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CURRENT AND FUTURE CHALLENGES OF THE CERAMIC TILE FIRMS

(The case of the INKJET technological innovation)

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ABSTRACT

The following work integrates three theoretical perspectives in the field of economics: the situation in the ceramic sector at a global and national level, the perspective of the territory (also known as a “cluster”) and the innovation and new technologies in the same sector. An analysis of the current and future challenges of the companies in the Spanish ceramic sector will be realized. For it, first the situation of the sector will be analyzed from a European and global perspective, with data from the production and consumption of tiles of the main countries as well as data on export and import.

Once the situation of the sector is analyzed from this perspective, I will study carefully the territorial agglomerations, like the clusters, which have specific characteristics in terms of the flow of knowledge through their networks. In addition, I will focus on the Spanish situation in particular, in the Italy-Spain cluster, and also in the importance of the congregation in this kind of companies in the province of Castellón.

Finally, I will emphasize innovation since it is probably one of the best indicators of value creation by companies and thus the importance of study and research in R & D. In the case of this work, I will talk about the inkjet technology in the ceramic industry, since it has supposed a revolutionary change for the companies in the sector.

INTRODUCTION

The tile industry has become one of the main sectors of Spain. It has a unique importance for the Spanish economy as it is an industry of Spanish origin and capital, which occupies a leading position in both technology development, and design and quality materials and services.

Territorial agglomerations of firms, in any of their most relevant conceptualizations (industrial districts (Becattini, 1979) or clusters (Porter, 1990)), have played an important social role in the growth of many regions and countries with a huge economic, social and labor impact in a limited geographical area (the ceramic district of the province of Castellón). Castellón competitiveness cluster is largely due to the efforts in R + D + i, which have placed the tile industry as a world leader in areas such as flooring or ceramic frits and glazes.

Contexts or realities of geographical proximity as the industrial clusters (Porter, 1998a; Tallman et al, 2004; Inkpen and Tsang, 2005) can be seen as networks since they are made by different actors, such as: final companies, suppliers, clients, service companies, local institutions, etc. In fact, a cluster can be defined as a network within a productive context, located in a defined geographic area (Branston et al., 2005; Boschma and Ter Wal 2007; Parrilli et al., 2008).

During the years 1992 - 2002 the ceramic industry in Spain was in its best moment, because it was leading the EU thanks to this sector. Furthermore, this is due to the quality of raw materials, the wide network of research and development, the expert staff, the energy efficiency, the powerful sales policy around the world, and the domestic demand. In addition, in 2000, it reached a record production value, exceeding 650 million square meters last year (nearly 1.5% of GDP). Besides the sector at that time provided about 35,000 jobs in the province of Castellón.

Despite this, the ceramic industry in 2009 was hit by the economic crisis that we are living nowadays. However, moderately, this sector is experiencing a slight increase because since 2014, Spain is the first European producer and the second largest exporter. Likewise, the ceramic sector is the third industrial Spanish sector that contributes the most to the Spanish trade surplus, which is very favorable for the current situation.

Moreover, innovation has captured the attention of many economic and business studies in recent decades (Mansfield et al., 1971). In fact, innovation is probably the best indicator of value creation of companies (Hitt et al., 1996). This concept refers to the conversion of knowledge into new products, services or processes introduced on the market after passing through a series of stages of development.

In the current economic context, highly competitive, innovation is one of the keys to business survival since competitive advantages are obtained through innovation (Porter, 1990).

For all that, ceramic industry is one of the most powerful sectors to compete with major world powers, emergent countries in particular, that have an important role within the sector.

So, the objectives to be achieved in this study are:

- Study and analyze the importance of the sector and the impact it has as a producer of tiles on a global and European level. The purpose of this objective is to establish a global framework of the overall situation, noting the great importance of the sector.
- Understand the main characteristics of the ceramic cluster located in Castellón over time, as well as knowing which elements have contributed to its geographical location and further development.
- Explain what the generated agglomeration and capabilities as they are generated, sediment and transmitted in a localized context. It is important to highlight that my goal is confined to the cluster of Castellón and not to the Spanish ceramic sector in general.
- Obtain a wide vision of innovation and contribute to a better understanding of the innovative behavior in products.
- And in particular, analyze inkjet technology for the ceramic industry and its impact on the economic area.

This work is structured as follows: First, the theoretical framework, then, we explain the methodology and finally we describe the results, conclusions of the study.

1. THEORETICAL FRAMEWORK

Before getting into the complete study in the ceramic industry, the aim of this work is to introduce the reader to the topic of the business cluster. Therefore, we will analyse in a systematic form the difference in social terms among the industrial district of the cluster.

The concept of industrial district will be developed, in the first instance, by the Italian school. However, as many other topics of study, that concept is an open and unspecific definition, which will give place to later authors to tinge the term.

Becattini (1990) retouches Marshall's ideas and he defines the industrial district as "a socio-geographical entity that is characterized both by the active presence of a community of people and by a set of companies historically established in an area".

According to Sforzi (1992) an industrial district is a gathering of companies related by interdependent production processes, often in the same sector, which are located in a local community and determined by the daily distance of work.

In both definitions, we can appreciate the social component they have. The authors insist that it is not just a more or less number of companies that share territory, because in order to generate positive externalities, there is a need of social integration and a strong interrelation among actors in the same district.

As for the benefits derived from this type of agglomerations, Menghinello (2010) speaks of the system's ability to achieve collective solutions, which generates a series of positive externalities for the location (oriented to the collective efficiency), the improvement of the firms' productivity (Schmitz, 1999) and the systematization of productive capacity (Helmsing, 2001).

With regard to the concept of "cluster", Michael Porter (1990, 1998b, 2000) is an author that has powered the issue by putting it in the centre of the academic attention of business organization. Specifically, his contributions are based on the diamond model of competitive advantages, and mainly its proposal establishes a new form of organization of the value chain, which ranks among the black box market and the organizational hierarchies or vertical integration.

The trust among stakeholders, resulting in local proximity, and the relationships between them generate more coordination than occurs between geographically dispersed organizations. In addition, this coordination and confidence is much more flexible than that providing vertical interactions or formal relationships between companies as networks, alliances or partnerships (Porter, 1998b).

One of the best known and accepted definitions is that of Porter (2000: 253) "Clusters are geographic concentrations of interconnected companies, specialized suppliers of goods and services, industry related companies and associated institutions (e.g. universities, standardization agencies or trade associations) in a particular field that compete, but also cooperate."

Moreover, we would like to emphasize the official OECD definition: "Clusters are defined as highly independent network companies, producer institutions of knowledge (universities, research institutes, technology provider companies, and services of companies in knowledge), bridge institutions (brokers, providers of technical services and consultancy) and customers, linked to the supply chain creating added value". (OECD, 1999).

2. METHODOLOGY

The methodology followed in this work has been the use of different secondary sources, such as specialized books and reports with related data and information about the tile industry. Some of the keywords used to search the literature are: "tile companies", "ceramic sector", "ceramic cluster in Castellón", "global production of tiles", "innovation in the ceramic sector", "inkjet technology", among others.

I consulted the data for the study in associations related to the sector, such as ASCER, ANNFEC, ASEBEC, ALICER, ATC, museums (Onda's Tile Museum called "Manolo Safont") as well as the different websites of many companies located inside Castellón's cluster, among others. The main source of qualitative information is a series of personal face-to-face semi-structured interviews with a member of the ITC (Institute of Ceramic Technology), in which the purpose was to identify the evolution of the cluster and the knowledge of innovations and new technologies implemented in the field of ceramics. Specifically, these interviews have focused on inkjet technology because they are specialists in its development.

3. ANALYSIS OF THE SITUATION OF THE CERAMIC SECTOR.

According to ASCER, the Spanish ceramic industry is the leader in the domestic market. Due to the investment in R & D, quality and development of new products, and also in applications, this industry is well ahead of its competitors.

Currently, the sales in this sector, between 70% are for external trade and 30% are for domestic trade. Furthermore, it is noteworthy that 10% of ceramics sold in Spain comes from other countries, which leads to the idea that the majority of consumers in this sector prefer the Spanish product quality and supply rather than from other countries.

