based HRM practices as a bundle, we created a second-order construct in order to group them all together. We modelled this construct as molar (equivalent to a formative first-order construct), because changes in one of its components do not necessarily involve changes in the rest of them (Chang, Franke, & Lee, 2016; Coltman, Devinney, Midgley, & Venaik, 2008). Moreover, we treated the latent variable scores used to build this second-order molar construct as composite indicators instead of causal indicators (Bollen, 2011; Bollen & Bauldry, 2011; Sarstedt, Hair, Ringle, Thiele, & Gudergan, 2016). This means that they contribute to the construct rather than truly causing it and that the composite variable (i.e. the linear combination of used indicators) is a proxy for the latent concept (in this case, knowledge-based HRM policies and practices). As Hair, Hult, Ringle, and Sarstedt (2017) point out, in social science research, viewing measurement as an approximation is more realistic than assuming that a concept can be fully measured by a set of indicators and an error term.

We modelled innovation performance and all first-order constructs as reflective, following previous studies on IC, HRM and innovation (e.g. Bontis, 1998; Cabello-Medina et al., 2011; Jiang et al., 2012;

López-Cabrales et al., 2009; Yang & Lin, 2009). In reflective models, specific items comprising each construct serve as a representative sample of all possible items available within the conceptual domain of the latent variable. Since all items within a particular construct 'reflect' the same latent phenomenon, they should be highly correlated (Hair et al., 2017; Sarstedt et al., 2016).

As the concept of knowledge-based HRM is still nascent and established measurement scales do not exist, we developed scales based on a thorough literature review (Alavi & Leidner, 2001; Andreeva & Kianto, 2012; Cabello-Medina et al., 2011; Le Deist & Winterton, 2005; Narasimha, 2000). We assessed the content validity of the scales using an international panel of experts and incorporated their suggestions. We adapted measures for the IC categories from previous literature and discussed them with the panel. We developed the scale for human capital based on the insights of Bontis (1998) and Yang and Lin (2009), and we adapted the scales for structural and relational capital from Kianto, Hurmelinna-Laukkanen, and Ritala (2010). Finally, we adapted measures for innovation performance from Weerawardena (2003).

To control possible confounding effects, we included additional relevant variables, such as company size, industry and the degree of commitment to renewing their knowledge base (measured in terms of R & D intensity; Lane & Lubatkin, 1998). Finally, we measured all the items corresponding to the latent variables using five-point Likert scales. Table 1 shows all the constructs and measures used.

4.3. Statistical analysis

We used SEM based on PLS to test the proposed hypotheses. This type of SEM fits the composite approach previously discussed and is also the safest option when estimating data from an unknown population (Sarstedt et al., 2016). In this case, we ran a preliminary model in which we tested the relationships between each type of knowledge-based HRM practice, IC stock and innovation performance. This allowed us to verify the reliability and validity of each HRM scale, as well as to obtain the latent variable scores required to treat knowledge-based HRM practices as a bundle. After running the final model (in which the HRM practices were bundled), we conducted a Sobel test to verify the mediation effects (Sobel, 1982) and compared the resulting ratio to a standard normal distribution in order to establish statistical significance (Preacher & Hayes, 2004).

Table 1
Constructs and measures.

