



Facultat de Ciències Jurídiques
i Econòmiques · **FCJE**

CHALLENGES OF CERAMIC INDUSTRY

AUTHOR: VICENTE JAVIER ROMERO ROMERO

TUTOR: FRANCESC XAVIER MOLINA MORALES

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0. INTRODUCTION

This work is focused on the analysis of the current and future challenges of ceramic tile companies internationally, but above all we have focused on the ceramic sector of our country, exactly in the ceramic cluster that is in the province of Castellón. The Spanish ceramic industry is one of the most dynamic and modern industries in the country, comparable to the textile sector. In addition, the ceramic sector has positioned itself as one of the indisputable leaders worldwide in terms of production, quality, design and technology.

In addition, we have made a brief study of the Italian ceramic sector that is located in Sassuolo in the province of Modena, as well as the Brazilian ceramic sector located in the states of São Paulo and Santa Catarina. With the analysis and comparison of these countries, we will have a perspective of our current situation, how competitive our sector is and where we want to go. This comparison is very interesting since Spain, Italy and Brazil are some of the largest ceramic producers worldwide. On the other hand, we also mentioned how important emerging countries such as China and India have become in terms of ceramic production over recent years.

Also, we have done a brief study of the economic crisis of 2008 or "housing bubble" as Spain suffered a heavy blow and entered a recession that lasted almost 10 years, now in 2019 we have already recovered the pre-crisis economic levels but not the jobs. Therefore, this economic period or time axis, will serve us to analyze how the Spanish ceramic industry and its auxiliary companies behave before, during and after the crisis. We will also see how this industry was more reinforced and less affected by the crisis than other industries, thanks to the efforts made among others such as internationalization, investments in R & D and increase the quality of their products.

Due to all these factors the Spanish ceramic industry is growing rapidly and has a very positive future ahead. In addition, the study of competitiveness is also interesting, since the ceramic industry is one of the most competitive at an international level, thanks to the quality of all its products, constant innovation in its production processes and the development of new products.

This sector has always had a large volume of business, great benefits and a large number of companies, making it more interesting for its study. In addition, almost all ceramic companies are concentrated in the Valencian Community, exactly in the province of Castellón, which we can say is the epicenter of the entire Spanish ceramic industry and where the great advances are made thanks to an environment that favors

innovation and the collaboration between private companies, auxiliary companies, public entities and different associations.

Therefore, the following study is focused mainly on the Spanish ceramic sector but also on the Brazilian, Italian, Indian and Chinese ceramic sector, for which information is gathered and collected from different national and international sources and different previous studies along the last 10 years to obtain quality information and contrasted.

Finally, the procedure followed by this work is the analysis of different secondary sources such as books, reports published by both public and private entities with information on this topic and web pages that contain relevant information on the ceramic sector.

0.1 Objectives of the work

The purpose or *general objective* of this work is to analyze the challenges faced by ceramic companies in the future and explain to the reader the evolution of the ceramic sector based on several factors, first making a historical journey to understand and analyze the evolution experienced by the theoretical concepts of cluster and district. And later analyze the different *specific objectives* linked to the ceramic sector.

The specific objectives are to study the following aspects:

- Origins of the cluster and district concept
- Differentiate between cluster and ceramic district
- Evolution of the ceramic sector in recent years
- Know the 5 most important countries in ceramic production
- Analyze the sector of ceramic machinery as well as frits and glazes
- Trends in the ceramic sector
- SWOT analysis of the Spanish ceramic industry

I CHAPTER: THEORETICAL FRAMEWORK

The main objective of this chapter is to explain the concept of cluster and district, as well as the main differences between the two. We have also analyzed the historical and economic origins of these concepts together with the leading economists who gave it the name.

First, we have made an analysis on the origins of the term industrial district by the hand of the economist Alfred Marshall, who was the first to use this concept. And later, we have analyzed how the Italian economist Giacomo Becattini contributed to shape the concept of industrial district with his studies and define it in a more precise way.

Then, we have focused on the cluster concept, which was suggested by Michael Porter with the help of a group of researchers at the prestigious Harvard Business School.