The volume of sales of ceramics in Spain on the domestic market is placed in the last decade over 1.000 million euros per year.

For what it concerns to the innovation in this sector, it owes its position in the sector worldwide for its commitment to R & D, in which, by means of diverse researches across projects such as of the Institute of Ceramic Technology (ITC, initials in Spanish) and ASCER, play a role importantly in the investment by firms in the sector.

The Spanish industry and ceramic tile pavements bet for the sustainable development, based on improving available skills to optimize the process and to make it traditional and ecological, reaching a viable result for the environment.

The sustainable construction has, as objective, the balance between the building and its environment, minimizing its environmental impact, in order to guarantee the satisfaction of the present generations without compromising the needs of the future generations. So that, according to the forecasts from the European Commission, the European Commission in 2020, which gives priority to energy savings, connects with international partners and innovation to ensure supplies and the competitiveness of the European energy market.

3.1 SITUATION OF THE WORLDWIDE SECTOR

During 2012, the world production of ceramic industry increased approximately 5.4%. Therefore, China, Iran, India and Brazil concentrated 65.1% of the total production, and this leads to a greater production than Italy and Spain.

With regard to the world production in 2012, it exceeded 11.000 million of square meters, which marked a growth of 5.4% as mentioned above. That fact affected in a positive way all the geographical zones where that sector had power.

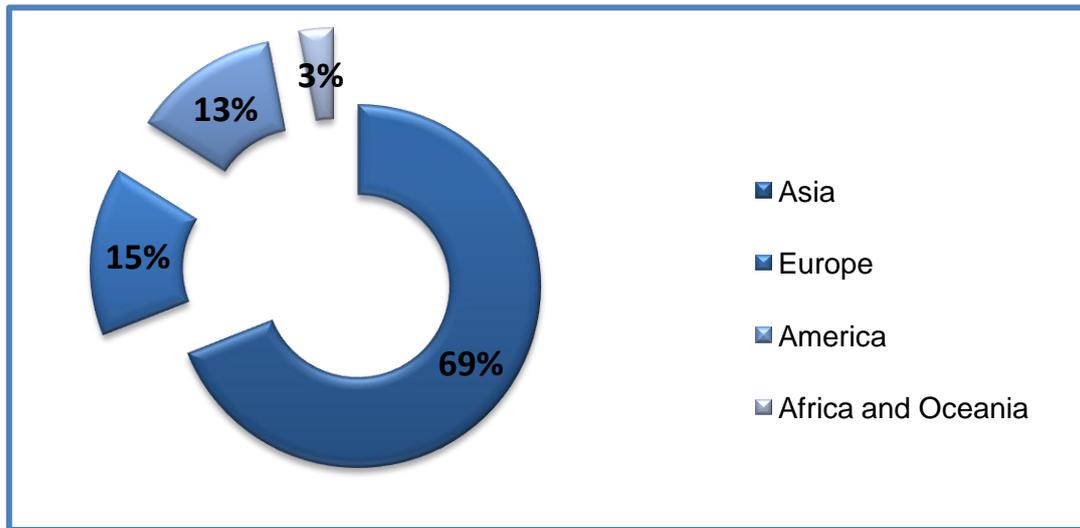
As for the 68.5% of the production, it is centred in 10 countries. Spreading more on this topic, it is necessary to mention that Asia took position as the major producer with a growth of 5.7 percent, given the contribution of China and other emergent countries that were consolidated as big producers in the tile industry.

Europe experienced a slight growth of around 2 percent with increases primarily in Spain, while Italy diminished their production and was placed as the sixth world producer.

In 2012, the increase registered in the American production stood out thanks to the boom experienced in Brazil (7.8% over the previous year). Africa was remained stable, with growths of around 2 percent and supporting a similar contribution as the world production compared to the previous years.

After this paragraph, in figure 1, we meet the world production of ceramics per continents. As we can observe, Europe concentrates the great part of the production with 69 percent, followed by Asia with 15 percent, (which most of that percentage comes from China). In the third place, we find America with 13 percent and, finally, Africa and Oceania both with 3 percent.

Figure 1. World production per continents



Source: Own elaboration based on Ceramics World Review (2015)

For what it concerns to table 1, it is necessary to emphasize that, nowadays, the country with major production is China since it is placed in a situation of extension of the product, followed by Brazil, which has been an emerging country up to 2012, producing to a very high pace. If we observe the graph, we can see that Spain is the fifth country with major production. The advantage of Spain is that, in spite of the crisis, the information remains stable and it continues to be one of the major ceramic producers of the world.

Table 1. Production per country

País	2010 (Mill.m2)	2011 (Mill.m2)	2012 (Mill.m2)	Producción Mundial en 2012 (%)	Variación 11/12 (%)
1.CHINA	4.200	4.800	5.200	46,6	8,3
2. BRASIL	753	844	866	7,8	2,6
3.INDIA	550	617	691	6,2	12,0
4. IRÁN	400	475	500	4,5	5,3
5. ESPAÑA	366	392	404	3,6	3,1
6. ITALIA	387	400	367	3,3	(8,3)
7. VIETNAM	375	380	298	2,7	(21,6)
RESTO DEL MUNDO	2.588	2.688	2.840	25,4	5,7
TOTAL MUNDIAL	9.619	10.596	11.166	100	5,4

Source: Ceramics World Review (2015)

3.2 SITUATION OF THE SPANISH SECTOR

Throughout 2014, the Spanish ceramic sector continued to recover (table 2), although at a slower pace than in 2013. This year had the best growth in the last six years, i.e. more or less since the economic crisis began. Production is estimated to be around 425 million square meters, 1% of volume in 2013, while total sales amounts to 2,895 million, an increase of 100 million euros (+ 3.5%).

Table 2. Spanish ceramic tile sales in value

Spanish ceramic tile sales in value (million Euros)									
Vendite di piastrelle spagnole in valore (milioni di Euro)									
	2007	2008	2009	2010	2011	2012	2013	2014*	% var. 14/13
Exports	2,295	2,211	1,673	1,747	1,897	2,082	2,240	2,320	+3.6%
Domestic sales	1,871	1,460	918	801	700	575	557	575	+3.2%
Total sales	4,166	3,671	2,591	2,548	2,597	2,657	2,797	2,895	+3.5%
Production (million sq.m)	585	495	324	366	392	404	420	425	+1.2%

Source: Ceramics World Review (2015)

Below, we show two tables of great interest. The first one emphasizes exports, which account for 80% of total turnover in the industry. As we can see, in 2014 the value of Spanish exports grew by 3.6%, compared with the 8% in 2013 to reach 2,320 million euros for the first time and return to exceed the level before the crisis of 2007 (2,295 million euros).

With regard to the second table, it refers to the domestic market, which after six years has had positive results as national sales 575 million euros, up 3.2% were obtained in 2013. The president of the Spanish Association of Manufacturers of Ceramic Tile, ASCER, Isidro Zarzoso says, "even though the numbers are positive, the overall situation is difficult" and also claims that exports in Spain in 185 different countries suffered one slowdown in the second half of 2014 and the difficult situation, both social and political, geographical areas or key cities has had an adverse impact, as evidenced by the drop in sales in the Middle East, Libya and Eastern Europe.

As for export markets, export figures in the first 11 months of 2014, the trends have been quite uneven across regions, and in some cases they have altered the results of the previous year.

