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WHICH IS THE ROLE OF INNOVATION IN CURRENT SOCIETY? EVIDENCE FROM THE SPANISH PHARMACEUTICAL INDUSTRY

María Jesús Luengo-Valderrey*

* Department of Management Evaluation and Business Innovation, Universidad del País Vasco/Euskal Herriko Unibertsitatea (University of the Basque Country)

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ABSTRACT

At current knowledge society, innovation is considered essential in order to achieve survival and growth in organizations. Therefore, the engineering managers need tools facilitating the best innovation strategies for their organizations. In this sense, we present an original study about how Spanish companies. In the Pharmaceutical Industry handle innovation and we present the most relative factors in this process. Then, we realize a cluster analysis by which we identify eight behaviors according to how enterprises manage their innovation process. As a result, this research provides action guidelines to engineering managers in order to promote success in their innovation process within the Spanish Pharmaceutical Industry. In general, this industry is composed by organizations which find total quality, management excellence and knowledge management; therefore, this paper could support innovative strategies in any other industry.

KEYWORDS: Innovation; R&D; Innovation strategy; Engineering Managers; Pharmaceutical industry; Spain.

1. INTRODUCTION

Innovation is considered to be an essential activity for organizations to survive and achieve growth [1] [2], while also being a key factor in their competitiveness [3] [4], therefore engineering managers should achieve the best tools in order to develop successful strategies related to innovation and, in their case, also with protection (patents). In addition, and according to Schumpeter [5], innovation is linked to the theory of economic growth; therefore, this process being as important as it is for the present-day society, its study is a must. In this sense, changes in lifestyles stimulate this same process in organizations related to products, services, operations, processes and people [6].

Taking this information into account, having a strategic innovation orientation in enterprises could be essential in order to achieve competitive advantages [7] [8] and also for the general society, because it helps to create an environment of sustainability [9]. In fact, for instance, organizations which are focused in full on the innovation of processes and products are more related to environmental improvement than the rest [10]. However, the intangible nature of innovation and enterprises' heterogeneity hinder their management.

In this scenario, where there is no consensus about how to manage innovation in enterprises, we propose an original study about how enterprises manage innovative activity. In this way, this research could be useful to engineering managers when it comes to decision-making about objectives and investment on innovation.

The contributions of this paper have two different parts: on the one hand, we identify, using factor analysis technique, critical factors in this process analyzing which variables are more interesting in innovative process. On the other hand, we recognize different types of behaviors according to how enterprises manage innovation using a cluster analysis and we realize a comparison between these clusters. As a result, we obtain the actions of the clusters which show better results, lower results and critical factors in the process. Therefore, we provide for engineering managers an interesting guide of actions for all enterprises interested in improving their situation by using innovative activities.

Innovation is more interesting when we speak about industries dedicated to improving people's welfare like the Pharmaceutical Industry. This industry continuously invests in research and development (R&D) and their

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innovations have to be able to eradicate diseases and increase the quality of life for those who are chronically ill. In this way, following Gutierrez [11], "innovation in medicine represents an essential contribution to economic and social welfare".

From this information, we choose pharmaceutical industry because this it is a reference for enterprises in other industries. Because pharmaceutical companies could have different behaviors in different countries, we focus our analysis in a one specific country: Spain. The Pharmaceutical Industry is the top industry investing in R&D in Spain [12].

This means that the potential population of this research is composed of different agents: First, Pharmaceutical Enterprises in Spain, because we analyze how they manage their know-how. In this way, they can understand their situation and know if they need to change their actions in order to improve their results. Second, our results could be interesting for pharmaceuticals in other countries because we provide support for the decision-making process. Generally, all enterprises interested in innovative activities could use the guide provided in this paper. Finally, scholars may find the results of this paper interesting in order to focus their research into innovation activities in enterprises, because it takes a fresh look and provides a start point in the area.

The remainder of the paper is organized as follows: first, we propose the theoretical framework and more details about the aim of the paper, where we identify the gap in knowledge to which our research contributes. The next section exposes our methodology and then, we show the results. In the next section, we present an interesting discussion related to the results and finally, we conclude with the principal findings of our research, the main limitations and the future lines and the implications derived from the analysis and influence to engineers.

2. INNOVATION THEORY AND RESEARCH GOALS

The concept of innovation stems from Latin in which innovare which means to change things by introducing something new [13]. However, in the business area there are several definitions about what innovation is [14] and some scholars identify this lack of consensus as a problem [14] [6]. One of the first was proposed in 1965 by Thomson, who linked innovation with the generation and use of new ideas to, for example, new processes, new products or new services.

In this way, Baregheh et al. [6] expose an interesting and very quoted definition about the concept set forth by Damanpour [16, p. 694]: "Innovation is conceived as a means of changing an organization, either as a response to changes in the external environment or as a pre-emptive action to influence the environment. Hence, innovation is here broadly defined to encompass a range of types, including new product or service, new process technology, new organization structure or administrative systems or new plans or program pertaining to organization members". In any case, innovation is related to the idea of change or something new [17]. Consequently, an interesting strategic line in innovative organizations is linked to protect innovation results using patents or similar tools in order to maintain their competitive advantage as long as possible and hindering the imitation process [18]. Innovation is an activity related to people because it is only effective when society accepts the change [19], and the process requires the engagement of people working in teams and dedicating efforts to this activity. Therefore, innovative activities are linked to employees, who should be committed to them and dedicate their efforts to these activities [20]. In this way, all top managers (and engineering managers) are important in order to decide the general strategic direction and, in particular, the innovation projects. Therefore, top management teams are key to this area of study [8] thus tools about strategic management including previous experiences and collaborations are essential in order to identify the essential knowledge in future innovation processes [21].

