KNOWLEDGE MANAGEMENT STRATEGIES, INNOVATION AND FIRM PERFORMANCE - AN EMPIRICAL STUDY

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Abstract

This work investigates, from the knowledge-based view of the firm, whether there are groups of firms with homogeneous behaviours, as regards to knowledge management strategies (KMS) and tries to identify their influence on innovation management and firm performance. We focus on the following domains of KMS: conception, objectives, development over time and extension, introduction mechanisms and practice and support systems. These dimensions allow overcome some difficulties of earlier studies, because establishes a new KMS typology, with a holistic view of KMS, a greater number of variables and a multi-sectorial analysis. A postal survey was sent to a sample of Spanish firms for empirical research. The results show important differences in the conception and implementation of KMS, and significant relationships between the performance of some firms and their efficiency in the transmission and application of existing knowledge. They also show that the complexity of a knowledge strategy has performance implications.

Keywords: knowledge management strategy, innovation, firm performance, strategic management.

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1 Introduction

This work has been undertaken from the *knowledge-based view of the firm*. From this perspective, knowledge can be considered as the most important strategic resource for ensuring an organization's long-term success and survival, because it is unique and difficult to imitate (Grant, 1996; Kogut and Zander, 1992; Penrose, 1959). Moreover, it is strategically important for the management of technology and innovation. These facts have motivated investigators to center their studies on the internal aspects of businesses as being fundamental to their competitiveness, particularly those of an intangible nature which are linked to organizational knowledge (Nonaka y Takeuchi,

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1995). The Knowledge Management Strategy (KMS) of a firm is based on the best possible strategic design to create, maintain, transfer and apply organizational knowledge to reach competitive goals (Grant, 1996; Liebeskind, 1996).

The development of a KMS includes all the operations related to the creation, acquisition, integration, storage, transmission, protection and application of knowledge (Day and Wendler, 1998). KMS is increasingly regarded as an important factor in contributing to a firm's pursuit of competitive advantage through innovation (Foss, 1999). A firm can also achieve superior performance on the basis of its ability to generate new knowledge and utilize the existing base more effectively and efficiently than its competitors.

The current situation of research into the management of business organizational knowledge varies according to the specific area being investigated: (a) management of business innovation; (b) implementation of knowledge management and (c) the influence of each of these on results. The three areas have been thoroughly researched in recent decades, but have not been connected with KMS from a strategic perspective. This study aims to deal with this perspective.

The formulation of strategies based on organizational knowledge and its effect on economic results is a new line of research, which has not yet generated notable findings. McEvily and Chakravarthy (2002) point out that there are very few works which have found a clear relation between knowledge and the superior performance of the firm and that only a few studies have investigated how competitive advantage based on knowledge can be sustained. Some studies have tried to analyze the influence of innovation efforts on firm performance (Bierly and Chakrabarti, 1996; Hansen, Nhoria and Tierney, 1999; Schulz and Jobe, 2001). These works recognize the importance of knowledge for innovation management and on results. However, the efforts to formalize and measure knowledge and its importance for innovation efficiency and company performance has not been satisfactory, due to the difficulty of measuring knowledge (Nonaka, 1994).

This work –undertaken from the *knowledge-based view of the firm*– tries to investigate whether there are groups of firms with homogeneous behaviours, as regards knowledge management, which we call KMS, and tries to identify what influence these behaviours have on innovation management, innovation efficiency and firm performance. The dimensions and variables used in this work allow us to analyze the most relevant KMS aspects. They also provide a way to overcome some of the limitations of earlier studies, because the present work establishes a new KMS

typology via an empirical analysis with a holistic view of what a KMS means to a firm, a greater number of variables and a multi-sectoral analysis which is more general.

The additional research effort is justified by the fact of the limited research into strategies based on knowledge management, and on the increasing relevance of this question as the current “knowledge society” grows.

2 Theoretical Background

2.1 Knowledge Management Strategies

The empirical study of Bierly and Chakrabarti (1996) identifies clusters of knowledge management strategies with different implications on firm performance (explorer, exploiters, loners and innovators). The authors consider some dimensions such as internal versus external learning, radical versus incremental learning, fast versus low learning speed and narrow or broad knowledge base. Other studies analyzes KMS (Hansen, Nhoria and Tierney, 1999; Schulz and Jobe, 2001) but only consider the way in which knowledge is stored and transmitted (codification or personalization). The problem with all of these studies is that they only analyze KMS on the basis of some dimensions, meaning that they are incomplete.