Table 3. Spanish exports by geographical area

(Values in million Euros)				
Esportazione spagnola per aree geografiche (valori in milioni di euro)				
Areas / Aree	Jan-Nov 2013	Jan-Nov 2014	14/13 (%)	Share (% on total exports)
Europe	977.5	1,012.1	3.5	47.0
European Union-UE27	691.5	750.1	7.4	34.9
- EU15	582.9	625.0	7.2	29.0
- Eurozone	497.3	518.1	3.7	24.1
- EU New members	108.6	125.1	8.1	5.8
Eastern Europe	258.8	232.6	-7.6	10.8
Middle East	456.0	440.8	-3.4	20.5
North America	125.1	136.1	8.8	6.3
- of which USA	85.6	95.4	11.5	4.4
Central America	38.5	41.6	8.2	1.9
South America	48.1	45.7	-4.9	2.1
Asia	530.6	513.0	-3.3	23.8
Far East & South East	61.1	63.0	3.1	2.9
Africa	344.7	387.6	12.5	18.0
- of which Maghreb	238.7	262.8	10.1	12.2
Oceania	12.1	16.0	32.5	0.7
World Total	2,076.5	2,152.1	3.6	100

Source: Ascer (2015)

Table 4. Main exports markets for the Spanish ceramic tiles

Main exports markets for the Spanish ceramic tiles (Values in million Euros) Principali mercati di esportazione dell'industria ceramica spagnola (valori in milioni di euro)			
Country / Paesi	Jan-Nov 2013	Jan-Nov 2014	14/13 (%)
France	214.1	209.8	-2.0
Russia	157.6	153.6	-2.5
Saudi Arabia	164.8	141.2	-14.3
United Kingdom	99.9	123.2	23.4
Algeria	90.0	122.3	35.8
USA	85.6	95.4	11.5
Germany	77.8	79.4	2.1
Israel	83.8	71.6	-14.5
Libya	85.2	65.3	-23.4
Jordan	46.6	61.4	31.8

Source: Department of Customs and Taxes and ASCER figures (2015)

This is for example the case of Europe, which has resumed growth (up 3.5% against the first 11 months of 2013) and confirmed STI position as the top destination market for Spanish tiles with 47% of the total exports. Specifically, sales to the EU grew by 7.4% and accounted for 35% of export turnover, which contrasts with a fall in exports to Eastern Europe (-7.6% versus +5.8% in 2013 and +13.4% in 2012). Analysing the markets of the European Community, we find that in France there was a fall of 2% more on exports, maintaining its position as the leading export market for Spanish tiles, plus the UK was consolidated as the fourth largest market export, an increase of 23.4%; and Germany (+2.1%) recovered the ground lost in 2013 to return to sixth position. Russia saw a contraction (-2.5%) while remaining the second largest export market.

Outside Europe, Asia remains the second largest market for Spanish exports, with a share of 23.8% of total exports in spite of a fall of 3.3% (compared with growth of 7.5% in 2013). The Middle East, which accounted for 20.5% of total exports, also saw a decline (-3.4% versus +6.3% in 2013). Sales in this region were affected negatively by the sharp fall in Saudi Arabia (-14.3%, which corresponds to a 20 million euro drop in sales, the following growth of 41.5% in 2012 and 7.5% in 2013) and Israel (-14.5%, a drop of 12 million euros, compared to 17.7% growth in 2013). These falls were not entirely offset by the good results in Jordan (+31.8%). Saudi Arabia fell from second to third place in the top 10. Regarding the African continent has been strengthened, being an important market for Spanish tiles, which now represent 18% of total exports.

Powerful growth over the two-year period 2012-2013 (+48% and +30%) was followed by a more modest 12.5% increase in 2014. This was largely thanks to the markets in the Maghreb region (+10%), especially Algeria (5th largest export market), where sales rose to 122 million euros in the first 11 months of the year (up 35.8% on the same period in 2013). By contrast, the fall in sales in Libya was as severe (-23.4%) as it was predictable.

Lastly, Spain's exports to the American continent in 2014 maintained the previous year's trends: 8.8% growth in North America, where sales to the United States (the 6th largest export market) rose by 11.5%; a positive performance in Central America (+8.2%); and a further 4.9% year-on-year fall in South America.

Something that we consider relevant in the ceramic sector are the Alfa Gold awards, which were presented by the Spanish Ceramics and Glass Society (SECV) for the most innovative technologies developed in the ceramic cluster of Castellón. This year the prestigious awards went to Kerafrit, Neos Additives and Natucer.

KERAFRIT received the award for developing Kerxshield, a technology applied to ceramics that acts as a shield against ionizing radiation (such as low and high energy X-ray), resulting in an innovative new building material.

NEOS ADDITIVES won the prize for developing vapour-permeable glazes which can be applied to the bodies of low ceramic density. The research project conducted in collaboration with manufacturers of ceramic tiles Bestile and Azuliber opens possibilities for the use of ceramics in the new building applications and ceilings.

NATUCER was awarded the Alfa Gold Award for developing ceramic tiles for using in custom and urban design projects. Furthermore, the award was presented in recognition of new opportunities for the use of ceramic products with high added value.

3.3 SPAIN - ITALY CERAMICS

According to a study realized in the tile sector by the KPMG company, which is named as "The tile industry in Spain through 21 large companies", we will make a detailed analysis about the ceramics in Italy and Spain and, at the same time, about the emerging and growing countries as China.

Down below, there is a graph of the evolution of sales in Spain and Italy (figure 2).

Figure 2. Evolution of sales in Spain and Italy



Source : Ascer y Assopiastrelle (2015)

In 2013, the Spanish ceramic sector invoiced 5.4 more per cent with regard to the previous year. It is highlighted the number of exports with an increase of 7.6 percent. This fact mitigates the fall of 2.6% that takes place in the domestic market, because of the contraction in the construction industry and the non-recovered private consumption. The Italian ceramic industry presents a growth of 3.2 percent in turnover, but also the negative behaviour of the domestic market is offset by exports, which grew 5.7 percent.

Continuing with the comparison between Spain and Italy, we can observe in table 5 that the Italian ceramic industry has been characterized by a very high export quota of products, with 81.9% in 2013 and also by a significant international production presence. For its part, the Spanish ceramic industry increased its export rate to 80 percent (78.4 percent in 2012), despite the bad behaviour of the French and German markets, which their imports were reduced to 8.6 and 4.6 percent respectively.

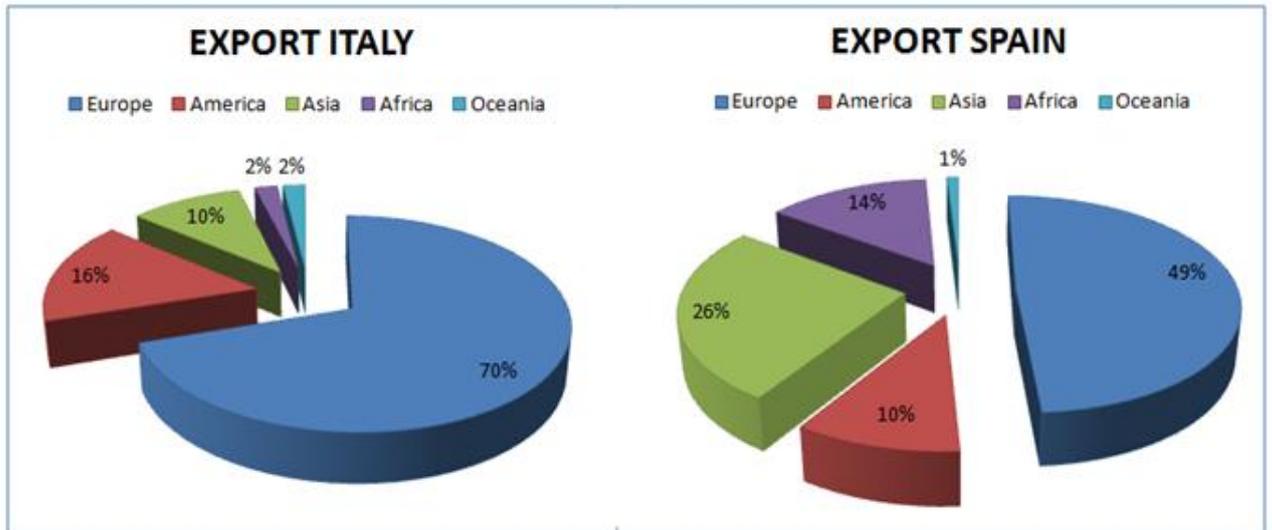
Table 5. Comparison of total sales in Spain and Italy

Ventas totales (millones de euros)	ITALIA			ESPAÑA		
	2013	2012	Variación	2013	2012	Variación
Mercado nacional	856	919	(6,9%)	560	575	(2,6%)
Exportación	3.870	3.662	5,7%	2.240	2.082	7,6%
Total	4.726	4.581	3,2%	2.800	2.657	5,4%

Source: Ceramics World Review (2015)

In 2013, (Figure 3) Italy maintained its position as the third largest exporter country in square meters behind China and Spain, and thus it was placed as the seventh world producer country, behind Spain. Italian exports increased by 5.7 percent, mainly due to the increase in sales in the American and African continents. The square meters sold were increased by 4.8 percent from 2012. The increase in Spanish exports by 7.6 percent came mainly due to the increase in sales in Africa and America. The square meters sold increased by 7.4 percent from 2012.