Constructs and measures	Item wording
Size (control variable)	Natural logarithm of the number of employees.
Industry (control variable)	Manufacturing firm = 1; service firm = 0.
R & D intensity (control variable)	Proportion of R & D staff of all employees.
Recruiting and selection (reflective)	
REC1	When recruiting, we pay special attention to relevant expertise.
REC2	When recruiting, we pay special attention to learning and development ability.
REC3	When recruiting, we evaluate the candidates' ability to collaborate and work in various networks.
Training and development (reflective)	
TD1	We offer our employees opportunities to deepen and expand their expertise.
TD2	We offer training that provides employees with up-to-date knowledge.
TD3	Our employees have an opportunity to develop their competence through training tailored to their specific needs.
TD4	Competence development needs of employees are discussed with them regularly.
Performance assessment (reflective)	
PA1	The sharing of knowledge is one of our criteria for work performance assessment.
PA2	The creation of new knowledge is one of our criteria for work performance assessment.
PA3	The ability to apply knowledge acquired from others is one of our criteria for work performance assessment.
Compensation (reflective)	
COMP1	Our company rewards employees for sharing knowledge.
COMP2	Our company rewards employees for creating new knowledge.
COMP3	Our company rewards employees for applying knowledge.
Knowledge-based HRM (molar)	
REC	Latent variable score for recruiting.
TD	Latent variable score for training and development.
PA	Latent variable score for performance assessment.
COMP	Latent variable score for compensation.
Human capital (reflective)	
HC1	Our employees are highly skilled at their jobs.
HC2	Our employees are highly motivated in their work.
HC3	Our employees have a high level of expertise.
Structural capital (reflective)	
SC1	Our company has efficient and relevant information systems to support business operations.
SC2	Our company has tools and facilities to support cooperation between employees.
SC3	Our company has a great deal of useful knowledge in documents and databases.
SC4	Existing documents and solutions are easily accessible.
Relational capital (reflective)	
RC1	Our company and its external stakeholders - such as customers, suppliers and partners - understand each other well.
RC2	Our company and its external stakeholders frequently collaborate to solve problems.
RC3	Cooperation between our company and its external stakeholders runs smoothly.
Innovation performance (reflective)	
	Compared to its competitors, how successfully has your company managed to create innovations/new operating methods in the following areas over the past year?
INNOPER1	Products and services for customers.
INNOPER2	Production methods and processes.
INNOPER3	Management practices.
INNOPER4	Marketing practices.
INNOPER5	Business models.

Table 2
Measurement model evaluation part I.

Constructs and measures	Model 1	Model 2*
Recruiting and selection (reflective)	ρ_c = 0.806	
	AVE = 0.587	
	Loadings	
REC1	0.5838	
REC2	0.8659	
REC3	0.8188	
Training and development (reflective)	ρ_c = 0.910	
	AVE = 0.717	
	Loadings	
TD1	0.8470	
TD2	0.8766	
TD3	0.8379	
TD4	0.8423	
Performance assessment (reflective)	ρ_c = 0.896	
	AVE = 0.742	
	Loadings	
PA1	0.8347	
PA2	0.8911	
PA3	0.8569	
Compensation (reflective)	ρ_c = 0.930	
	AVE = 0.815	
	Loadings	
COMP1	0.8965	
COMP2	0.9114	
COMP3	0.9008	
Knowledge-based HRM (molar)		Maximum VIF: 1.451
		Maximum: CI: 2.039
		Weights
REC		0.2969**
TD		0.4342***
PA		0.4401***
COMP		0.0957
Human capital (reflective)	ρ_c = 0.839	ρ_c = 0.839
	AVE = 0.635	AVE = 0.634
	Loadings	Loadings
HC1	0.7893	0.7872
HC2	0.7674	0.7715
HC3	0.8325	0.8297
Structural capital (reflective)	ρ_c = 0.898	ρ_c = 0.898
	AVE = 0.688	AVE = 0.688
	Loadings	Loadings
SC1	0.7738	0.7737
SC2	0.8234	0.8229
SC3	0.8410	0.8413
SC4	0.8772	0.8774
Relational capital (reflective)	ρ_c = 0.888	ρ_c = 0.888
	AVE = 0.726	AVE = 0.726
	Loadings	Loadings
RC1	0.8403	0.8412
RC2	0.8299	0.8310
RC3	0.8847	0.8828
Innovation performance (reflective)	ρ_c = 0.875	ρ_c = 0.875
	AVE = 0.584	AVE = 0.584
	Loadings	Loadings
INNOPER1	0.7538	0.7546
INNOPER2	0.8024	0.8020
INNOPER3	0.7769	0.7767
INNOPER4	0.7509	0.7512
INNOPER5	0.7357	0.7352

ρc: composite reliability; AVE: average variance extracted; VIF: variance inflation factor; CI: condition index.
* $p < 0.05$ (based on t_{499}, one-tailed test).
** $p < 0.01$.
*** $p < 0.001$.