Although knowledge strategy has many dimensions, for the purposes of this study we choose to focus on the following domains: a) strategic conception; b) objectives; c) development over time and the extension of the implementation process; d) introduction mechanisms and practice and e) support systems for implementation. Dependent variables have been used to cluster the firms into knowledge groups (Table 1).

Table 1. Dimensions and Variables of the Knowledge Management Strategy

DIMENSIONS	VARIABLES
KMS CONCEPTION	Strategy to facilitate informal knowledge exchange Emphasis on the use of information technologies Emphasis on the creation and application of new knowledge Management of an important strategic resource
KMS OBJECTIVES	Improved quality Improved productivity Improved innovation efficiency Increased growth rate
IMPLEMENTATION MECHANISMS AND PRACTICE	Knowledge creation methods Knowledge distribution methods Knowledge storage methods Knowledge application methods Knowledge protection methods

SUPPORT SYSTEMS	Implementation supported by mission principles Implementation supported by organization's leaders Human resources management practices to support the implementation
DEVELOPMENT OVER TIME AND EXTENSION	Time of strategy development

With these dimensions and variables to be contrasted, we can establish the first hypothesis:

H1: Firms develop homogeneous behaviours for the conception and implementation of the creation, distribution, storage, application and protection of knowledge. These can be grouped into different knowledge management strategies.

2.2 Innovation Management

Innovation management is characterized by a series of essential features (Pavitt, 1990; 18). Firstly, there is an implication of continuous and intensive co-operation and interaction between groups which are specialists both functionally and professionally. Secondly, it involves a series of activities whose nature is uncertain in terms of results. In addition, it is a cumulative activity: the greater part of technological knowledge is specific and although this knowledge and these abilities can be bought in from outside, there must be an assimilation capability in place for this to happen. Finally, it is highly differentiating, since it is possible to apply specific technological abilities from one field to another. All these characteristics make clear that innovation in a firm will be a very wide-ranging process, involving the obtaining of knowledge from within the existing organization, the combining of information, data or previous experience and the generation of new uses for the resources (Nonaka and Takeuchi, 1995).

Innovation efficiency and technological advance are related to the strength of the organizational knowledge base, because if the firm has a strong knowledge base this, in turn, means a better ability to focus innovation efforts efficiently (Nelson, 1982: 454).

Many authors show the relationship between innovation and knowledge management (Galunic and Rodan, 1998; Kim and Mauborgne, 1999; Leonard-Barton, 1995 and Metcalfe and De Liso, 1998). Knowledge strategy determines innovation efforts and may have a strong influence on their cost and performance. In addition, newly created knowledge guides the succeeding innovation efforts (Guadamillas and Forcadell, 2002).

This relationship also occurs in the other sense. That is, the results of the innovation management of the firm create new explicit knowledge on products and technologies and also lead to the accumulation of tacit knowledge (Kim and Mauborgne, 1999). As a consequence, a firm's innovation efforts lead to an increased knowledge base.

In this work, innovation management is analyzed on the basis of the following dimensions (Table 2): (a) strategic orientation as a technological pioneer or follower; (b) innovatory effort, and (c) policies on the incorporation, application and protection of technology. These innovation management dimensions are set up on the basis of their importance for KMS. The strategic orientation of a firm aims to identify the degree to which that firm is a pioneer or a follower on the introduction of new technology and other innovations. The introduction of new technology is an indicator of a firm's efficiency in the knowledge creation process, resulting from an efficient management process of this. The firm's innovatory effort is a measure of the resources dedicated by the company to the creation of new knowledge and innovation. It is related to absorption capability, because the extent to which the firm can develop internal knowledge governs its ability to assimilate and apply external knowledge (Bierly y Chakrabarti, 1996: 127). The policy for incorporating and protecting technology measures the extent to which a firm uses technology developed internally or acquired externally, the ways in which it is used and the protection methods involved. In the same way as the variables above, this gives an indication of the firm's capability to create new knowledge and to innovate. This point has a special relevance as regards the new information technologies, which facilitate convergence between explicit and implicit knowledge and makes knowledge storage and distribution easier.

These dimensions are defined in a series of variables (Table 2).