Figure 3. Export Spain and Italy



Source: Own elaboration based on Ceramics World Review (2015)

4. TILE SECTOR IN THE PROCINCE OF CASTELLÓN AS A CLUSTER

4.1 THE CONCEPT OF CLUSTER

A cluster can be defined as a network within a production context in a geographically defined area (Boschma and Ter Wal 2007; Branston et al. 2005; Parrilli and Sacchetti 2008). Contexts of geographical proximity such as those defined as industrial clusters (Inkpen and Tsang 2005; Porter 1998; Tallman et al. 2004) can be viewed as networks since many different actors are involved, including final product firms, suppliers, customers, service providers, local institutions, policy agents, and so on. In fact, a cluster may be identified as a dense and strong-tie network with intense, frequent, and close relationships between members (Cooke 2002; Trigilia 2001; Wolfe 2002).

In seminal works in the Spanish context, Ybarra (1991) and, more recently, Boix and Galletto (2006) and Boix (2009) clearly identified this ceramic tile agglomeration as a case of Marshallian-type industrial cluster (district). Even Porter (1990) mentioned the existence of this Spanish ceramic tile concentration when describing international competitors of the Italian ceramic tile case.

A concept that is very important in the ceramic industry is the 'cluster' that Porter defines as "geographic concentrations of interconnected companies and institutions, belonging to a concrete field and joined to each other by common and complementary features" (1999:52). Thus, clusters in the value chain spread vertically up to suppliers and auxiliary industries, and horizontally up to the technology and related sectors. The principal advantage of business clusters is the improvement of the competitive advantage of the member companies, because it contributes to the improvement of the competitiveness of the region where it is placed.

Why does a cluster contribute to the improvement of the region where it is located?

Here are the factors (Porter, 1999):

- Increase of the productivity as a consequence of: the specialization, the complementarity between the activities of the member companies and the increase of the bargaining power of firms. All those facts reduced transaction costs significantly.

- Promotion of the innovation as a result of an increased ability to perceive new customer needs and new technological, commercial or productive potential through joint research.
- Creation of new companies, because of the reduction of risk and entry barriers along with the existence of established relationships and potential customers for new businesses.

On the one hand, many clusters include governmental and other institutions such as universities, agencies responsible for setting standards, study centres, training providers and trade associations that provide training, education, information, research and technical support to member companies.

On the other hand, we must not forget that in spite of the fact that the companies support relations of cooperation among them, they remain rivals. Specifically, between the companies of a cluster, the most interesting competition is not the competition in prices, but the one that takes place as a consequence of the innovative capacity of the companies, that is, the competition derived from the creation of new products, the development of new technologies, the detection of new needs and the new forms of organization and management, among others.

This type of competition does not eliminate the cooperative behaviour, but there are two intrinsically close concepts since the development of innovation that would not be possible without the cooperation of different companies. Due to that fact, it is very important to reach the balance between competition and cooperation, because it turns into one of the key factors for the success of a cluster.

Finally, to guarantee the success of the cluster there must be fulfilled a series of requirements related to the creation and composition of itself. The creation process is complex, principally for the existence of cultural differences between the companies, where collaborators impede the establishment of the policies and collaborative activities. In addition, it is necessary the full and egalitarian participation of all the segments involved in the cluster, for what they will have to perceive the existence of added value in the cluster and not to appear situations of the domain of the big companies on the SMEs, or of the manufacturers on the suppliers. The work should also be considered to be developed by the Public Administration, which plays a key role in the initial stage of a cluster (identifies and defines the cluster, brings together the components thereof, financed the initial stages...). Besides, it is necessary to consider

the developing labour made by the Public Administration, which exercises a fundamental paper at the start of the cluster (identify and define the cluster, make contacts, finance the initial stages...)

6.2. TILE INDUSTRY IN CASTELLÓN AND ITS IDENTIFICATION AS A CLUSTER

As we have previously mentioned, one of the principal characteristics of the Spanish tile sector is the high geographical concentration of the industry in the province of Castellón, especially in the northern area delimited by Alcora and Borriol, in the western area (Onda), in the southern area (Nules) and in eastern area (Castellón de la Plana) (Figure 4). According to ASCER information, approximately 94% of the national output in 2012 had origin in this province, where there are located the 81% of the companies of the sector. This geographical concentration of companies of the sector constitutes a clear example of the organization of the productive activity in the shape of a cluster or an industrial district. In it, they give themselves the totality of elements that define a cluster so much in its quantitative aspects (related to the geographical concentration of the activity), as well as in those of qualitative character (related to the set of relations established between its members). And that is one of the keys of its competitiveness worldwide.

According to ASCER information, in the cluster of Castellon, there are located approximately a total of 130 companies, which employ directly approximately 14,400 people as of 2012. In the factories, the number of workers is placed in a minimum of approximately 40, though the average is 150 employees. This way, the cluster is integrated by all kinds of companies that include the industrial process of the manufacture, since it enters the raw material until the final product goes out. Depending on the strategy of every company, on the one hand we consider the companies that have the different production rounds integrated in the same facilities, in order to assure the control of the raw materials; and on the other hand, we look at the companies specialized in certain phases of the production process, especially in those that contribute major added value or that need a more specialized knowledge or technology.

This is a good indicator of some behaviours of the members of a cluster. Thus, first it is observed the capacity of the major size companies to take advantage of the economies on a large scale that stem from the incorporation of diverse phrases of the productive process; and at the same time, the cooperative behaviour is verified in concrete phases of the manufacturing process among rival enterprises in the final product.

One of the weak points of the companies constitutes the construction of machinery, where a major degree of dependence appears in companies outside Castellón. In particular, the construction of ceramics machinery in Spain is reduced, and most of it is imported from Italy. This weakness of the cluster stops the Spanish sector in a clearly improvable position, regardless of the internationalization degree of the machinery companies and the collaboration in some phases of design and construction.

Furthermore, another characteristic that is given in the cluster of Castellón is the importance that entails the relation of the companies with organizations and institutions of sectoral support, fundamentally the University and the Technological Institutes. The technical advice lends especially from the Institute of Ceramic Technology (ITC) of the Jaume I University of Castellón, which is a Centre for Innovation and Technology, created with the mission to rest and promote the ceramic industry, and it forms a part of the network of Technological Institutes of the IMPIVA. Among the functions of the ITC, the activities included in R & D are: the diffusion of technological and commercial information, the technical information service (especially used for technical personnel, although they also offer ruled and constant formation), elaboration of tests of

laboratory, the quality control and certifications, and other services of technical assistance.

Finally, the first evidence supporting the industrial districts offers benefits that companies are Marshall, or agglomeration economies. The author of the original concept of Industrial District, (Marshall, 1890) identifies a type of external economy that focus on: the benefits obtained from individual companies, and the increase of the common factors exchange, (including skilled human resources, specialized suppliers, and technological spills) (Krugman, 1991). Similarly, Marshall's concept of industrial environment can be interpreted as a reference to the existence of intangible assets based on experience, knowledge and information that are common to companies in the district. Several researchers have claimed that territorial agglomerations benefit businesses in the form of intangible externalities or interdependence marketed. Others emphasize the superiority of this form of industrial organization of mass production and vertically integrated companies (Piore, 1984). However, as noted by some authors, the most important advantage of industrial districts is not so much agglomeration economies, but rather the existence of a community of people.