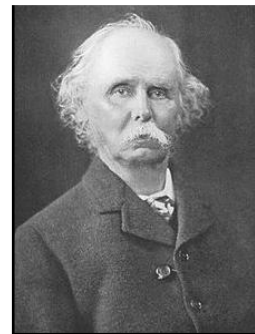
Finally, we will explain the main differences between the district and cluster.

1.1 District definition

1.1.1 Alfred Marshall

The first economist to use the industrial district term was Alfred Marshall (1842-1924), who in his book *The principles of Economics* in 1890, he defined the districts as macro-organizations characterized by complex and intense relationships between industries and companies, which form interwoven networks of economies and external diseconomies that also encompasses the historical and cultural legacies of the local community.

Figure 1. Alfred Marshall



Source: *Wikipedia.*
Photograph taken in 1921

Marshall in that book was opposed to the standard conclusion that the concentration of all productive operations in one place together with a high degree of vertical integration, was automatically superior to the more geographically dispersed and less integrated production methods. Marshall came to the conclusion that in certain types of production processes there are two efficient production modes: the first one based on large vertically integrated production entities and the second one based on the concentration of small factories that specialize in one phase of the production process in a locality.

Marshall was convinced that some advantages such as the division of labor can only be obtained in large factories but that the vast majority of advantages could be obtained with small factories and workshops while there is a high number that perform the same activity in the same place or district. In addition, this concentration of companies will generate an auxiliary industry to meet their specific needs.

Therefore, both large and small companies obtain advantages and benefits from the location of the industry but it is the small ones that really benefit as they avoid many disadvantages that they would suffer by having to compete against the largest.

1.1.2 Giacomo Becattini

Years after the death of Alfred Marshall (1924), around 1975 several economists, among them the Italian economist Giacomo Becattini (1927-2017), they perceive peculiar phenomena in certain areas of the country, such as in the Tuscany, where large companies operating in sectors of high technology and capital intensity show signs of decline, while small businesses live a time of flowering, whose growth increases the employment, income and exports of the area, as well as the fact that these concentrations of small companies were similarly technically prepared as large companies.

Figure 2. Giacomo Becattini



Source: Presentazione del libro "La coscienza dei luoghi" (2015)

These two conclusions were scandalous at that time and the authorities announced an unstoppable deindustrialization with very serious consequences such as social decadence, the increase in poverty, lack of technical knowledge, etc..

This leads us to ask ourselves a question: When and how are the conditions for the birth of industrial districts produced? The answer to this question can be summarized in two: on the one hand the local conditions of supply and on the other hand the general demand.

From the perspective of supply, the ideal conditions arise in countries where cultural complexity has been preserved in some parts of its territory, a diverse productive structure and a credit structure during the industrialization phase and the two world wars.

In terms of cultural complexity, we refer to the values, behaviors and institutions that have survived an industrial, mass and standard culture. The diverse structure refers to the productive structure formed by large, small companies, craft workshops and family businesses, all sharing the same area. Finally, regarding the credit structure, we refer to the existence of entities willing to finance small and innovative companies that allow them to develop in this economic context.

From the perspective of demand, comfort standards are exceeded when countries develop economically, they take for granted a series of standards of quality and comfort, which create the new conditions for the birth of needs of high qualitative content that give place to demands of differentiated and personalized products. It is in this situation, when large companies based on economies of scale and the manufacture of standardized products are in a vulnerable position compared to small companies linked to their population and territory.

Years later, Giacomo Becattini in his book "*From the industrial sector to the industrial district*" in 1979, raised the problem of a research unit between the system as a whole and the production process at the individual level so it was necessary to define a design to determine a stable and defined border between what is an industrial area and an industrial district, therefore establishing these certain borders allowed us to differentiate these two concepts in a more precise way.

According to Becattini (1989, p.58) the industrial district is "*a socio-territorial entity characterized by the simultaneous active presence, in a territorial area limited from the natural and historically determined point of view of a community of people and a population of industrial companies. In the district, unlike what happens in other environments, the community and businesses tend, so to speak, to interrelate with each other*"

In other words, we can define the district as a socio-territorial entity characterized by being delimited in a territory for historical or natural reasons and community of people and a group of companies that tend to interact and produce synergies with each other, that is, the industrial district is deeply rooted in the social context in which the population and businesses are interconnected, in other words, economic development and the development of society are integrated.