5. Research findings

5.1. Measurement model evaluation

Prior to testing the research hypotheses, we assessed the quality of the measurement model for both the first-order and second-order constructs. For constructs comprising reflective indicators, we considered individual item reliability, construct reliability, convergent validity and discriminant validity. For formative or molar constructs, however, we analyzed multicollinearity issues. Tables 2 and 3 show the detailed results of the measurement model evaluation.

Beginning with the reflective constructs, and in terms of individual item reliability, all indicator loadings are > 0.707, with one exception: REC1 (Model 1 = 0.5838). According to Barclay, Higgins, and Thompson (1995), loadings above 0.5 and 0.6 are also acceptable in early stages of scale development, as is the case with this construct. To test construct reliability or internal consistency, we calculated the composite reliability (ρc). As shown in Table 2, all research constructs had a composite reliability over 0.8 (Nunnally, 1978), suggesting an acceptable internal consistency. We assessed convergent validity by means of average variance extracted (AVE), which should be > 0.50 (Fornell & Larcker, 1981). As Table 2 shows, this was the case with all research constructs. Lastly, to ensure appropriate discriminant validity, AVE should be greater than the variance shared between the construct and other constructs (i.e. the squared correlation between two constructs). Once we obtained the correlation matrix, it was easier to calculate the root AVE value for each construct (the diagonal of the correlation matrix) and compare it to the correlations obtained. The diagonal elements in our research were greater than the off-diagonal elements in the corresponding rows and columns, suggesting adequate discriminant validity (see Table 3).

With regard to the molar construct (i.e. knowledge-based HRM), we checked the absence of multicollinearity problems using SPSS software. As summarized in Table 2, the variance inflation factors (VIF) were lower than 5 in all cases (Kleinbaum, Kupper, & Muller, 1988), and condition indices (CI) were lower than 30 (Belsey, 1991), ruling out any multicollinearity issues. Table 2 also shows the weights of the indicators comprising the molar construct, which measure the relevance of each indicator used to calculate the score of the latent variable in order to maximize the amount of variance explained in the dependent variables. According to the scores obtained, all knowledge-based HRM practices except compensation were statistically significant.

5.2. Structural model evaluation

Once we guaranteed the quality of the measurement model, we assessed the strength of the path coefficients and the amount of variance explained (R^2). To examine the former, we used bootstrapping techniques. Moreover, as the hypotheses formulated in this research involved several mediation relationships, we tested the significance of the indirect effects using the Sobel test. Fig. 2 and Tables 4 and 5 summarize the results obtained for the final model.

As Table 4 points out, knowledge-based HRM practices have a strong and positive direct influence on both IC and innovation performance. Moreover, human capital positively and significantly affects structural and relational capital, although it does not exert a significant direct impact on innovation performance. Lastly, structural and relational capital have a positive and significant direct influence on innovation performance.

The Sobel test (see Table 5) shows that all the mediation relationships proposed in the research (i.e. hypotheses H1 through H6) were fully satisfied. First, human capital positively mediates the relationships between knowledge-based HRM and the other IC components (i.e. structural capital and relational capital). Since the relationships between the independent (i.e. HRM) and dependent variables (i.e. structural capital and relational capital) were statistically significant, partial mediation applies. Second, structural capital and relational capital positively mediate the relationships between knowledge-based HRM practices and innovation performance and between human capital and innovation performance. Since the direct influence of HRM practices on the dependent variable (i.e. innovation performance) was statistically significant, partial mediation applies. However, total mediation applies for the latter, as the direct influence of human capital on innovation

Table 3
Measurement model evaluation - part II (discriminant validity).