5. INNOVATION AND NEW TECHNOLOGIES

The evolution in the competitive environment is changing the product innovation into a crucial element for the survival of the majority of the companies. In this sense, Bachalandra and Friar (1997) consider that the successful introduction of new products is vital for most organizations. In literature, it is widely recognized and exhaustively mentioned the importance of product innovation for good results in the company in the long term (Capon et al., 1992; Brockman and Morgan, 2003; West and Lansiti, 2003).

In consequence, a special interest receives the analysis of the innovative behaviour of the company inasmuch as it represents a key factor of its competitiveness. To detect differences in the innovative behaviour of various industries, Kleinknecht et al. (1993) and Santarelli and Piergiovanni (1996) adopted a scheme based on two aspects: the degree of complexity, or the degree of diversity of knowledge incorporating new products; and the type or degree of novelty, going from the most radical to the most incremental.

With this work, I try to contribute to a better comprehension of the innovative behaviour of firms. For it, I propose, as a research aim, to analyse the concept of innovation on the novelty and diversity of knowledge that incorporate these new products and their degree of complexity, in order to understand the inkjet technology in Spanish companies, which are the manufacturers of flooring and wall tiles.

5.1 CONCEPT OF INNOVACIÓN

Innovation is a term that, mainly, explains the appearance of new products, services and processes on the market, or even significant changes in the existing markets.

In an economy as changeable as the actual one, with large commercial pressures, the companies try to stand out in order to be competitive or, in some cases, simply to survive. This current dynamism makes 'innovation' a term very present in scientific literature, and it also makes that the definitions of the term abundant (Table 6).

Table 6. Definitions of Innovation

AUTHOR	DEFINITION
Pavón & Goodman (1981: 19)	Innovation is the set of activities, enrolled in a certain time and place, leading (for the first time) to the successful introduction on the market of an idea in the form of new or improved products, services or technologies of management and organization.
Nelson & Winter (1982: 135)	Innovation is: a) new products or services, new processes, and new organizational structures that companies use to compete with each other and satisfy the clients' demand; b) the adoption of a new idea, process, product or service, developed internally or externally acquired as a function of the technical, strategic and administrative skills of a company.
Gee (1981: 5)	Innovation is the process in which develops a product, technique or service from an idea, invention or recognition of a need, until it is commercially accepted.
OCDE (2005: 56)	Innovation is the introduction of a new or significantly improved product (good or service), or the introduction of a process, or the introduction of a new marketing method, or even of a new organizational method into the internal practices of the company, into the organization of the place of work or into the external relations.

Source: Own elaboration from the doctoral thesis of Luis Martinez Chafer (2015)

Nevertheless, the majority of these definitions comes from Joseph A. Schumpeter (1942:66) and according to him, innovation would include the following cases:

- The introduction of a new good on the market (a good that unfamiliar to the consumers) or a new class of goods.
- The incorporation of a new method of production not experienced in a certain sector or a new way of commercialising a product.

- The opening of a new market in a country, regardless of whether that market existed already in another country.
- The conquest of a new source of raw materials or intermediate products, regardless of whether that source previously existed or if it has to be previously created.
- The reorganization of the market by creating, for example, a monopolistic structure or breaking an existing monopoly.

5.2 TIPOLOGY OF INNOVATION

The concept of innovation is multidimensional and it has been studied from different perspectives. Since there is no single taxonomy to describe different types of innovations, this work will focus on a specific type of classification, some of which attempt to define the level of originality of innovations, distinguishing between radical and incremental innovations (Ettlie et al, 1984;. Dewar and Dutton, 1986; Adler, 1989; Damanpour, 1996).

The difference between a radical innovation and an incremental one resides primarily in its originality. A radical innovation is a sudden break with the previous state, while incremental innovation is based on a knowledge that is already in use (Fernandez, 2005). A variant of incremental innovations is introduced by Kodama (1992) in what he calls 'fusion technology', referring to innovations that are obtained from the combination of technologies from different areas.

In this sense, the definition from which we started (Schumpeter, 1942) refers mainly to radical innovations, since the author only considers those as real innovations. Although we should know that there are flows that value continuous improvement as a source of competitive advantage, for example, the supporters of Japanese philosophy Kaizen (Imai, 1989; Escorsa and Valls, 2003).

Innovative processes usually respond to demand. In the current economic environment, ceramic companies are required to be innovative and to respond quickly to the changes in the needs of their clients. The company runs the risk of being reached by its competitors if it is not agile enough and, therefore, it would stop being competitive (Escorsa and Valls, 2003).

From this perspective, we can understand that companies are the main sources of innovation since their survival depends a lot on it. We could even understand the secrecy of innovative processes and the lack of motivation on the part of companies to share the innovations developed by their departments of R & D.

Once the empirical analysis of innovation and multiple perspectives is realized, I will study a technological innovation within the cluster of Castellon. Therefore, I will explain in detail the inkjet technology, as it has been a revolution for the ceramic industry. The information I have found on inkjet technology has been largely facilitated by the Institute of Ceramic Technology (ITC), since I requested the help of experts in the field in order to realize my study with a basic knowledge of this kind of technology.

6. INKJET TECHNOLOGY

6.1 HISTORY AND EVOLUTION

The history of electronic printing systems is very recent. In the case of printers, the first one for the computer was developed in 1953, but it could only write text. In 1959, Xerox developed the photocopier machine and in 1973, Canon created the colour photocopier. In the early 70s Centronics Corporation of Nashua manufactured the first dot matrix printer. In 1978, the daisy wheel printer is created, although at that moment it could only write letters and numbers. In 1980, the laser printer is invented and in 1988, it was improved to work in colour. And approximately in the 90s, the printer turned into a common object in any office and workplace, and even in the majority of households with IT equipment.

When all this development moves to the industrial field, problems that hinder the development of technology appear. Whereas in sectors like graphic arts or photography, inkjet technology becomes instrumental in the development thereof, other sectors continue with the traditional technologies given the difficulty that, a priori, uncovers the change.

Due to that fact, the use of digital printing technology inkjet in the ceramic sector was postponed until 1998, in which the company KERAJET is founded in order to industrially manufacture the first prototype of Inkjet machine, specifically developed for the decoration of ceramic pieces.

Since 2000, when the first inkjet machines for decorating tiles are shown in Cevisama, it has been a constant evolution of mechanics, electronics, inks, dyes and chemical substances. The highly competition among the different firms has been a strong catalyst for this new technology in the ceramic sector.

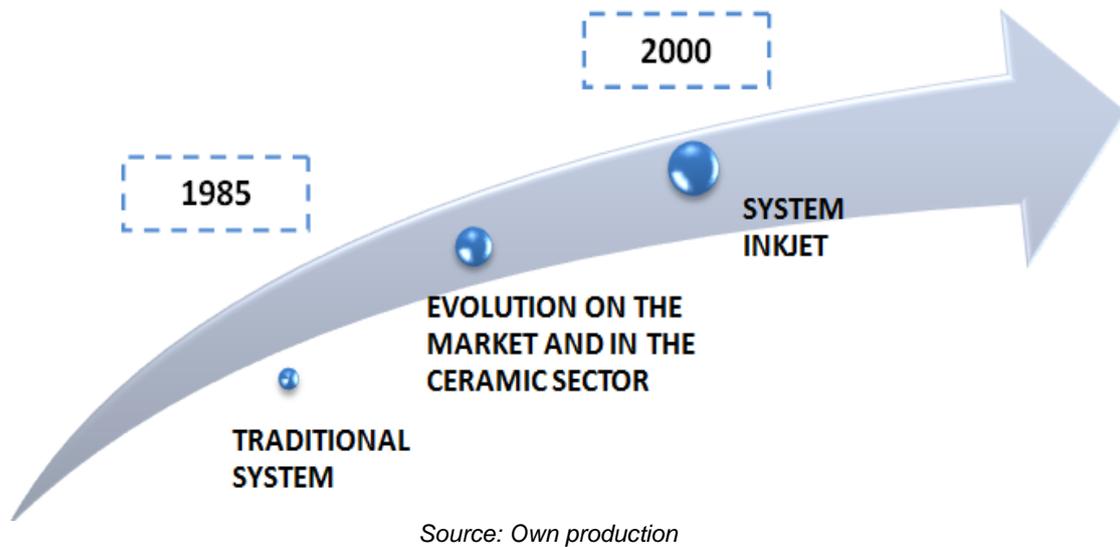
Nowadays, several companies are competing to develop new machines capable of decorating tiles 24 hours a day. The inkjet machines perfectly adjust to the decoration glazing lines in order to improve efficiency. It has been over 10 years since this technology was held in the ceramic industry, where the difficulties of the development of a major technology like this have been found.