Therefore, while the clusters focus more on the economic benefit and productive efficiency, as we will see later, in the districts we have a triangular relationship between

institutions, companies and local population where each part plays a very important role.

In conclusion, we can see how Marshall and Becattini agree that in the districts, both the community, companies and institutions are equally important and that they are closely interrelated with each other also to seek sustainable development over time..

1.2 Cluster definition

1.2.1 Michael Porter

The cluster concept emerged some ten years after the district concept proposed by Becattini, thanks to Michael Porter who in his book "*The Competitive Advantage of Nations*" (1990) with the help of a group of researchers, conducted a study which opened a new problem to the district definition.

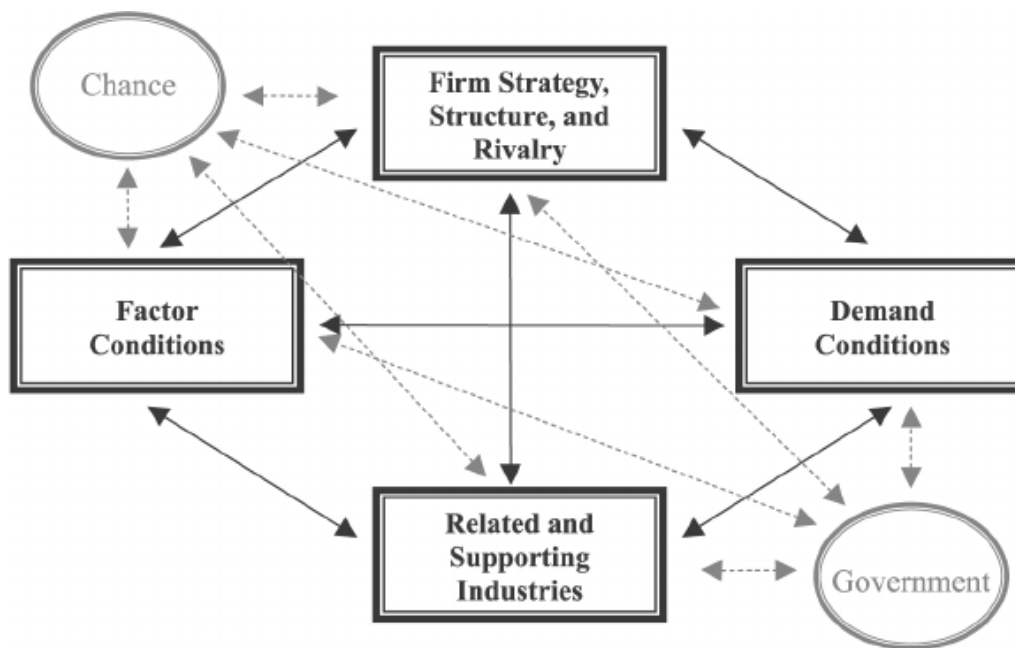
The research they carried out about trade worldwide, showed that there were territorial concentrations of small companies (especially in Italy) which had acquired a great competitive advantage in sectors such as footwear, textile and ceramics, despite the inferiority technology in front of large companies and the low labor costs of other competitors in other countries, therefore to explain this, Porter began to call these districts with the term cluster, and since Porter conducted this study at the prestigious Harvard Business School, this term was subsequently coined by different economists.

In the study "*The Competitive Advantage of Nations*" (1990, p.197-198) Porter defined the cluster as "*geographic concentrations of interconnected companies, specialized suppliers, service providers firm in related industries, and associated institutions in particular fields that compete but also cooperate. Critical masses of unusual competitive success in particular business areas, clusters are striking feature of virtually every national, regional, state, and even metropolitan economy especially those of more economically advanced nations*"

As we can see in the definition, the social aspects of a community where companies are located have no importance in the Porter cluster, unlike the Becattini district.

To explain the factors of competitive advantages, Porter studied the competitiveness of nations especially the great powers of the time such as Japan and Germany and how their competitiveness also affected the innovations of American industries. In that book they began to study what were the sources of competitive advantages both at sector and national level.

Figure 3. Diamond of National Advantage



Source: Porter (1990) p.77 The Competitive Advantage of Nations

In addition, the study focused on defining the best internationalization strategy, taking a number of successful countries, sectors and companies, both European and Asian and what competitive advantages and sources of innovation they had to have become success stories.