Table 2. Dimensions and Variables of Innovation Management

DIMENSIONS	**VARIABLES**
STRATEGIC ORIENTATION	Technological pioneer Technological leader Recognized innovator
INNOVATORY EFFORT	% R&D spenditure/ sales
POLICY OF INCORPORATION AND PROTECTION OF TECHNOLOGIES	Internal technology development Incorporation of external technologies Use of technology protection methods

With the dimensions and variables given above and considering the KMS, the following hypotheses can be established:

H2: The Groups of firms established through their Knowledge Management Strategies will vary significantly in their Innovation Management.

The second hypothesis implies establishing that the business groupings obtained develop homogeneous KMS and take differing decisions on the strategic orientation of their innovation, their innovation effort and their policy on technological incorporation and protection. Also, the result of innovation management in the firm will increase its knowledge base and influence the KMS.

2.3 Knowledge Management Strategies and Firm Performance

Having determined the various KMS typologies, and having established the relationships between them and the management of innovation, the influence of KMS on firms performance can now be studied.

The organization's overall results are measured combining several elements such as profitability, growth and market share. These indicators are habitually used in empirical work on the measurement of overall company results (see for example Gupta and Govindarajan, 1986). The variables used are shown in Table 3.

Table 3. dimensions and variables of firm performance

DIMENSIONS	**VARIABLES**
FIRM PERFORMANCE	ROI ROE Sales growth Market share

New hypotheses are now established using these dimensions and variables:

H3: The Groups of firms established through their Knowledge Management Strategy will vary significantly on their performance.

The third hypothesis establishes that the KMS developed by a firm, especially as regards the generation of new knowledge, has an influence on its financial results and growth.

3 Methodology

3.1 Selection of the Sample and Data Collection

The empirical research was undertaken via a postal survey sent to a sample of firms from Castilla–La Mancha, a region of Spain, belonging to several different economic sectors. No particular sector was chosen; instead the aim was to try to analyze the general situation, as per the study's overall approach. However, some minimum requirements were established regarding firm size. The firms selected were required to have a minimum of 25 employees (all micro-businesses were eliminated) and an annual sales figure of 2 million Euros. Business data was obtained from the DUNS 50.000 database (from 1999). This database contains the 50,000 most important spanish firms, selected for inclusion on the basis of a determined sales figure. The questionnaire was sent to a selected target population of 559 firms, along with a personalized letter –in which they were encouraged to participate in the investigation and confidentiality was assured–. The questionnaire was referred to the knowledge management strategy and innovation management, and data referred to performance. The questionnaire was sent a second time –two months later– and finally 85 were received back, but 9 were not considered valid. This represents a percentage of valid questionnaires received of 13.6%. This percentage can be considered valid in other papers, basically due to the difficulty of getting that the individuals included in the sample to participate in the investigation (Lefebvre *et al*, 1992; Zahra y Bogner, 1999). Having collected together the material and finished the fieldwork, the SPSS for Windows (11.0) package was used to carry out the data processing via several statistical procedures. Firms which validly answered to the questionnaires (76) had 161 employees on average (d.t. = 368.07) and had an age of 26.16 years on average (d.t. = 17.87).

The next step was to establish a comparison –in respect of the number of employees– between the firms which responded to the questionnaire and those which did not, to determine the sample representativeness. This comparison was made through the *T-test,* which did not yield any important differences between them ($t = 1{,}868$; $p < 0{,}066$).

3.2 Measurement of the Variables

Knowledge Management Strategy. Knowledge Management Strategy was formed by five dimensions, the content of which is shown in table 5. Subjective multi-item scales were developed for four of them –KMS conception, knowledge management

objectives, implementation mechanisms and practices and support systems– but for the fifth –time of development of KMS– a categorical variable was used[1]. The different items vary from 1 to 5. The variables were typified to avoid problems with different scales.

A factor analysis through the principal components method –with varimax orthogonal rotation– was used to reduce the number of variables to consider for a posterior analysis cluster, applying every one of the specified multi-item dimensions. Twelve factors were obtained (with eigenvalues above 1.0). The adequacy of the variables to the analysis was tested through the Barlett test of sphericity[2] and Kaiser-Meyer-Olkin test[3] (KMO), the results of which are shown in table 5. The Cronbach α were also calculated for each scale to analyze its internal consistence –reliability. The values obtained were always over 0,6 –which is the figure we can consider as an acceptable limit, having in mind that a great part of these scales are composed by a reduced number of items[4].