Currently, we find that, despite this, the Inkjet technology has achieved significant technological challenges over the years and it has reached that degree of reliability and confidence on the part of tile manufacturers, and because of that, it has obtained excellent production results. Moreover, the personnel responsible for the operation and exploitation of these machines are starting to have adequate experience and training, which enables to optimize the technical and aesthetic possibilities of this technology, innovating with new amazing designs in the trade fairs (e.g. CEVISAMA Fair).

I have to mention that the aim of this study is to spread, among the companies of the ceramic sector, the art condition of this technology, as well as the advantages of the technological application of ink jet printing in the decoration of ceramic tiles.

Inkjet technology is called to occupy a privileged position in the technological evolution of the ceramic sector. The indications of the mentioned evolution are already evident, and they are materialized in the latest related innovations and recently presented in the sector.

Inkjet technology has promoted a revolution and has supposed a break with traditional decoration systems. A few years ago, the tile was analytically illustrated through silk-screens, and now this new system opens new ways to the art of ceramics. This technology has pleasantly surprised in a market that was already mature.

Figure 5. Evolution inkjet technology

6.2 WHAT IS INKJET TECHNOLOGY?

Inkjet technology is popularly known by the printing machines. It is based on the formation of an image from the controlled droplet deposition, and the joining of those droplets form the image on the paper. The main advantage offered by this technology to the industry is that it does not require intermediate tools, or contact between the substrate and the print head. In addition, it can print on many materials such as plastic, glass or metal. This allows offering competitive advantages over traditional techniques, especially in the customization of products.

Another definition, the digital decoration technology is based on a system of transfer of designs on different surfaces (smooth or textured), and it allows to print the tiles completely. Through this innovation, images/designs in high definition and realism are achieved.

This digital system is a contactless printing process in which images are formed by droplets shot at high speeds from the injector of the print heads. Ink droplets are combined accurately, generating various colours that, if you observed them in the distance, they form an image.

Now, we will analyse the advantages of the Inkjet technology:

- Stability of the images
- Drastic descent in consumption in the use of pigments with a consequent reduction in stocks of pasta.
- Elimination of screens, silicon rollers, recording devices, etc., and facility in the tests. All this implies a lower cost.
- Excellent potential to reproduce natural stones, photos and drawings in general.
- Reduction of the time to change the designs and colours.
- Better consistency of the decorations because the storage and control of all the printing parameters are easier.
- It is possible to decorate the edges.
- When it is necessary, you can obtain the decoration in high definition.

But we should know that digital printing cannot always replace traditional printing methods. Recent advances in this technology predict that the evolution in terms of improvements will be faster than we all think within the sector, being able to be implanted in a short term in almost the totality of the companies of the ceramic sector. That same thing happened already in the photographic sector at the time in which digital technology surpassed traditional technology in almost every aspect.

Now, we have an example of what Inkjet technology is capable of doing in the ceramic industry:

Figure 6: Ceramic floor tiles decorated with organic inks for Inkjet printing

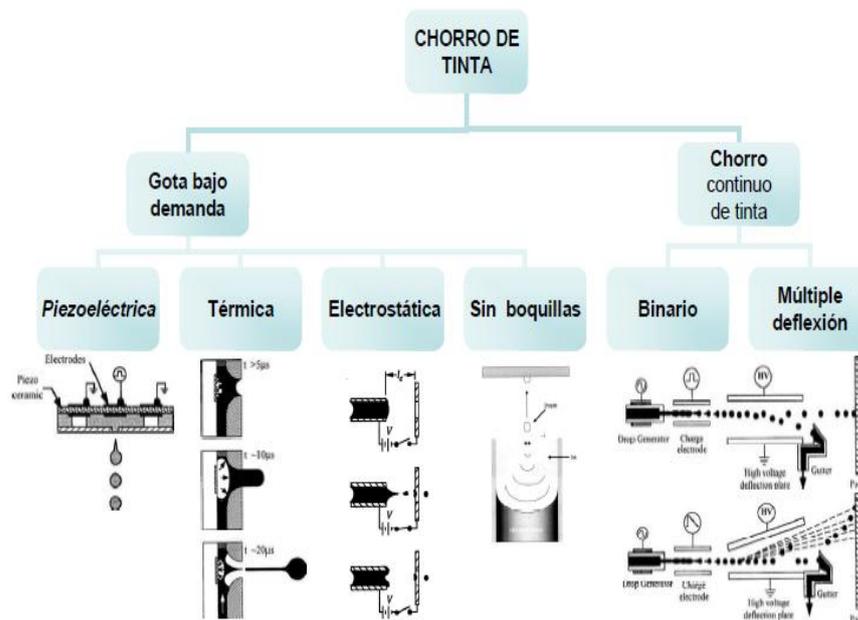


Source: ITC (2015)

6.3 TYPES OF PRODUCTS

Inkjet printing is a method of non-contact ink deposition. Attending to the ink supply mechanism, it is possible to distinguish two methods: the continuous inkjet and inkjet on demand. Figure 6 shows an outline of the different systems developed for each of the two deposition methods.

Figure 7. Classification of the inkjet printing technologies



Source: ITC (2015)

1. Continuous inkjet.

The method of continuous inkjet is more designed for printing on paper. The information about the image is converted into a latent image and then, a continuous flow of ink drops proportionally charged to the position they occupy on the substrate is created. This type of product has some advantages and some disadvantages shown below:

Table 7: Advantages and disadvantages continuous Inkjet

ADVANTAGES	DISADVANTAGES
Variable size drops	High cost of the system
High speed printing	Complex maintenance
High quantity of deposited ink	Low graphical definition of the decoration

Source: Own elaboration based on ITC (2015)

2. Inkjet on demand.

The method of jet of ink under demand is characterized by the generation of every drop only in the moment that is needed. Nowadays, it is the most used on an industrial scale for different reasons, for example: the precision, the minor size of a drop, the high number of drops per inch (dpi) and the simplicity.

Therefore, we can affirm that the Inkjet technology has allowed ceramics to reinvent itself and to exploit a business which, in part, already belonged to this type of coating by using different decorative manual techniques (brushing) or semi-industrial. Inkjet technology has allowed to adapt time to this type of work and, in the same way, it is possible to edit our own work as a client in order to be printed by an expert on the corresponding coating and sent home in a few days.

6.4 WHAT IMPACT HAD THIS TECHNOLOGY AS A CONSEQUENCE OF THE ECONOMIC CRISIS?

The Institute of Ceramic Technology (ITC, initials in Spanish), through the Technological Observatory, has developed over the past year a detailed study focused on detecting other applications or uses that might be made by inkjet technologies. The relevance of these possible new applications resides in its potential dedication to the ceramic sector. The main objective of this report is to promote innovation in the companies of the ceramic sector from two points of view: new materials and the production of new products or ceramic systems with properties and innovative

applications. The final implementation of this technology as a decorative system par excellence, has coincided with the economic crisis that it has been lived in the last years, especially in the national area. There, the construction sector has been extremely affected.

Given this scenario, the only way to increase sales is the internationalization of sector companies, being forced to face the strong international competition and the substitute materials, so as to gain market share. Here is where inkjet technology can increase its prestige, becoming a tool that goes well beyond the current decoration.

6.5 PRODUCTIVE PROCESS

The ceramic tile manufacturing sector is facing a very competitive market with a very demanding consumer. Investigators and companies have bet, especially, for the improvement of ceramic materials, and the diversification of the designs.

In this work different techniques of digital image processing are exposed to automate the creation of new designs specially designed for inkjet printing. Based on these techniques, own processing codes have been developed and the prototype program has been generated. By means of "automation" is not limited at all the designer's work, but quite the opposite.