Model 1												
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Size	(1.000)											
2.	Industry	0.163	(1.000)										
3.	R & D intensity	− 0.168	− 0.274	(1.000)									
4.	Recruiting	− 0.171	− 0.020	0.235	(0.898)								
5.	Training	0.066	0.115	0.098	0.410	(0.954)							
6.	Assessment	− 0.118	− 0.047	0.288	0.407	0.565	(0.947)						
7.	Compensation	− 0.116	0.005	0.036	0.294	0.399	0.576	(0.964)					
8.	HRM												
9.	Human capital	− 0.032	− 0.163	0.085	0.367	0.339	0.341	0.256		(0.916)			
10.	Structural cap.	− 0.077	− 0.028	0.080	0.411	0.482	0.502	0.373		0.457	(0.948)		
11.	Relational cap.	− 0.024	− 0.079	0.150	0.317	0.323	0.348	0.208		0.397	0.305	(0.942)	
12.	Innovation	− 0.022	− 0.014	0.134	0.248	0.405	0.387	0.269		0.241	0.387	0.368	(0.935)
Model 2													
1.	Size	(1.000)											
2.	Industry	0.163	(1.000)										
3.	R & D intensity	− 0.168	− 0.274	(1.000)									
4.	Recruiting												
5.	Training												
6.	Assessment												
7.	Compensation												
8.	HRM	− 0.070	0.032	0.238					NA				
9.	Human capital	− 0.032	− 0.163	0.084					0.429	(0.916)			
10.	Structural cap.	− 0.077	− 0.028	0.080					0.587	0.458	(0.948)		
11.	Relational cap.	− 0.024	− 0.079	0.150					0.376	0.398	0.305	(0.942)	
12.	Innovation	− 0.022	− 0.014	0.134					0.445	0.241	0.387	0.368	(0.935)

Diagonal elements (values in parentheses) are the square root of the variance shared between the constructs and their measures, relative to the amount due to measurement error (AVE). Off-diagonal elements are the correlations among constructs. For discriminant validity, diagonal elements should be larger than off-diagonal elements. NA: not applicable (molar construct).

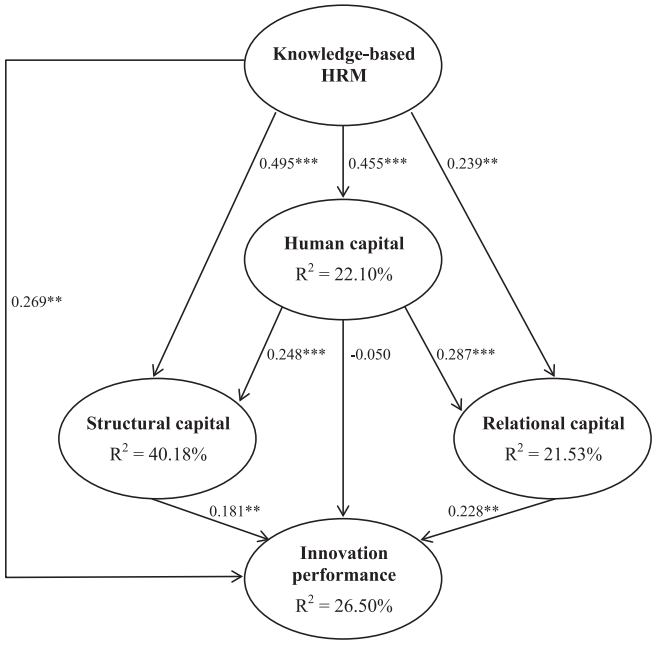

Fig. 2. Structural model evaluation.

performance was statistically non-significant.

The Sobel test relies on the normality of indirect effects (i.e. the product of coefficients *a* and *b*, or the coefficients linking the independent variable with the mediator and the mediator with the dependent variable). We explored normality using SPSS (graphic method) based on the values obtained in the PLS for coefficients *a* and *b* using bootstrapping techniques. The results obtained showed that all indirect effects fit well with a normal distribution and that the average value of each was significantly distinct from zero (confidence level: 95%), confirming mediation (Hayes, 2009).