Also, he defined his model of the 5 forces: threats of entry of new competitors, bargaining power of suppliers, threat of substitute products, rivalry between competitors and bargaining power of buyers which each is a basic factor that defines the competitiveness of a cluster.

1.3 Differences between District and Cluster

As we explained in the previous section, the district focuses on development at the local level where communities of people and businesses have a strategic role in the development of the district and are deeply rooted in the social fabric, in other words, it is a model that integrates social and economic development, while clusters are simply focused on the grouping of companies located in different geographical areas in order to achieve competitive and productive advantages. Although, it also mentions the social component, this only appears as a backdrop and does not acquire as much prominence as the economic component, as if it happens in the district. (Albuquerque, 2006)

In addition, the clusters do not seek a model of economic development that combines social and economic well-being. The social component in the cluster is only one factor outside the equation and does not acquire the importance of the economic component.

Another important difference is how both territories are considered in terms of habitability. In the districts the territory is considered a place to live, in which the development of the human capacity of production and work of a community is prioritized, while in the clusters they are considered merely as an organizational model of networks of companies and institutions contextualized in a certain geographical area (Rodríguez, 2014)

Regarding the methods of analysis used, the analyzes in the districts are exhaustive analyzes that study in depth the relationships between the companies, the local community and the institutionsin, which they intervene different disciplines such as geographical, sociological, historical and political analysis.

On the other hand, in the clusters the purpose of the studies is the realization of competitive strategic analyzes, which seek the sources of the competitive advantages derived from the location and later with this information they use it to improve the competitive. (Rodríguez, 2014)

The following difference is found in the formation of networks and collaboration strategies between companies, since there is a certain difference between clusters and districts in terms of the perception of trust and rivalry between companies.

In the district we can see apart from internal competition, that there are social networks and trust between companies that allow a balance between the rules of competition and collaboration that result in a social construction of the market. On the other hand

Porter emphasizes the positive role of rivalry along with cooperation between companies, since this combination of both favors the improvement of cluster performance and increases innovation.

Finally, we find the strategic role of location. For the district, the localization is a place for life and priority is given to human and community development, as well as being a combination of links between different parts. While in the cluster, the location or territory has a very important role and it is a key factor in the competitive strategy. (Albuquerque, 2006)

Table 1. Main differences between District and Cluster

DISTRICT	CLUSTER
Integrates social and economic development	Focuses on achieving competitive and productive advantages
Priority is given to human and community development. It is considered a place to live	Grouping of companies and institutions in a certain territory. Human capital is prioritized, not his development
The analysis study in depth the relationships between companies, the local community and institutions	The analysis focuses on finding sources of competitive advantages derived from localization in order to improve competitive strategies
There is a balance between the rules of competition and collaboration that result in a social construction of the market. There is trust	The combination of rivalry and cooperation improves performance and cooperation. There is no trust between companies
Location is a place of life and a combination of links between different parts	The location or territory has a very important role and is a key factor in the competitive strategy

Source: Compiled from data by Albuquerque (2006)

II CHAPTER: EVOLUTION OF THE CERAMIC INDUSTRY

The success of the ceramic sector is today an indisputable fact and how the goals achieved have been increasing. Currently, the world production of tiles has exceeded 7 billion square meters a year thanks mainly to the technological and commercial improvements that have occurred in particular in the Italian and Spanish ceramic industries.

Thus, the ceramic sector can be considered as a mature sector in the economies of developed countries while in emerging countries has just begun to emerge. But we must take into account the new context in which we are currently located where there is a global market that offers new and interesting opportunities. As a result of this globalized world, the future can be faced with confidence by both developed and emerging countries as the new market can reward or punish them.

2.1 Evolution of the ceramic sector from 1970 to 2000

Regarding the evolution over the years of the ceramic industry, we have focused on two parts, on the one hand the evolution in the factories and production equipment and on the other hand in the evolution of the final product which has been adapted to the new trends.