It is a question of providing it with computational tools so that it can focus completely on the aesthetics of his design, so the adjustment of itself to the characteristics of a particular product (size, resolution requirements, etc.) will be solved with the computer help.

It aims to promote diversity and creativity of these designs, to make flexible and automate the design process itself and also to optimize the decoration in the manufacturing line so that the final result of the process corresponds to the initial design optimally. It seeks to integrate the new concept of ceramic design, based on the automated digital image process with the new ceramic printing technology by inkjet. This combination will create and manage ceramic designs in a much wider range, with a lower investment of time and money.

6.6 KERAJET DEVELOPMENT

6.6.1 TECHNOLOGICAL CONTEXT

As I said previously, the base technology of mechanical equipment has been led (for many years) by the Italian companies. During the second half of the 80s, a paradigm shift in technology (single firing process) opened up new opportunities for producers of Spanish pigments and glazes that, since then, led to technological advances.

As a result, this process has allowed Italian and Spanish clusters of floor tiles to lead technologically the production of ceramic tiles in the last 30 years (Albors, 2002; Albors Hervas Garrigos and Oliver, 2006). Until 1994 the decorating process in the field of ceramic tiles was based mainly on the silk screen printing technology using flat or cylindrical screens. This process required the production of a series of screens for each design and it had to be replaced when wear was excessive.

In 1994, the Italian company System, launched the Rotocolor machine, which represented a significant innovation in the sector. Although this technique was a significant improvement, it did not solve the problems of reproduction of designs and it implied the need of specialized technicians to handle the production process. Moreover, there were inherent difficulties to stabilize the process each time the design was changed. Additional problems accounted the control of the machine, the instability of the process and the difficulties to reproduce a certain design with the precise tones of the previous batch.

6.6.2 THE DEVELOPMENT OF A REVOLUTIONARY INNOVATION

In 1998, an engineer and entrepreneur of Castellon with extensive experience in the ceramic industry, along with a chemist who was employed at one of the principal multinational producers of glazes and pigments, began to discuss new possibilities for decorating ceramic tiles based on digital technologies. In 1999, with private support and public funds from CDTI (Centre for Industrial Technological Development), a first prototype based on inkjet printing was developed. The initial prototype demonstrated its feasibility and it facilitated the foundation of Kerajet in 1999. In March 2000 they presented their first industrial prototype in the CEVISAMA exhibition, and they won the

“Alfa de Oro” prize for innovation. This prototype was based on a design consisting of a system of multiple inkjet heads, a hardware of control, and a software of image and subsystems transmission of management of inkjet system. Kerajet also filed two PCT patent applications.

In this first stage, the financial support of the multinational producer of glazes was crucial. It was agreed with the multinational that Kerajet would develop electronics and software applications, and the decorating machine, while the multinational would focus on the development of inks. However, the adoption of technology by the producers of ceramic tiles was not as successful as expected. They faced the innovator's dilemma (Christensen, 1997). The dilemma was to adopt, on the one hand, a new technology intended to change the existing culture of craft production in the process of decorating the ceramic tile to a digital computing environment; and, on the other hand, to adopt a technology whose benefits were not so clear apparently, that required a new learning invented by a Spanish company.

The role of the final user, I mean the producers of ceramic floor tiles, was not revealed until later in the development process of technology. The final clients saw the cutting-edge designs and applications with the possibilities of new technology, for example, mimic and even improve models of natural materials such as marble or wood that influenced the interest of the clients to decoration with inkjet technology. However, at the beginning, only three or four producers of ceramic floor tiles (with capabilities and resources in advanced production technologies) understood the new technological implications and committed, at this early stage, with inkjet technology. These two events (the development of digital inkjet technology, and the slow adoption by producers of ceramic tiles) developed in parallel, because the fact of the interaction and communication between the Italian cluster and the Spanish one was essential for the conclusion and the eventual success of the new technology.

6.6.3 THE NEW TECHNOLOGY TURNS INTO A DOMINANT DESIGN.

In the middle of the 2000s the development of inkjet technology was a dominant design. Kerajet was challenged by new entrants and had to face the first patent infringement litigation. The inkjet heads for decoration of ceramic tiles began to standardize and manufacturers of inkjet heads entered the market of ceramic tile. Consequently, after a big effort in R & D, the main producers of glazes and pigments

developed special inks for decoration of ceramic tiles. This confirmed the effect of dominant design and promoted the standardization assuming an encouraging normalisation of production and the search for other complementary economies (Utterback and Abernathy, 1975).

The new technology was recognized as a competitive tool and Kerajet was submerged by numerous purchase orders. The new technology was recognized as a competitive tool Kerajet was submerged by numerous orders. New models of machines with higher number of attributes and improved specifications were developed. It can be estimated that, currently, there are more than 500 lines of production process of ceramic floor tiles equipped with Kerajet machines. According to informants, the following elements have been decisive in the ultimate success of the expansion of Kerajet. Some of them are classic in the literature of entrepreneurship, but I will concentrate on those that are essential for the actors involved and the structure of the cluster.

The first actors responsible for the success of the project were the initial entrepreneurs. Their knowledge of the various characterized areas in Spanish and Italian clusters (tile producers, equipment suppliers, glazes and pigments producers, clients) combined with their skills and capacities (information and communication technologies, mechanical engineering, electronics and chemistry) and their vision of the industry were the main drivers of the new project. The vision was necessary to overcome the conservatism in the innovation and application of new technologies required to tile decoration processes (an area where the craft was the dominant paradigm). The fact that the Spanish actors manufacturer of the mechanical equipment industry were not important in the development, made it possible to innovate in this field. However, some of them did have an important “follower role” after.

The research center ITC (the Institute of Ceramic Technology) was very relevant because it paid attention to technology dissemination and it contributed to its standardization. Now, we should consider the fact that many entrepreneurs established links with various companies within and outside the cluster that permitted the cluster to know the knowledge of other industries in the effect of an open innovation. Moreover, a research cooperation was made by two manufacturers of inkjet heads from Europe and Japan. This led to the development of made-to-measure print heads for the use in the field of ceramic floor tile and, eventually, the standardization of this application. The development of electronics and software for control and management of the equipment was carried out in collaboration with various research centers and foreign companies.

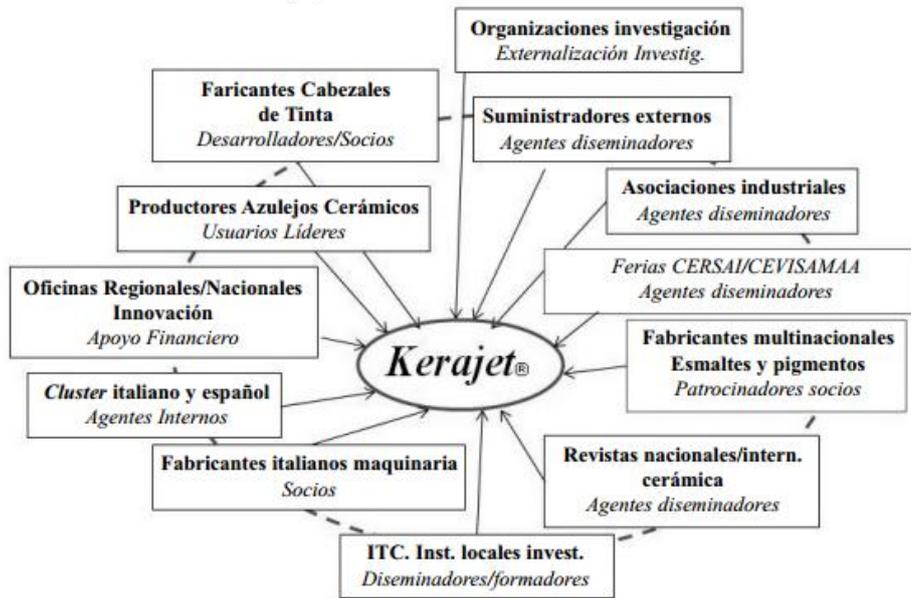
Moreover, it should be noted that cooperation with equipment suppliers of the glazes and pigments industry was instrumental in the development of innovative processes required for the production of the new inks.