Table 5. Dimensions and Variables of Knowledge Management Strategy

DIMENSIONS AND VARIABLES	**Barlett test of sphericity***	**KMO**	**Explained Variance (%)**	**α**
Knowledge management strategy conception (4 items)	30,86	0,644	59,707	0,661
Knowledge management objectives (5 items)	54,45	0,642	43,272	0,668
Knowledge management mechanisms and practices				
Knowledge creation methods (5 items)	110,01	0,741	58,034	0,782
Knowledge distribution methods (5 items)	57,61	0,726	48,935	0,684
Knowledge storage methods (4 items)	68,43	0,669	47,494	0,607
Knowledge application methods (5 items)	74,13	0,756	48,832	0,729
Knowledge protection methods (6 items)	93,11	0,737	61,954	-
Support systems				
Implementation supported by mission principles (6 items)	168,56	0,769	56,253	0,842
Implementation supported by organization's leaders (5 items)	131,99	0,803	51,664	0,809
Human resources management practices to support the implementation (10 items)	417,23	0,882	67,247	-
Time of development of KMS in the firm (1 item)	-	-	-	-

*χ^2; significance: 0,000

[1] This variable could have one of these values: 1- less than a year; 2 -from 1 to 2 years; 3- from 3 to 5 years; 4- from 6 to 10 years; 5- more than 10 years.
[2] The Barlett test of sphericity contrasts the null hypothesis that the correlations matrix observed is an identity-matrix.
[3] The Kaiser-Meyer-Olkin measure of sampling adequacy is an index which compares the magnitude of correlation coefficients observed with the magnitude of partial correlation coefficients. If the value of the measurement is under 0.6 –the value of wich is considered as a limit (Pardo and Ruiz, 2002), it may not be pertinent use the factor analysis.
[4] It must be considered that the Cronbach α statistic, the value of which depends on the length of the scales, "rewards" the ones composed by a high number of items.

When the factor analysis was applied to the dimension *knowledge protection methods,* two factors with an eigenvalue above 1.0 appeared. Each of them includes three items. The first of these were called knowledge *protection methods based in internal factors* (secrets, patents, first in going into the market), α=0,632; the second one, knowledge protection methods *based in external factors* (brands, publicity effects, cooperation agreements with other firms), α=0,635. The same happens with the dimension *support to the implementation based in Human Resources Practices:* two factors appeared with an eigenvalue higher than 1.0. The first of them included seven items (α=0,926) and was called *support practices not based on financial incentives*. The second one was composed of three items (α=0,631), and was called *support practices based on financial incentives.*

Innovation management. We consider that Innovation Management is composed of several variables, the same as KMS. Strategic orientation included three variables –technological pioneer, technological leader and recognized innovator– each of them was measured through a subjective scale of five points (they take values from 1 to 5). The *policy of development and protection of technologies* included three groups of variables –internal development of technologies, incorporation of external technologies, use of technology protection methods– measured through composed scales, in which each different item vary from 1 to 5. The variable *innovatory effort*, in line with previous studies (Chatterjee y Wernerfelt, 1991; Mahoney y Pandian, 1992; Silverman, 1999), was defined as the average of the percentage of sales devoted to R&D by the firm in the last three years. All these variables were standardized to avoid problems of scale.

Different dimensions and variables are shown in table 6, along with the value of the Barlett statistic (χ^2), KMO, the explained variance for the different factors obtained from the factor analysis –principal components (to which a varimax orthogonal rotation was applied) and the Cronbach α –wich corresponds to the reliability analysis of the composed scales.

Table 6. Dimensions and Variables of Innovation Management

DIMENSIONS AND VARIABLES	KMO	Barlett test of sphericity*	Explained variance (%)	α
Strategic Orientation				
Technological pioneer (1 item)	-	-	-	-
Technological leader (1 item)	-	-	-	-
Recognized innovator (1 item)	-	-	-	-
Policy of incorporation of technologies				
Internal technology development (3 items)	0,719	117,42	80,435	0,877
Incorporation of external technologies (3 items)	0,623	20,51	53,97	0,620
Use of technology protection methods (3 iems)	0,743	111,90	80,63	0,879
Innovatoy effort (1 item)	-	-	-	-

*χ^2; significance 0,000

Firm Performance. Measures of financial results were selected. These are habitually used in empirical studies that relate innovation management with firm performance (see e.g., Lefebvre y Lefebvre, 1993; Parker, 2000; Zahra y Das, 1993; Zahra y Covin, 1993; 1994; Zahra 1996; Zahra y Bogner, 1999). These measures were estimated as on average for the last three years, to reflect as much as possible the effect in time of the performance of KMS and innovation management (see e.g., Zahra y Covin, 1994; Zahra 1996). The selected variables were sales growth (SG), return on equity (ROE), return on sales (ROS) and return on assets (ROA). The variables were typified to avoid problems with the scale.