As a consequence, for organizations with high levels of innovation, good management is vital because they are different to traditional businesses: they need managers, and primarily engineering managers, not only working to plan, organize and control, but also to help their collaborators to enrich their lives [22]. In this sense, innovative organizations are composed mainly by "knowledge workers", that is to say, by employees applying their ideas, concepts and information to their work more than just manual labor, and where continuous innovation is a significant part of their responsibility [23].

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Knowledge workers do not just work in order to obtain salaries and professional advances, but they find personal development through their work [24]. Consequently, they are creative people that identify self-management as one of the best tools to grow [25], and these people need leaders to be facilitators more than organizers [26]. That is to say those managers should learn more about the ways in which their employees learn and about how people create knowledge [25] promoting their creativity with recognitions (financial or not), introducing risk tolerance and accepting the failures and human mistakes as experience and knowledge [27]. At the same time, all managers should know how they could motivate their employees, whether they are knowledge workers or not because their characteristics are highlight in this process. In this way, managers collect the information adapting their motivational strategies in order to increase satisfaction level [28]. This action has a positive influence in creativity development, implication and innovation level in organizations.

Another interesting part of innovation process it are research and development activities, which are related to innovation [29]. In this way and following Ganotakis and Love [2], internal R&D is necessary in order to find, use and take advantage of the best external R&D, while external R&D also is beneficial. In general, "R&D increase the market success of innovative products" (p. 843) thereby increasing innovation quality [30], and high levels of R&D expenditures influence internal knowledge which is needed for product innovation [31]. Following Un, Cuervo-Cazurr and Asawaka [32] collaborations with suppliers, competitors, universities and clients which are linked to R&D influence the product innovative activity in organizations. For instance, recent studies show how failures related to commercialization new designs derived from a lack of understanding by customers more than the technology capacity. To avoid this problem engineering managers in organizations should incorporate tools like embedded toolkits [33] promoting a high level of communication between employees because motivated teams undertake successful innovation projects [27]. These teams should include employees but also the main suppliers because all of them are necessary in order to focus their efforts and capacities in programs with the aim of increase performance and innovations [34].

Therefore, innovation is a complex concept and there is no consensus about it. However, scholars agree upon the importance of innovative processes in enterprises. This consensus highlights the need of find a model in order to support innovative decisions made by engineering managers in enterprises, but there are some difficulties about its creation. On one hand, heterogeneity in enterprises supposes a problem because different enterprises may need different innovative strategies. On the other hand, the intangible character of innovation hampers its management. As a consequence, there is no model about how to manage innovation in enterprises.

In this scenario, we present a preliminary analysis in order to provide a first step in the creation of that model and a support for the decision-making process linked to innovation activity in enterprises. Results are very interesting for engineering managers working in the industrial industry, especially in small and medium enterprises (SMEs), because these organizations have difficulties with their innovative strategies.

We choose the pharmaceutical industry because it contributes to the general society by improving economic welfare. In addition, historically the pharmaceutical industry has generated innovative products in order to help people who are not well and innovations linked to new medical methodologies could be considered as an important source of competitive advantages. In this way, following Gutierrez [11, p. 7], "an innovative pharmaceutical industry is a key element in the global knowledge economy" and amounts to around 10 percent of total investment in R&D in OECD countries. Moreover, this industry is very interesting because it is characterized by fast changes and positioning in the market over time [35].

Concretely, we carried out our study in Spain because it is "a strategic and important industry that contributes with value, employment and knowledge to society. To perform R&D in the pharmaceutical industry supposes a high cost when faced with new challenges and paradigms and it employs around 4,500 highly qualified professionals" [36, p. 8].

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In this scenario, the paper has two purposes with implications related with the management process in organizations:

i. First, we want to identify critical factors in the innovation management process using variables linked to innovative activities in order to propose a guide with factors where stakeholders should focus their activities.
ii. Second, we want to analyze different behaviors according the previous factors by identifying clusters of enterprises in order to compare which behaviors are better and what enterprises should improve depending on their situation.

3. MATERIALS AND METHODS

Sample Collection

The sample is composed of 266 Spanish enterprises in the pharmaceutical industry (following the statistical classification of economic activities in the European Communities, all of them are in NACE 21). Data has been extracted from the Spanish National Institute of Statistics (INE) from the year 2015 and while applying a questionnaire about innovation in enterprises and authors' access to this database in September 2018. The sample was selected from the INE at random from their DIRCE (Centralized Directory of Enterprises), obtaining a final sample made up of more than 40,000 firms in all sectors.