A key role was played by the lead users in the producer sector of ceramic floor tiles. Three or four producers in Castellon committed to the new technology, not only with the early acquisition of machines, but through cooperation with numerous suggestions for the further development of new models. Sporadically, 80% of the changes in a new model was based on feedback from these lead users. Most of them built basic competencies with his mastery of the new technology. Furthermore, in the beginning of the development of technology they were already aware of the cost advantages of inkjet technology and they got benefits from its design and logistical improvements. When inkjet technology started to become popular, some lead users had almost replaced all its lines of digitized screen for printing inkjet equipment. Regional innovation agencies, as IMPIVA, among others, welcomed the project proposals with a positive attitude (a fact that facilitated its development with grants and funding from the beginning to the final stages). Their support was crucial for the sustainability of the R + D. In addition, participation in a European research program helped in the dissemination effort.

As I mentioned before, the clusters of Spanish and Italian ceramic floor tiles were well interconnected. It was thought that all the innovation efforts in the decorating process were led by the Italian producers of mechanical equipment, while chemistry innovation was led by Spanish companies of glazes and pigments. What is more, the culture of the ceramic industry was quite conservative and, at the same time, the adoption of information technology was acceptable in the areas of marketing and distribution, but was still weak in the areas of production (Albors et al, 2009; Herva-Oliver and AlborsGarrigós, 2011).

Therefore, the ceramic industry had a passive attitude, in terms of performance, to the new technology of digital decoration. Fairs exposure of the ceramic industry worldwide, CERSAI in Italy and CEVISAMA in Spain, were the scene of the progression of technology during the 2000s. New equipment was exhibited each year and the producers of ceramic showed vanguard designs with marble imitation, natural stone, as well as classic period furnishings based on new technology. Figure 8 refers to the effects of networks and partnerships in the innovation process that led to the development of the new inkjet technology.

Figure 8: Elements facilitators in the development of technology



Source: Albors Garrigós (2011)

As a result of this study, we can say that it emphasizes the importance of social capital in the dynamics of innovation in clusters, as indicated by Landry et al (2002).

In this case, the cluster is a place where social interaction, context and shared cognitive schemata build the right framework for learning and knowledge creation. This case highlights the importance of the diversity of the network as a facilitator of radical innovation as well as the number of contacts that interact (Ouimet et al, 2004). From this view, the radical innovation in a cluster requires high levels of social innovation, as well as the necessary capital, trust, mutual understanding and shared values and, in a very early stage, all the different interest groups that are essential in the innovation process (Reid and Carroll, 2007).

6.6.4 WHAT WERE THE FACTORS THAT FACILITATED THE DEVELOPMENT OF A RADICALLY INNOVATIVE TECHNOLOGY WITH GLOBAL IMPACT?

The lack of culture in companies producing ceramic floor tiles, related to mechanical engineering, hindered the Italian mechanical companies to detect and seize the opportunities of information technologies in the process of ceramic decoration. The complexity of the technology required a more open context (Bell and Abu, 1999).

Nevertheless, in the Spanish cluster, vision and skills of Kerajet engineers, its alliance with one of the leading producers of pigments, and the financial support of this producer facilitated the break of the innovative existing paradigm, although it took a lot of years in getting a broad level of adoption. Therefore, most researchers in the field say that if the innovation had developed in Italy, the adoption would have been faster because of the main effect of the mechanical engineering companies. Electronic culture and networking of Kerajet engineers facilitated the contact and the collaboration with leading companies in inkjet technology that developed print heads adapted to this ceramic application. Also, a key role was played by leaders (including some SMEs), who were able to identify and adopt new technological paradigms that could strengthen their competitiveness (von Hippel, 1986).

Finally, it is important to consider the great relevance that established companies in the clusters exploit their specific local resources and external knowledge for the development of market opportunities and the role that supplier's specialization plays in innovative developments. Moreover, what we have learned is that clusters are a good environment and a context with the objective of encouraging innovation, creation and dissemination, ie, they are the appropriate ecosystem for innovation.

7. CONCLUSION

As I have mentioned at the beginning of this work, it integrates three theoretical perspectives in the field of economics: the situation in the ceramic sector at a global and national level, the perspective of the territory (also known as a “cluster”) and the innovation and new technologies in the same sector. The principal aim has consisted in the current and future study of the ceramic sector, its evolution and its key aspects we should consider when implementing a strategy, as well as the innovation of the firms located in the cluster. Specifically, my study has focused on the ceramic cluster of the province of Castellón.

For the better understanding of this study, first of all, I analysed the theoretical aspects, thus, first I will refer to the economic situation of the ceramic sector, and then I will discuss the conclusions of the territorial agglomerations of firms and, ultimately, the conclusions derivative from the innovation and the inkjet technology.

The tile manufacturing worldwide has always been characterized, year after year, by the increasing of the produced square meters. However, the economic crisis (started in 2007) had a great impact on the above mentioned sector, because the global growth fell in 2008 and 2009. Many were the countries whose production declined in an alarming way, but certainly, the decline affected the countries of the European Union, especially in the industries of Italy and Spain (from 2007 to 2009 their production decreased more than 30%). Nevertheless, Asian countries have helped to the production and to the world consumption in this sector, because the industries of China, India, Iran, Vietnam and Indonesia continued to increase the square meters of production and they also continued to buy tiles after the outbreak of the economic crisis.

In 2013 the Spanish production of tiles and ceramic flooring grown at around 3-4 percent. Besides, Spain is the first European producer and the second European exporter, as well as the third global exporter of tiles only surpassed by Italy and China. In 2013, the global turnover of the Spanish industry reached 2.797 million euros, of which 80% was allocated to exportation (ASCER). These data are very encouraging for the country since it attenuates the sharp fall that occurs on the domestic market, because of the contraction in the construction sector and the unfavourable behaviour of

private consumption that has affected the market. So the only way for the tile industry to progress in Spain is the exportation.

The territorial agglomerations of firms, and the geographical and cognitive proximity between companies and institutions favours the development of relationships characterized by trust and collaboration. This facilitates the transmission of information and knowledge, but certainly another factor that increases the competitiveness of Castellón's cluster is the importance given to the R & D activities, as companies are in constant evolution and they need to continue to develop new production processes and new technologies to improve the design and quality of the tiles. Technical advice is provided especially by the Institute of Ceramic Technology of the Jaume I University, which is the most important with respect to the activity of innovation, but there are other institutions and organizations providing support to the ceramic industry in Castellón and also being one of the keys to success in the cluster.

In short, the relationships established between the companies and the institutions of the clusters generate mechanisms of integration in the form of social networks that improve the accessibility of the companies to external knowledge. However, the way in which this benefit takes advantage depends on the skills and characteristics of each factor to capture such knowledge and exploit it suitably.

Therefore, innovation has a close relation with the above mentioned, since the companies that invest in innovation show a higher degree of complexity and novelty, due to the involvement of more departments, the knowledge of the market, the better management of design, and the innovative use of materials. Definitively, it enjoys a greater knowledge and a greater organizational and technological competencies. With regard to inkjet technology, it can be said that has revolutionized the world of the ceramics; and I should say this is an issue which I consider of great interest, because the decorative advantages and versatility of inkjet technology make possible the aesthetic creativity.

Now, it is important to emphasize the strategy chosen by every company, as these decisions will mark its performance on the market, and those decisions are very important and complex. Throughout this work I have tried to show the characteristics of the Spanish ceramic sector and its importance and relationship with key competitor countries. It has been seen that there are two quite clear and distinct trends: those who base their sales in the fight for the low price, and those who make an effort to seek

added value for their product so that they can collect a better price, that is the differentiation.

Since in Spain the necessary conditions do not exist to produce with lower costs, but rather the opposite, it seems clear that the only option that is presented to the industry is to develop a strategy for quality products in which value added means a factor that allows the identification and differentiation of Spanish ceramics in those markets where it competes. For this, a constant evolution in R & D will be required, so that the other competitors on the market find it increasingly difficult to imitate and copy, not only products but also strategies.

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