3.3 Empirical analysis and results

Firstly, in order to analyse H1, and in line with literature, a *cluster analysis* was undertaken to determine if the firms of the sample can be grouped on the basis of their knowledge strategies, in terms of certain critical factors. The variables (or factor scores) considered for the grouping were the ones previously shown (table 5). Ward's hierarchical agglomeration method was employed to establish the clusters, which minimises the differences among cases in the cluster[5] and has been used in similar studies (see e.g. Bierly and Chakrabarti, 1996; Ordóñez de Pablos, 2001). Finally, the number of clusters was determined through the study of the *dendrogram*. Three firms from the sample were excluded in the first analysis (wich was finally composed of 73 firms) because they showed an atypical behaviour which made its grouping in any of

[5] Ward's hierarchical technique as the algorism of agglomeration uses the square Euclidean distances between every element and the center of the clusters as measure of similarity.

the clusters not possible. Finally, it was decided that the ideal number of cluster was four.

A discriminant analysis was used to confirm that the number of clusters selected was suitable. This method –in contrast to the analysis of variance– classifies cases in different groups, where the belonging to one of them, previously known, is used as a dependent variable, and the variables which supposedly differentiate to the groups are used as independent variables (or classification variables).

The Wilks Lambda contrasts in a hierarchical way the significance of the three discriminant functions obtained (number of groups less one). In the first line of the table the null hypothesis –that the whole model (including the three discriminant functions) does not allow distinguish the mean values of the groups– is contrasted. We can affirm that the model let distinguish significantly between the groups (table 6) because the Wilks Lambda has associated a level of significance under 0,05.

Table 6. **Results of the Discriminant Analysis**

Contrast of the functions	Lambda of Wilks	Chi- square	Sig.
1 to 3	,057	191,691*	,000
2 to 3	,274	86,620*	,000
3	,749	19,381*	,001

* p <0,05

This technique correctly classificated the 90,41% of cases. This proves that the groupings made fit well into the selected clusters through the hierarchical cluster analysis.

Next, the original mean scores of the variables (Hair *et al*., 1999) were used to interpret the resultant clusters. Also, the *Levene test* was used to verify the fulfilment of the supposed homogeneity of the variances for the analysed groups and the differences between groups through the analysis of variance[6]. The post-hoc contrasts of multiple comparisons were also undertook using the *Scheffé test*. The *T2 of Tamhane* test (based in *t statistic*) was used in cases in which the equality conditions of variances among groups were not carried out. The number of firms included in each cluster, the mean values of each variable (or factor), the Levene statistic, the F related to ANOVA and post-hoc contrasts –Scheffé test in case of homogeneity of variances and T2 of Tamahne in those cases in which this conditions is not carried out– are shown in table 7.

[6] Previously, the multivariate analysis of variance (MANOVA) was used to check that the vector of mean values (corresponding to the set of the dimensions which formed the KMS) was significantly different among groups (F= 9,661, p< 0,05). This proved that the four clusters differ significantly in their KMS.

Table 7. Cluster Analysis

Variables	Clusters				Levene statistic	F	Post-hoc (Scheffé or T2)
	1; N=12	**2**; N=33	**3**; N=17	**4**; N=11			
KM conception	2,88	3,71	3,902	3,06	3,200**		1<3 4<3
KM objectives	3,73	4,332	4,79	4,60	2,494	31,186*	1<2,3,4 2<3
Knowledge creation methods	2,433	3,281	3,871	2,563	0,035	22,804*	1<2,3 2,4<3 4<2
Knowledge distribution methods	2,40	3,093	3,679	2,636	0,777	18,637*	1<2,3 1,2,4<3
Knowledge storage methods	2,895	3,36	3,878	2,950	1,515	14,074*	1,2,4<3
Knowledge application methods	2,933	3,288	3,874	2,642	3,263**		1,2,4<3
Knowledge protection methods based in internal factors	2,231	3,09	3,388	3,740	1,125	7,754*	1<2,3,4
Knowledge protection methods based in external factors	2,726	2,99	3,062	3,398	4,145*		
Support based in culture	3,347	3,843	4,372	2,740	1,242	17,922*	1,2,4<3 4<2
Support based in leadership	3,375	3,61	4,529	2,858	1,520	24,056*	1,2,4<3 4<2
Support based in financial incentives	3,439	2,656	3,952	2,997	0,088	7,932*	2<1,3
Support not based in financial incentives	2,777	3,001	3,395	2,720	2,508	3,275**	1<3
Time of development of KM	2,926	3,364	3,412	2,091	0,589	3,979**	