The study originally arouses out of the OECD's interest in preparing and improving useful indicators for gathering and interpreting data on innovation since 1990. These indicators of innovation together with others on business strategy and plans; factors influencing the organizations' capacity to innovate and performance (including government action); and their innovation performance and profitability are published by EUROSTAT, the statistical office of the European Union in its Community Innovation Survey (CIS), which began gathering data in 1993 (in Spain from 1994).

The CIS provides the European Union with a stable framework for the analysis and presentation of overall and sector-specific data on innovation, allowing comparison between member states. It also meets all the essential criteria required of any questionnaire in terms of validity and reliability, making it an appropriate instrument for use in this study. This choice is due to the fact that being a survey sent by a public body, it offers reassurance to the recipient which results in greater sincerity in the response, giving it in turn a high level of reliability. The effectiveness and speed of response avoids the bias that appears when there is no response within a certain and short period of time. A high response rate is obtained (over 96%). And the use of a methodology widely accepted at European level gives it a strong consistency and facilitates the interpretation of the results.
Description Variables

We select variables linked to innovative activities for our study, and we classify them into four categories (see Table 1):

Table 1: Variables classification

MOTIVATION	PERFORMANCE	INVESTMENT	HUMAN CAPITAL
*Innovation: to reduce response time *Innovation: to increase quality * Innovation: to reduce unit cost * Innovation: to create new products * Innovation: to increase information shared * No innovation: a lack of technology	* EPO patents * OEPM patents * USPTO patents * PCT patents	* R&D equipment * Software R&D * Researchers' wages * Technicians and Assistants' wages * R&D consultant costs * Innovation in technological development * Applied innovation * Basic innovation	*R&D Consultants * R&D Researchers * R&D Technicians * R&D Assistants

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* No innovation: a lack of market information * No innovation: a lack of quality employees *No innovation: a lack of cooperation * No innovation: market is dominated * No innovation: demand is uncertain * No innovation: a lack of internal funds * No innovation: a lack of external financing * No innovation: High costs * No innovation: there is no demand *High innovation activity in past years			

i. Motivation to innovate. In this category we include managers' motivation to innovate.
ii. Performance. In this category we include variables linked to results which are measured using patents.
iii. Investment. This category includes the monetary investment in both equipment and people.
iv. Human capital. This category includes people: employees dedicated to innovation.

Research Method

For the analysis, we use different statistical techniques. First, we carry out an exploratory factor analysis, a technique described by Kim and Mueller as a "variety of statistical techniques whose objective is to represent a set of variables in terms of a smaller number of underlying variables or factors" [37, p. 1] with help from the SPSS program. More specifically, we use principal component analysis with Varimax rotation.

Next, by using the factors obtained in the previous step, we classify enterprises in groups with a hierarchical cluster technique. Cluster analysis is a statistical method based on "classified objects (that is, responses, products or other entities) where each object is very similar to the others in the same cluster" [38, p. 492]. In this sense, enterprises within each cluster are homogeneous and clusters themselves are heterogeneous [38].

We choose Ward's method in our cluster analysis. Following Aldenderfer and Blashfield [39, p. 43] "this method is designed to optimize the minimum variance within clusters. This objective function is also known as the within-groups sum of squares or the error sum of squares". Ward's method is one of the most often used [40].

4. RESULTS

Construct Validity

Following Hair et al. [38], a factor analysis sample should have more than 50 observations and preferably it should have more than 100. In general, the number of factor analysis observations should be at least 5 times the number of variables. In our case, we have a sample with 266 observations and we use 32 variables for our factor analysis, so this point is correct.

In order to analyze adequacy, we performed Bartlett's test of sphericity and it shows that our analysis is adequate because it is 0, less than the explicit level of 0.05 (see Table 2). Also, we use the KMO (Kaiser-Meyer-Olkin coefficient) measure and it is 0.783, that is to say, it has an acceptable level (see Table 2) [41]. Therefore, a factor analysis is appropriate for this data.

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Table 2: KMO and Bartlett's test of sphericity

KAISER-MEYER-OLKIN MEASURE OF SAMPLING ADEQUACY		
.783		
BARTLETT'S TEST OF SPHERICITY		
Approx. Chi-Square	Df	Significance
355.039	120	0.000

Exploratory Factor Analysis
Using a rotated component matrix (see Table 3), we found nine factors that explain 71.707% of data variability (see Table 4). Hair et al. [38, p. 378] argue that "it is not uncommon to consider a solution that accounts for 60% as satisfactory". In this way, our study is considered satisfactory.