Regarding the control variables, only industry showed a significant influence on one of the IC components analyzed (human capital). According to the results obtained, service companies have more qualified, skilled and motivated workforces than manufacturing firms. Lastly, size, industry and R & D intensity have completely non-significant influences on innovation performance.

Finally, we conducted a Stone-Geisser test (Hair et al., 2017) to test the model's predictive relevance for innovative performance. The Q^2 value yielded by the applied blindfolding procedure was above zero (Q^2 = 0.0015), suggesting sufficient predictive relevance.

6. Discussion

Our results confirm the role of human capital as a precursor to structural and relational capital (Bontis, 1998; Bontis et al., 2000; Cabrita & Bontis, 2008) and its influence on innovation via these IC components (Wu et al., 2007). They are also consistent with previous studies that acknowledge the key role of an organization's knowledge base (i.e. structural capital) in terms of its capability to innovate (e.g. Leitner, 2011; Martín de Castro et al., 2009; Menor et al., 2007). Likewise, they also echo earlier studies that emphasized that relationships with extra-firm parties can introduce new knowledge and insights and support novel constellations of ideas and collaborations, as argued by literature on open innovation (e.g. Chesbrough, 2006; Huizingh, 2011).

This paper makes several contributions to existing literature. First, it contributes to the strategic HRM literature by extending the understanding of knowledge-based HRM practices. Building on previous research by López-Cabrales et al. (2009) and Minbaeva (2013), this paper explicitly discusses the composition of the bundle of HRM practices that focuses on stimulating organizational knowledge processes. We conceptualize such practices as *knowledge-based HRM*, and our empirical

Table 4
Structural model evaluation (model 2) - path coefficients and amount of variance explained (R^2).

	Control variables			Exogenous constructs				
Endogenous constructs	Size	Industry	R & D intensity	Knowledge-based HRM	Human capital	Structural capital	Relational capital	R^2
Human capital	0.020	− 0.201**	− 0.076	0.455***				22.10%
Structural capital	− 0.043	− 0.016	− 0.071	0.495***	0.248***			40.18%
Relational capital	0.017	− 0.025	0.065	0.239**	0.287***			21.53%
Innovation performance	0.019	− 0.003	0.028	0.269**	− 0.050	0.181**	0.228**	26.50%

* $p < 0.05$ (based on t_{499}, one-tailed test).
** $p < 0.01$.
*** $p < 0.001$.

results suggest that these practices increase organizational knowledge assets and, thus, through them, have a positive indirect impact on innovation performance. Our study also adds to the knowledge on the impact of knowledge-based HRM practices on various elements of IC, thereby strengthening the link between strategic HRM and the knowledge-based view of the firm by demonstrating that HRM increases other organizational knowledge assets besides human capital.

The paper also contributes to literature on IC by enriching research into the interplay among the different components of IC and, in particular, the scarce literature that explores human capital as an antecedent construct of structural and relational capital. Unlike previous studies that examine similar issues (e.g. Cabello-Medina et al., 2011; De Winne & Sels, 2010; López-Cabrales et al., 2009), we conceptualize IC in terms of structural and relational capital as well as human capital and address the mediation relationships among these three types of IC. Thus, our study provides a more thorough understanding of the interactions among the different elements of intellectual capital as mediators of the HRM–innovation linkage.

Lastly, our paper adds to the understanding of innovation management by articulating and empirically demonstrating the role of knowledge-based HRM and IC in increasing innovation performance, thereby contributing to literature on how HRM mechanisms can facilitate innovation (Beugelsdijk, 2008; Laursen, 2002; Shipton et al., 2006).