*significant p<0,01
**significant p<0,05

The analysis of variance (ANOVA) shows that there are significant differences for the different variables (or factors) among the groups formed through the cluster analysis. We can observe that the clusters are significantly different to all variables considered except for “time of development of KMS” and “protection method of knowledge based in external factors”.

Several different knowledge management strategies were found and four basic groups were established:

(a) Cluster 1 (n = 12): *“Backward in Knowledge Management”*. These firms have a lower score than the rest of the groups in relation with a very important number of variables, although they have been developing knowledge management for a long time. It is remarkable that in respect of the question about whether they consider

knowledge management contributes in achieving the objectives of the firm, this cluster has a significantly lower score than the other three groups. It also scores significantly under the others groups regarding the question about knowledge management concept –The firms don't seem to have a clear idea about what this means for them. It also has a low score in the use of methods and practices of knowledge management (significantly lower than the rest of clusters in protection methods; significantly lower than 2 and 3 in creation and distribution methods; significantly below 3 in storage and application methods) and in support systems for knowledge management, although it always surpasses cluster 4 in this last dimension (but not significantly) and scores significantly higher than cluster 2 in the importance conferred on human resources practices as mechanisms of support to the implementation of KMS.

This first KMS group includes firms with an inefficient KMS, with no defined strategic conception and not clear objectives. The implementation ambit is very limited, the firm's understanding of knowledge management methods is precarious and there is no clear support for KMS from the organization's leaders, its culture, or its human resources practices.

(b) Cluster 2 (n=33): *"Followers in knowledge management".* This is the cluster with the higher number of firms. It has high scores, but not as much as 3. Firms in this cluster have been developing KMS systematically for a long time, although for a shorter time than cluster 3 on average. This group does not score the highest for any of the variables considered, although it does significantly in respect of clusters 1 and 4 in creation knowledge methods, in respect of cluster 1 in distribution and protection methods based in internal factors, and finally in respect of cluster 4 in support methods based in leadership and cultural principles, to which it seems to give more importance to than human resources practices in order to support the effective implementation of KMS.

In general terms, we can consider that the firms in this group emphasize knowledge transmission over creation to achieve a number of improvements in quality and productivity. They monitor the implementation of the strategy, which is not always applied to the whole organization. They emphasize the use of mechanisms and systems for knowledge storage, transmission and distribution. The strategy is only supported by some cultural principles and human resources practices.

(c) Cluster 3 (n=17): *"Leaders in knowledge management".* Firms in this group are focused on the creation of knowledge and innovation. They are pioneers in introducing the KMS, which has been developed during more time –on average– than in the other

groups. This group scores higher than clusters 1, 2 and 4 in all variables, except for knowledge protection methods, in which it is surpassed by cluster 4 (although not significantly). This shows that they have a wide knowledge base, which is continually updated. They have a very good control on creation, distribution and application methods, significantly surpassing the rest of the clusters. It also significantly surpasses the rest of the groups in the importance given to cultural principles and leadership as systems of support for the implementation of KMS. It is also excels the rest of the groups in the two human resources practices (it stands out over cluster 2 for practices based on financial incentives and over cluster 1 in practices based on no financial incentives). They use diverse mechanisms and systems to motivate knowledge creation and their strategy is strongly supported by the organization's leaders, its culture, and its human resources practices.

(d) Cluster 4 (n=17): *"Beginners in knowledge management".* This is the group which has developed knowledge management activities for the shortest period and probably it has a very limited understanding of mechanism and practices of implementation (in which it scores under the rest of the clusters, with the exception of cluster 1), although it has a good understanding of protection techniques, in which it surpasses the rest of the clusters (only significantly with cluster 1). It is remarkable that although it is close to cluster 1 in relation to some variables (albeit normally achieves higher results), its KMS development time is shorter.