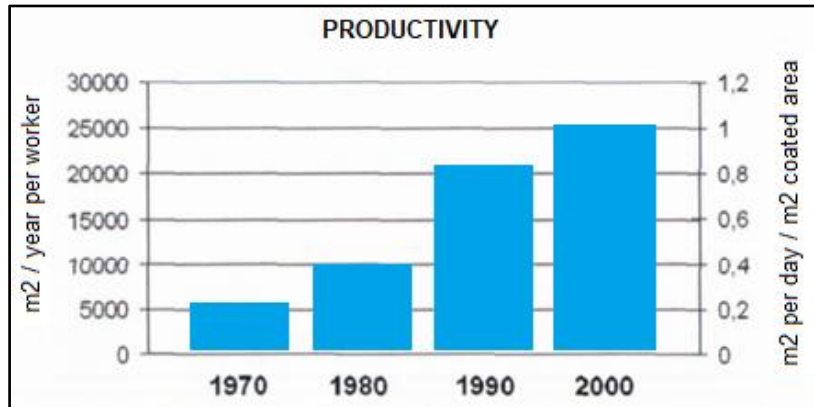
2.1.1 From the perspective of factories and production equipment

The ceramic industry began in the early seventies, until then the production of ceramic tiles were based on craft processes that were characterized by low productivity and high labor and energy consumption. In 1970, the demands were marked by the need to build houses driven by the economic boom that was going throughout Europe and that could be satisfied with simple tiles of small formats and with little aesthetic content, that is, with geometric designs or without any class of decoration. (Qualicer, 2004)

In addition, the factories and production equipment consisted of technologically very old machinery, which created the perfect climate for a technological takeoff. In 1980, the expected revolution came, especially thanks to the introduction of the mono roller layer furnace, which meant that the baking process until then discontinuous became continuous, allowing a considerable increase in productivity, as well as, having greater control in the energy consumption.

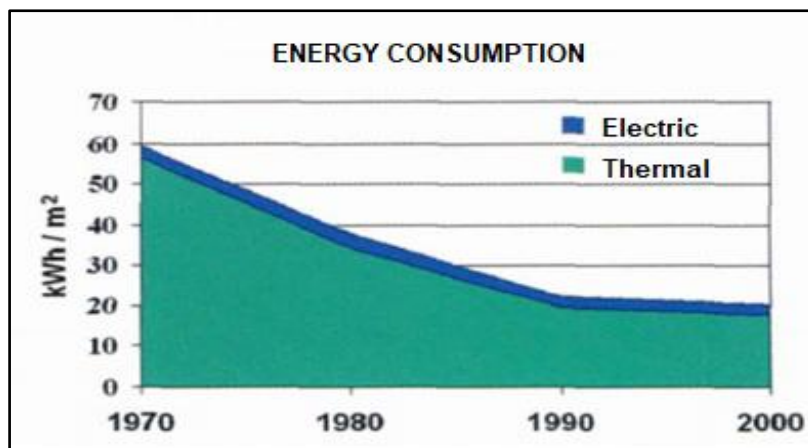
The graphs below show us this productivity growth, that is, the production of coated surface per unit of worker. And in the second graph, the decrease in energy consumption, which in the case of the ceramic sector is mostly thermal.

Figure 4. Increase in productivity from 1970 to 2000



Source: Adapted from QUALICER (2004)