Table 3: Rotated component matrix

	COMPONENT								
Variables:	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Innovation: to reduce response time	**.970**	.025	.016	-.021	-.063	.009	-.069	-.053	-.028
Innovation: to increase quality	**.970**	.030	-.004	-.005	-.043	.037	-.083	-.036	-.034
Innovation: to reduce unit cost	**.963**	.047	-.009	-.005	-.053	.040	-.057	-.066	-.021
Innovation: to create new products	**.963**	.043	-.028	-.026	-.052	.057	-.081	-.043	-.034
Innovation: to increase information shared	**.959**	-.002	.006	.002	-.037	.040	-.079	-.056	.000
No innovation: a lack of technology	.004	**.849**	.010	-.008	.023	.055	.044	.064	-.001
No innovation: a lack of market information	.012	**.839**	-.108	.056	-.009	.034	.123	-.092	.083
No innovation: a lack of quality employees	-.029	**.770**	-.066	-.142	-.068	.049	.077	.015	.027
No innovation: a lack of cooperation	.072	**.739**	-.104	.014	.016	.243	.025	-.077	-.076
No innovation: market is dominated	-.007	**.722**	-.037	-.070	-.053	.102	-.009	-.043	.001
No innovation: demand is uncertain	.055	**.713**	.070	-.008	-.054	.124	.064	.091	-.035
Researchers' Wages	-.069	-.057	**.771**	.260	.183	-.100	.068	.116	-.065
R&D Equipment	.025	-.018	**.733**	.021	.151	.076	.057	-.112	.085
R&D Researchers	-.053	-.086	**.679**	.447	.016	-.141	.128	.039	-.085
EPO Patents	.036	-.129	**.596**	-.113	.006	.150	.028	.369	-.170
OEPM Patents	.085	.060	**.387**	-.058	-.098	-.254	-.144	.048	.357
R&D Consultants	.029	-.066	.066	**.938**	.004	.004	.041	.012	-.012
R&D Consultant cost	-.046	-.068	.166	**.868**	-.064	.092	.035	-.008	.071
R&D Technicians	-.053	.033	.081	**.549**	.545	-.294	-.060	.210	.003
Technicians and Assistant's Wages	-.164	.008	.156	.000	**.846**	-.122	-.099	.167	.072
R&D Assistants	-.166	-.074	.163	-.052	**.756**	.012	.034	.037	-.076
Software R&D	.133	-.065	-.044	.009	**.588**	.218	.151	-.117	.092
No innovation: a lack of internal funds	.050	.395	-.044	-.021	-.025	**.735**	-.025	-.021	-.033
No innovation: a lack of external financing	.157	.491	-.093	.060	.021	**.685**	-.001	-.012	-.002

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No innovation: high costs	.048	.521	.110	-.005	-.007	**.639**	-.081	.078	-.012
No innovation: there is no demand	-.150	.126	.083	.041	.051	-.025	**.891**	.056	.002
High innovation activity in past years	-.161	.152	.078	.037	.012	-.005	**.888**	.033	-.004
USPTO Patents	-.099	-.037	.078	.012	.074	.085	.017	**.843**	.049
PCT Patents	-.089	.046	.038	.059	.034	-.086	.057	**.785**	.062
Innovation in technological development	-.083	-.073	.324	-.032	.259	-.020	.168	-.019	**-.694**
Applied innovation	-.272	-.017	.110	.130	.249	-.227	.128	.066	**.647**
Basic innovation	-.045	-.101	.028	-.066	.204	.322	.106	.055	**.482**

Table 4: Total variance explained

Factor	ROTATION SUMS OF SQUARED LOADINGS		
	Total	% of variance	Cumulative %
1	4.939	15.435	15.435
2	4.378	13.680	29.115
3	2.385	7.452	36.567
4	2.284	7.138	43.705
5	2.205	6.891	50.596
6	1.968	6.149	56.744
7	1.791	5.598	62.342
8	1.639	5.123	67.465
9	1.358	4.243	71.707

Factor 1: Aims of innovative activities. The first factor explains around 15.43 % of data variability and it is made up of the aims of innovative activities priority for any manager: to reduce response time, to increase quality, to reduce unit cost, to create new products and to increase information sharing within the enterprises.

Factor 2: Innovation problems. The second factor explains about 13.68 percent of data variability and is composed of the innovation problems that managers face in the enterprises in this activity: a lack of technology, a lack of market information, a lack of quality employees, a lack of cooperation, market domain by competitors and demand uncertainty.

Factor 3: R&D effects. The third factor is linked with R&D activities and their protected results: researchers, researchers' wages, R&D equipment, EPO patents and OEPM patents, and it explains around 7.452 percent of the variability.

Factor 4: R&D Support. The fourth factor also is linked to R&D activity, however, in this case it is linked to technicians and consultants who support and are dedicated to the R&D process and the cost of external consults. It explains about 7.138 percent of data variability.

Factor 5: Assisting R&D activity. This factor is also linked to R&D activities, but from another perspective - assistants. It includes assistants, software dedicated to R&D and the wages of assistants and technicians. Factor 5 explains around 6.891 % of data variability.

Factor 6: Financing problem. In this case, factor 6 is linked to the problems in financing innovative activities, and it explains around 6.149 % of the variance. In this way, this factor includes: a lack of internal funding, a lack of external financing and the high cost of innovation.

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Factor 7: Non-innovative activities. Factor 7 explains about 5.598 percent of data variability and it includes the reasons to why there are non-innovative activities in some enterprises, with the following variables: there is no demand linked to innovation and the enterprise has innovated in past years.

Factor 8: Special patents. Factor 8 explains around 5.123 % of the variability and it includes special patents: patents registered in U.S. Patent and Trademark Office and patent cooperation agreements.