This cluster has a contradictory KMS, since their objectives and conception of the strategy do not match the ambit of implementation or the use of support methods in all knowledge management phases. Cultural principles, leadership and human resources practices do not clearly support the strategic approach.

The obtained results let us corroborate *hypothesis 1*: the firms can be grouped in homogeneous clusters according to their knowledge management strategies.

The next step was to check if the groups also follow different guidelines to management innovation in the firm (H2). We tried to establish if there was a relationship between the knowledge management strategy followed by the firms belonging to each cluster and their innovation management. The ANOVA was applied to each considered variable (or factor scores) to achieve this objective[7]. Table 8 shows

[7] In this case, the multivariate analysis of variance (MANOVA) did not give significant results on the difference among groups of firms in relation to Innovation Management, considering jointly all dimensions previously defined. The correlation analysis among variables which conformed the different dimensions showed that the "innovation effort" had a very different behaviour with respect to the rest of the variables (not significant correlations in most of cases). Its elimination of the analysis showed significant differences among groups. Obviously, this is an important limitation to consider in this work.

the mean values (original scores) for each of the variables (or factors), the Levene statistic of homogeneity of variances between groups, the F corresponding to the ANOVA and post-hoc contrasts (Scheffé in cases of homogeneity of variances and T2 of Tamahne in cases in which that condition is not carried out).

Table 8. Innovation Management

Variables	**Clusters**				**Levene statistic**	**F**	**Post-hoc (Scheffé or T2)**
	1; N=12	**2**; N=33	**3**; N=17	**4**; N=11			
Technological pioneer	2,417	3,446	3,422	2,818	1,800	3,969**	1<2
Technological leader	2,417	3,212	3.294	2,545	1,214	3,311**	
Recognized innovator	2,583	3,300	3,841	3,273	1,918	2,805**	1<3
Internal technology development	2,252	3,234	4,11	2,848	2,767**		1,2,4<3
Incorporation of external technologies	2,222	2,836	2,77	2,441	0,628	1,979	
Use of protection technology methods	1,333	2,235	2,05	1,575	2,056	2,981**	1<2
% R&D expenditure/ sales	2,50	5,26	3,90	2,40	0,861*		

**significant p<0,05
*significant p<0,01

The results show that there are some significant differences among groups in Innovation Management. Cluster 3 –leaders in knowledge management– has high scores in every variable considered, although in this case, cluster 2 –followers in knowledge management– surpasses cluster 3 in four of the seven considered dimensions of innovation management (but not significantly). It is also remarkable that this last one devotes a higher percentage of sales to R&D expenditure –on average. Cluster 3 is outstanding because it scores significantly higher than the rest of the clusters in internal development of technology. This means that this cluster, which is better than the rest in the implementation of knowledge management, is remarkable in the internal development of technology in its innovation management. On the other hand, although it is not a technological pioneer (in this case, only cluster 2 scores significantly higher than cluster 1), it is significantly *known for the introduction of innovation technologies*. Cluster 1, as with its KM strategy, is also the only group which scores lower in almost all the considered dimensions (in six of seven).

These results allow us to conclude that there are important differences in innovation management –if we consider each of its dimensions separately– in relation to the KMS followed by firms belonging to diffferent clusters. This seems to indicate that there are common factors among the knowledge management practices and innovation management.

We then had to examine if there were differences in the results obtained among different groups. The analysis undertaken was similar to the previous one. The analysis of variances (ANOVA) was used again to determine if the clusters were different –on average in the last three years– in sales growth, return on assets, return on equity and return on sales. This allow us to contrast hypothesis 3 –i.e. if the indicators –ROA, ROE, ROS and sales growth– significantly differ between the groups of strategies obtained in the cluster analysis. These variables jointly give us a correct approximation for firm performance, solving the limitations that could arise from having a unique indicator.