In terms of practice, our results show that successful innovation management is a human- and knowledge-related issue. Organizations can significantly improve their innovation performance by pursuing knowledge-based HRM practices designed to stimulate knowledge sharing, creation and application among employees. Furthermore, managers who wish to enhance innovation must improve their firms' structural and relational capital. Reinforcing management systems (e.g. information systems) and external relations is the key to shifting individual knowledge to an organizational level and, thus, to fostering organizational knowledge creation and innovation. Human capital, too, plays a substantial role in the development of other IC components, by extending the influence of knowledge-based HRM practices. In other words, on the one hand, managers should promote innovation by improving management systems and external relations in order to facilitate knowledge-sharing and the conversion of individual knowledge into organizational knowledge. On the other hand, managers should invest in people, since people's knowledge is critical for organizational knowledge creation and, hence, innovation.

7. Conclusion

The main conclusions drawn from this study refer to the key role exerted by knowledge-based HRM practices in the promotion of IC and innovation and to the pivotal role of human capital in generating other types of knowledge resources and subsequent innovation. On the one hand, human capital partially mediates the relationships between knowledge-based HRM policies and practices and both structural and relational capital. On the other, structural and relational capital fully mediate the relationship between human capital and innovation. Additionally, knowledge-based HRM practices affect innovation performance through their influence on structural and relational capital (partial mediation).

This study is subject to several limitations. First, like most current literature, this paper considers HRM mechanisms as a bundle, rather than addressing isolated HRM practices. This approach prevented us from examining whether some practices were particularly relevant for IC and innovation. Furthermore, some authors propose negative interaction or substitution relationships between HRM practices (Andreeva & Kianto, 2012; Jiang et al., 2012; Minbaeva et al., 2009), meaning that their co-existence in an organization might weaken their respective impacts on organizational performance. Obviously, the bundle-based approach adopted in this paper hindered the examination of such negative interaction effects.

Moreover, our study focused exclusively on unravelling the interrelations between HRM practices and IC components. As a result, it overlooked several issues known to impact innovation performance. For

Table 5
Sobel test.

Mediation hypotheses	*A*	*b*	σ_a	σ_b	*z*	Type of mediation
H1 Human capital positively mediates the relationship between knowledge-based HRM and structural capital	0.455	0.248	0.0609	0.0707	3.152**	Partial
H2 Human capital positively mediates the relationship between knowledge-based HRM and relational capital	0.455	0.287	0.0609	0.0706	3.546***	Partial
H3 Structural capital positively mediates the relationship between human capital and innovation performance	0.248	0.181	0.0707	0.0768	1.904†	Total
H4 Relational capital positively mediates the relationship between human capital and innovation performance	0.287	0.228	0.0706	0.0933	2.049*	Total
H5 Structural capital positively mediates the relationship between knowledge-based HRM and innovation performance	0.495	0.181	0.0733	0.0768	2.203*	Partial
H6 Relational capital positively mediates the relationship between knowledge-based HRM and innovation performance	0.239	0.228	0.0831	0.0933	1.800†	Partial

a: path coefficient linking the independent variable to the mediator; *b*: path coefficient linking the mediator to the dependent variable: σ_a: standard error of *a*; σ_b: standard error of *b*.
† $p < 0.1$.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

example, Woolthuis, Lankhuizen, and Gilsing (2005) have argued that structural characteristics, such as ecosystem-level interactions, institutional mechanisms and physical infrastructures, are determinants of innovation, while Hekkert, Suurs, Negro, Kuhlmann, and Smits (2007) have suggested that successful innovation systems require a certain set of processes. Achieving high innovation performance is a complex issue that hinges on satisfying multiple processual and structural conditions (Jenson, Leith, Doyle, West, & Miles, 2016). Integrating HRM practices further into the discussion on the functions of innovation systems and acknowledging the role of IC components in complementing innovation's other structural enablers are viable avenues for future research.

Furthermore, our analyses did not differentiate between firms that focus on innovation and those that focus on, for example, manufacturing efficiency or customer service excellence. It is possible that these strategic choices or other internal contingency factors could moderate the impact of knowledge-based HRM practices. Lastly, our study addressed only Spanish companies, and so our results might differ in other national and cultural contexts. Extending the proposed research model to alternative contexts and further exploring strategic and industry-related contingencies would, therefore, constitute fruitful avenues for further research.

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