Factor 9: Research investment. And finally, the least important factor in pharmaceutical innovative activities is the response to the question: what type of innovation are they investing in? In this sense, it includes the percentage of investment dedicated to basic innovation, applied innovation and technological development. It explains around 4.243 % of the variability.

Identifying different behaviors in innovative activity: A cluster analysis
From these data we identify clusters of enterprises according to how these firms manage innovation. In this sense, we first carry out an exploratory analysis using Ward's methodology and we obtain a dendrogram. Then, we establish a cut-off (see Figure 1) and identify eight clusters. Subsequently, we repeat cluster analysis using Ward's methodology but, in this case, we select an option in order to establish eight clusters beforehand.

From the cluster analysis, we compared the different behaviors between the factors. So, we develop a descriptive analysis with some variables used in factor analysis and others that we think are interesting like, for example, turnover in 2015 or year of creation (see Table 5).

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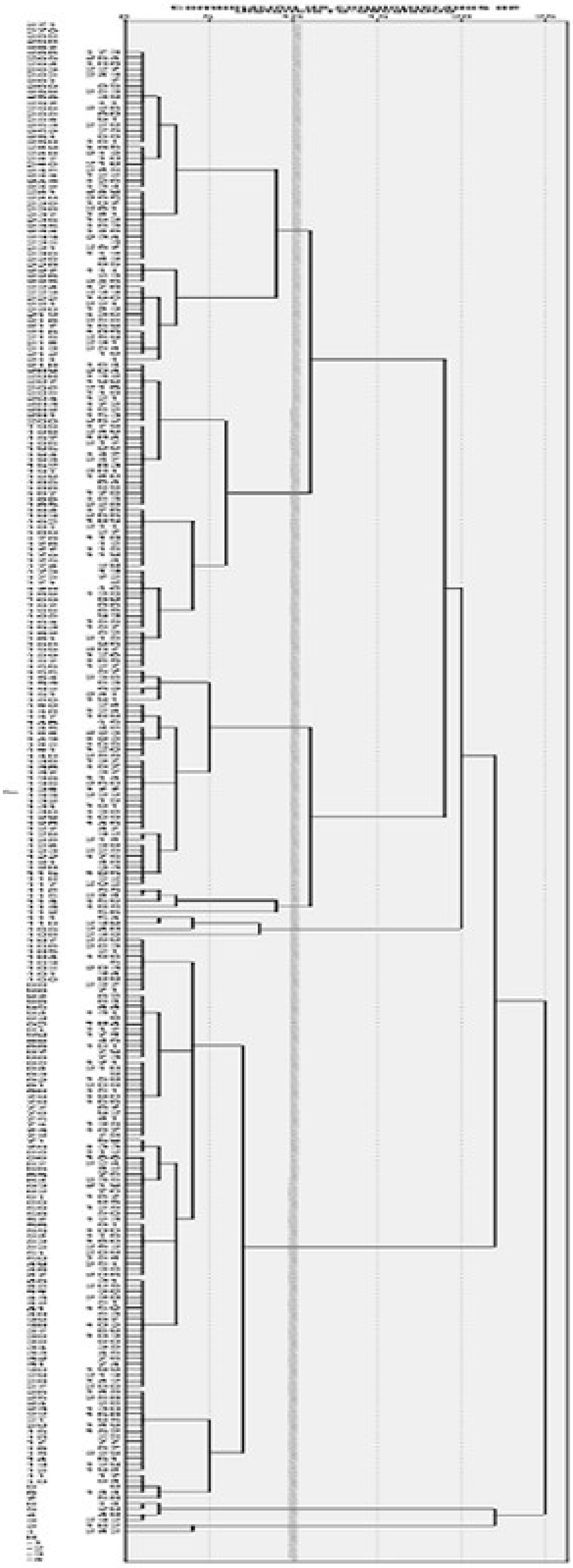

Figure 1: Dendogram

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Table 5: Clusters comparison

	CLU_1	CLU_2	CLU_3	CLU_4	CLU_5	CLU_6	CLU_ 7	CLU_8
Composition	56	55	101	4	39	4	5	2
Turnover	172,909	320,150	297,657	174,437	217,650	134,446	2,073,950	275,526
Researchers	0.01	0.05	0.06	0.3	0.2	0.7	0.2	0.8
Researchers' Wages	341	1,963	2,571	8,279	5,438	22,152	8,762	15,000
Assistants	0.008	0.04	0.06	0.2	0.1	0.1	0.6	0.5
Assistants' Wages	317	1,046	1,729	2,592	2,404	1,784	13,950	0
Consultant	0	0.0002	0.002	0.05	0.005	0.001	0	0.7
Consultant Costs	0	6.7038	43.0123	1,477.2	10.0847	2,118.2	0	14,603
R&D Equipment	89.44	206.67	621.27	491.67	2,895.2	21,250	2,870.5	1,243.3
R&D Buildings	179.25	47.96	89.01	0	1,515.8	0	518.58	0
R&D Software	0	16.23	13.86	0	99.96	0	1,097.21	215
Total Investment	926.69	3,286.5	5,067.1	11,839	12,363	47,304	27,198.2	31,061
OEPM Patents	0.0013	0.0077	0.030	0.0659	0.0028	0.3750	0	0
EPO Patents	0	0.0004	0.0031	0.0555	0.0092	0.1250	0.0214	0
USPTO Patents	0	0	0.0012	0.0840	0.0024	0	0.0105	0
PCT Patents	0.0006	0.0004	0.0048	0.2742	0.0049	0	0.0126	0
Total Patents	0.0019	0.0085	0.0391	0.4796	0.0193	0.5	0.0445	0

Cluster 1 is composed by fifty-six enterprises and it is characterized by underperformance and low investment in innovation. It is the cluster with lower levels of investment in personnel dedicated to innovative activities (consultants, assistants, technicians and researchers) who work with R&D software. In relation to innovation performance, its results are measured using patents variables are very low in comparison with others clusters. And finally, its general result (measured with average turnover in 2015) is the second lowest.