Table 9. Analysis of Firm Performance

Variables	**Clusters**				**Levene statistic**	**F**	**Post-hoc (Scheffé or T2)**
	1; N=12	**2**; N=33	**3**; N=17	**4**; N=11			
ROE	12,57	9,86	22,23	9,84	1,184	3,045**	2,4<3
SG	13,87	15,64	39,42	9,26	5,685*		4<3
ROS	6,41	6,56	4,81	6,85	0,300	0,230	
ROA	5,20	3,54	4,61	3,71	0,826	0,331	

*significant p<0,01
**significant p<0,05

Significant differences in the results among the clusters can only be observed in two variables: return on equity (ROE) and sales growth (SG). Cluster 3 –leaders in knowledge management– obtains significantly higher results –for these two variables– than cluster 2, and higher than cluster 4 for ROE and SG. This seems indicate that being leader in the development and implementation of knowledge management strategies –which allows a higher internal development of technologies– influences in the obtaining of higher performance. There are no significant differences among the groups for ROS and ROA. On the other hand, although cluster 2 seems to invest more on R&D –on average– and usually uses the protection methods of technologies based in patents than the other clusters, it is not able to benefit from the results significantly

higher than the rest. It is also important to remark that cluster 1 –called *backwards* in knowledge management– which obtained a low score in the management of its innovation activities, doesn't achieve significantly worse results than any of the other clusters. Moreover, although sales in cluster 4 –beginners in knowledge management– have a slower growth, this may be caused by the shorter time of the implementation of its knowledge management activities.

4 Discussion and Conclusions

This work analyses, from a knowledge-based view of the firm, the KMS development of a sample of spanish firms and the relationship with their innovation management and their performance. A new typology of KMS is established from the empirical study, which gives us a general perspective of what KMS means for the firm, a higher number of variables referring to the different aspects of its implementation and a multisectorial analysis.

The results of the exploratory analysis show that there are important differences between firms in the knowledge management strategy conception and implementation and a significant relationship among the performance of some firms and their efficiency in the transmission and application of existing knowledge.

This typology shows that there are four groups of firms in relation to its KMS: (a) Backward in knowledge management; (b) Followers in knowledge management; (c) Leaders in knowledge management and (d) Beginners in knowledge management. Two of these groups seem to have achieved efficient and coherent knowledge management strategies (b and c). One of these groups (c) focuses its strategy in knowledge and innovation creation, but the other one (b) excels in terms of internal knowledge distribution. It is not possible to determine which of these two approximations is superior, although future research will allow us to obtain a deeper understanding of the sectors or situations in which the application of a determined strategy may be more efficient than another. The rest of the groups (a and d) do not show efficient knowledge strategies.

In relation to Innovation Management (IM), it has not been possible to entirely confirm the hypothesis that there are important differences among groups of KMS. On the other hand, the separate analysis of each dimension of this construct (IM) allow us to confirm the existence of differences in relation to: *identification as technological pioneer, recognized innovator, internal development of technologies* and *protection of technology.* It is important to emphasize that cluster 3 (Leaders in KM), which

surpasses the others three clusters due to its ability in knowledge creation, transference and application, is also significantly better in the internal development of technology. This fact allows firms of this cluster to extend their actual knowledge base and capability regarding knowledge absorption from external sources (Cohen and Levinthal, 1990). The knowledge application in products and processes is confirmed because they are recognized as innovator firms within their sector of activity. Finally, we have checked that this is the group of firms with better results in return on equity and sales growth in the last three years considered.

Results and efficiency of innovator effort are very close in relation to efficiency in knowledge creation. All this allow us to value the consistency of the relationship between KMS and innovator effort and vice-versa. These results support the idea that knowledge is an essential strategic resource (Drucker, 1999; Grant, 1996) and that KMS is closely related to firm performance, innovation management and the development of dynamic capabilities (Teece, Pisano and Shuen, 1997). The empirical work also shows that the complexity of knowledge management strategy influences the global performance of the organization. These results can be used to develop specific strategic actions in innovation management and in the KMS for obtaining a competitive advantage, which is the main strategic objective.

On the other hand, although we have found important connections between KMS, innovation management and firm performance, this study has some limitations that we will try to solve in subsequent studies. For example, one limitation is the static character of the study, which complicates the analysis of the influence of some variables as innovator effort in posterior periods. This can be solved through longitudinal studies. Also, the statistic tools used have not examined the causality relationship between KMS, strategic management and firm performance. Firms belonging to the analysed KMS groups differ significantly in knowledge management and firm performance; however we do not demonstrate that this is a cause-effect relationship. The statistic methods and tools will allow us to overcome this limitation in future works.

Due to the complexity of the variables analysed in this work, the used scales are experimental and the database limited. We actually follow this research line, trying to develop a more elaborated scale to measure the variables and a wider, more comprehensive database. This will allow us to achieve a deeper understanding of the implications of knowledge strategy on innovation and firm performance.

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