Cluster 2 invests a little bit more than previous group and its innovation results are also a little bit higher. In this sense, the most interesting question related to this cluster are the general results it has an average turnover about 320,150 per employee, the second best. Conclusions are difficult because it is composed by fifty-five firms but from this information, enterprises in Cluster 2 seem to be firms that "live in the past", that is to say, enterprises that invested in the past obtained patents in the past and now they are reaping the rewards.

Cluster 3 (composed of 101 enterprises) is similar to Cluster 2 regarding its general results in that an average turnover around 297,657 per employee was obtained a good result. The principal difference with Cluster 2 is that its investment in innovation is higher and also its innovation results are higher, with 0.0391 patents per employee. In this sense, we can say again these firms "live in the past", however they reinvest some of their profits in innovative activities.

Cluster 4 is composed of only four enterprises and it is an interesting case because they invest more than twice than Cluster 3 (the highest so far), and obtain the second-best results linked to innovation (0.4796 patents per employee), but its general results are not that striking. The most interesting question is related to PCT patents, where Cluster 4 obtains the best punctuation by far. We know that enterprises in this cluster have been created after 1975, that is to say, in the last quarter of the century. As a result of this information, we can observe that enterprises in Cluster 4 pay attention to cooperation, since they see this activity to be an interesting tool in order to improve their position.

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Cluster 5, composed of thirty-nine enterprises, has an average age similar to Cluster 4 but it presents a different trend similar to Clusters 1, 2 and 3. These organizations invest less than previous cluster in innovation activities, and this fact could be similar in their patents results. However, their turnover is higher.

Cluster 6 is composed of only four young enterprises: they were created between 2003 and 2009 and have between 2 and 6 employees. Although their turnover is the lowest, it is a very interesting case because enterprises in Cluster 6 make large investments in innovation (the highest investment level) and their results measured using patents are also the best with 0.5 patents per employee from the European or Spanish Patent Office. Therefore, these firms seem like new businesses with a large potential although their general results are not high yet.

Cluster 7 is an exceptional case and it is composed of five firms. It is exceptional because its general result is extraordinary, with an average turnover about 2,073,950 per employee. Its investment in innovation is high, and it obtains the third highest score in innovation (following Clusters 4 and 6). As in the case of Cluster 4, these enterprises were created at the end of the century, and it is very interesting because it shows that enterprises with moderate-high investment in R&D obtain good innovation results and their general results are also solid.

Finally, Cluster 8 is a special case with only two small enterprises (with only 1 and 3 employees each). However, both of them manage their innovation process similarly and their results are similar too. Their innovation results are the lowest: zero patents.

5. DISCUSSION

Results show that managers in general, and in particular engineering managers define the strategy in organizations considering an essential factor the objectives in general and innovative aims in particular; specifying new ideas, specific goals and promoting innovation initiatives [42] and, according to Aragón-Correa, Garcia-Morales and Cordon-Pozo [43], leaders have a positive influence on innovative activities.

In this way innovation strategy is essential to achieve strategic competitiveness in organizations [44]. Managers are decision makers so they should recognize opportunities in innovation process [45] [46] and when they are linked to objectives.

However and although several previous contributions have determined innovation to be a source of competitive advantages (for example Zahara & Covin, [1]; Galia & Legros, [4]; Ganotakis & Love [2]), innovative activities also have some problems which make the process difficult for enterprises, and this factor is the secondary for managers and engineering managers when they manage innovation.

These problems hinder creativity process in organizations and they are derived from the lack of understanding in the market and motivational elements related to people in organizations. Following Denning [47, p. 4] "the failure rate of mature companies attempting to grow by creating new businesses is estimated to be over 90 per cent". There are some reasons that explain this failure: a lack of engagement in employees, an overabundance of innovative ideas, inadequate leadership, and technical, market and organizational impediments [48].

Tools like embedded toolkits [33], lines of communications integrating suppliers-employees-customers (external and internal) [34] and a factor related to risk tolerance and failures acceptance [27] have a positive effect in the motivation of working teams. In this way they influence reducing factors hindering decision making process linked to innovation [28].

After innovation barriers and according to the strategic lines in organizations, all managers are interested in innovation results (Factor 3: R&D effects) because these results are related to their competitive advantage making difficult the imitation of competitors [18]. This result is in accordance with previous studies where there is a strong correlation between R&D expenditures and patents (like, for example, in the chemical industry, following Ahuja and Katila [49], or in the computer industry, following Hagedoorn and Duysters [50].

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In this way patent propensity is defined as the number of patents per unit of R&D expenditure [51] [52], thus the relationship between both concepts is clear. In reference to the pharmaceutical industry, Graves and Langowitz [53] carried out a study where they linked R&D investment with innovative output [54]. Therefore, this factor is congruent with previous contributions.

Patents are very important because it is the protection in the innovation process and all managers know it, thus innovation results are considered a highlight factor ahead others like investing in R&D (Factor 4 and Factor 5). R&D investment affects product innovation [31]. This factor (Factor 4) is linked to people's creativity, where creative potential is defined as creative skills and abilities [55]. Following Amabile [56], creativity is related to innate skills, learned abilities and task attitudes, which are held by employees. In this sense, technicians and external consultants are key in innovative activities in organizations.

Then we find R&D investment linked with administrators and software. That is to say, they are linked to the facilitators. These variables are important because creative people (knowledge-workers) need software and assistance in order to carry out their activities [23].

However, innovation decisions could be hindered by financial problems because one of the most important barriers associated to innovative activities comes from costs [57]. An innovative organization needs a high level of funding in order to invest in people and equipment. Without this funding, innovative activities are more complicated for enterprises. These problems could be increased by negative thinking's or negative previous experiences, like for example if managers think nobody will buy their innovative products.

Non- European patents and invest in basic or applied innovation are considered residual factors by the managers. Cluster analysis confirms previous points. First and in general, sample is composed by mature enterprises (between 16 and 34 years) except those included in clusters 6 and 8 (they are between 0 and 3 years old). This could explain the results because 94.36 % of enterprises (clusters 1, 2, 3 and 5) do not have patents and they have less than 0.5 persons dedicated to R&D activity. At the same time, they highlight factors related to hindering innovation, especially those linked to know the market and previous innovation. These results are congruent with published theories like for example Sharma [48] or Denning [47]. In this group we identify a direct relationship between innovation efforts (measured using the average of employees dedicated to R&D, equipment's, buildings, software and total expenditure in R&D) with innovation results. That is to say: enterprises with a high effort in innovation are also enterprises with a high number of patents, and it confirms why engineering managers highlight it [54] [18]. Definitely, it seems that they are mature enterprises living on past income where they do not understand new needs in the market.

However, there are a group of mature enterprises composed by four firms and an age about twenty-one years (cluster 4) with a very significant and relevant different behavior for engineering managers. They focus their efforts in innovation activity and its results, with a high investment in R&D, especially referring to human factor. Following authors like for example Senge et al. [24], Novak [25], Harell & Daim [28] or Pellicer et al. [27] between others, employs are the key element in innovation process. This affirmation is confirmed in the analysis with the results of cluster 4 (an average about 0.4797 patents).

Cluster 7 is a special case. It is composed by 5 enterprises with an average age about sixteen years old realizing a high effort in innovation. In this sense, they have almost a person dedicated to R&D and a high investment in equipment's, buildings and other goods linked to innovation. However, their results (measured using patents) are very low, although their turnover is the higher. The explanation could be related to their innovation efforts are focused on the market and following Steiner et al. [33] it is one of the most sources of failures commercialization new designs. These processes do not generate patents and their final objective is improving the turnover and seeing the results, this group achieves its aim.

Finally, clusters 6 and 8 are composed by young enterprises dedicating high efforts to innovation activity, especially in human capital (measured using people dedicated to R&D). These efforts have a direct influence in the number of patents, where cluster 6 has the best figure. Although enterprises composing cluster 8 do not have results measured using patents, the reason is linked to they are very young (all of them were constituted on the year 2015 when the questionnaire was used).

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6. CONCLUSION

There presents an original study about how Spanish enterprises in the pharmaceutical industry manage innovation. In this sense, the most interesting factors in this process and in consequence, factors that all managers should consider are: (1) Aims of innovative activities, (2) Innovation problems, (3) R&D effects, (4) R&D support, (5) Assisting R&D activity, (6) Financing problems, (7) Non-innovative activities, (8) Special patents ad (9) Research investment. Furthermore, we determined that factors 1, 2, 3, 4 and 5 are the most discriminatory since they are where enterprises pay more attention.

From this information, we can say that leaders in pharmaceutical industry try to satisfy their clients demands by providing high value from their best response to the demand, increasing quality, reducing costs (without influencing sale prices and without reducing quality), and thereby optimizing business resources. Managers establish their innovation objectives after they know the problems their organization is facing, because Innovation problems is the second most important factor. These difficulties appear, in general, because there is still a long way to go to be able to apply management models based on people. In this way, organizations establish partial goals that prevent leaders from knowing technological advantages and they limit people's creativity and motivation towards continuous learning.

People are very important in innovation activities, and we can see it in Factors 3, 4 and 5 entitled R&D effects, R&D support, Assisting R&D activity. They are concentrated on investing in people who are realizing research activities (both employees and external professionals) and the results are measured by using patents. Previously, organizations tended to carry out innovation in their R&D department but now they are trying to change this trend to models more focused on people.

Factors Financing problems and Non-innovative activities are not as important as others, thus cost, financing and demand are not limiting factors in order to decide on innovation activities. And Factors Special patents and Research investment are not very important for innovative organizations.

In addition, we can conclude that in innovation management, the most important factor is the attitude of managers with respect this process and the perception of problems derived by it. Therefore, in order to innovate in enterprises, physical investments are less important than manager behavior. This conclusion is very interesting because, in general, people tend to think that financial problems are the most important barriers in the innovation process.

In this scenario the exploratory analysis shows that managers of enterprises interested in improving their results using innovation should focus their efforts on their attitude towards innovation and, therefore, investment will be a logical consequence.

In reference to the Spanish pharmaceutical industry, results show that it is composed, in general, of organizations that show total quality, management excellence and knowledge management. However, there are already mature enterprises whose innovation processes are slowed by their natural resistance to change.

This conclusion is confirmed by cluster analysis, because we identify that enterprises dedicating a high effort in innovation are also enterprises with better results measured using patents (clusters 4 and 6). In addition, enterprises focusing their efforts to the innovation process in order to introduce products in the market are also enterprises with a high turnover (cluster 7). The case of cluster 8 is very special because it is composed by enterprises created in the same year that the questionnaire was facilitated, therefore they cannot obtain results yet. At the same time, the trend of the other clusters confirms the previous results, because with a maturity level similar their efforts in innovation activity are lower than the previous cases and their results are lower too.

In this scenario the analysis shows that enterprises interested in improving their results using innovation should focus their efforts on their attitude towards innovation and, therefore, investment will be a logical consequence. In reference to the Spanish pharmaceutical industry, results show that it is composed, in general, of organizations that show total quality, management excellence and knowledge management. However, there are majority of mature enterprises whose innovation processes are slowed by their natural resistance to change.

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This original research has some implications. On the one hand, results are appealing to enterprises in the pharmaceutical industry in Spain because they show different behaviors when managing innovation, thus they could know in what clusters they would be situated and in what clusters they would like to be in the future. If in the future they would like to be in another cluster, they know what this cluster does and they could imitate it.

On the other hand, this research is useful for pharmaceutical companies in general because they can see that Spanish pharmaceutical companies have better results and could therefore compare with this activity and change if they consider that it is necessary. In addition, we can identify a future line of research derived of these stakeholders, carrying out the same analysis in different countries and comparing the situation of Spanish companies with other countries to test whether there are differences. This type of analysis could lead to some very interesting results in this area.

Generally, this research could be useful to enterprises in other industries. In this sense, they understand the case of pharmaceutical companies and they could be used as distinct innovative cluster. At the same time, future research possibilities are derived by these stakeholders. For example, a comparison between pharmaceutical industries and other industries could be interesting.

Finally, scholars could use this study as a start point in order to make a guide for managers and engineering managers of enterprises interested in the innovation process. There is not a lot of consensus about this intangible asset type and the enterprises recognize the problems related to its management (Factor 2), and we could provide an exploratory study about this topic.

This study has some limitations resulted from the database used, because there have been working with data extracted by other organisms. In this sense, other variables could have been interesting but we have not access to them. In addition, the data is static, that is to say, we have analyzed only a year.

However, these limitations are seen like new lines of research in the future. First, a confirmatory analysis could be realized in order to confirm the results obtained by cluster and factorial analysis. This is the following step. Second, each factor could be analyzed with more precision, especially those related to hindering innovation. Third, it could be interesting to replicate the analysis in different years in order to establish a comparison and to analyze trends, and of course, with the purpose of knowing the development of young enterprises. Finally, another interesting point is linked to the situation in other countries: are the situations in other countries similar to Spain?

Engineering Managerial Implications

This research obtained a number of critical factors that the engineering managers can use to identify, manage, monitor and communicate the strategy of innovation in their organizations. This is very interesting because engineering managers, especially those working in SMEs, have more difficulties collecting and interpreting intangible values like for example innovation. In this sense, this research focuses their efforts in this process highlighting its benefits in a competitive economy.

Among all useful implications for engineering managers, especially for those whose activities are linked to R&D and innovation, there is a very interesting one: they should consider that the most interesting factor in innovation process is the human factor, therefore knowledge workers in R&D area are essential, because they are related to patents ratio. This fact supposes a challenge managing employees because the motivators in their case are different than traditional motivators.

On the one hand, a successful factor introducing an innovation is related with market knowledge, so it establishes direct lines of communication with customers in order to know their expectations and promote the flow of innovation, which is essential. Consequently, the process of introducing new products must be adequate (see cluster 7). These new products should be protected by patent system in order to guarantee a competitive and sustainability advantage. Hence, protect innovations are essential in order to be protected from imitation by competitors.

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Finally engineering managers should make a great personal effort in order to manage the enterprise looking to the future instead of living on past incomes and they should maintain an innovative spirit. This effort will be dedicated to motivate employees and overcome their resistance to change with the aim of they focus their activity in innovative products according with customer´s expectations.

Innovation difficulties could disappear if engineering managers present an innovative behavior and establish management models based on knowledge workers. Accordingly, the engineering managers have knowledge about technological advantages in their enterprises and their teams will be composed by creative people focusing to a continuous learning.

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