Figure 5. Reduction of energy consumption from 1970 to 2000



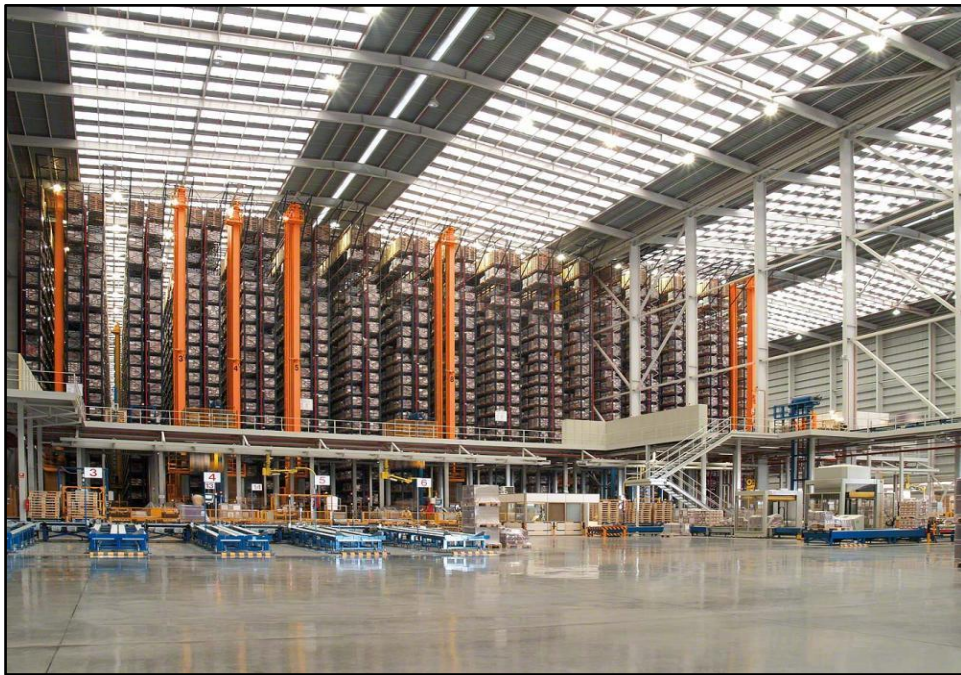
Source: Adapted from QUALICER (2004)

Therefore, we can observe an optimization of the production process especially throughout the 90s, in which they sought to achieve maximum flexibility of the lines and automate all possible production processes.

As a result of years of constant improvements and innovations in the production process, the ceramic sector has reached his minimum in relation to the cost of manufacturing and product quality, that is, it is very difficult to overcome the quality of the product with the technology currently available, although new ways of improving production are constantly being investigated, in the short and medium term it will be difficult to see new technologies that can replace the current ones and less be implemented on a large scale. (Qualicer, 2004)

Therefore, the improvements that we will see in the coming years will focus more on the outside of the production plants, such as the optimization of logistics focused on a global market, such as smart warehouses that predict demand and not simply production-oriented warehouses.

Figure 6. New Venis intelligent warehouse



Source: Porcelanosa's website (2019)

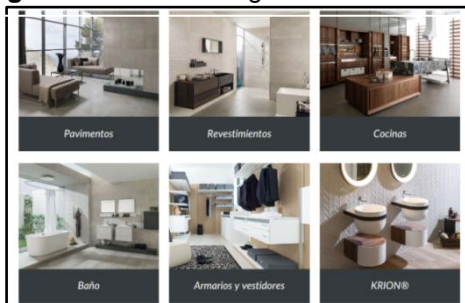
2.1.2 From the perspective of the final product

On the other hand, we have the evolution of the product and how it has adapted to the new trends. The development of new products and especially the differentiation of each ceramic type have been far more superior than any other industrial sector, only comparable to the textile and fashion sector, also characterized by the continuous development of new colors and designs.

From the 90s, a great technological effort has been made in the ceramic pastes and enamels for the various classes and ranges of final products as well as the porcelain stoneware research. For all these different kinds of products have deposited large amounts of resources to achieve differentiation, which each company has been built and characterizing its own brand. (Qualicer, 2004)

Also, we have seen in recent years the huge number of formats depending on the type of product, from the smallest formats for the realization of mosaics such as large formats. The main factors that have allowed this great variety of sizes and designs have been the flexibility of the presses and printing systems by typography and rotogravure.

Figure 7. Product range of Porcelanosa



Source: Porcelanosa's website (2019)

Figure 8. Bathroom made by Pamesa



Source: Pamesa's website (2019)

Figure 9. Keraben's mosaic



Source: Keraben's website (2019)

2.2 Evolution of the ceramic sector from 2000 to the present

In this section we will focus on the current situation of the ceramic sector both globally and nationally also we will see the evolution of the ceramic industry and its auxiliary industry as it has been changing since the *housing bubble* of 2008.

In addition, we have compared from different sources, the positive trend that the ceramic industry has accumulated over the years, in terms of workers, turnover, exports ...

In recent years, global ceramic production has expanded rapidly and as a consequence of that the competition is increasing. Despite the technological and commercial leadership of Italy and Spain, Brazil and China are becoming the new protagonists. In addition, emerging countries such as Turkey, Indonesia and India whose production is increasing rapidly due to internal and population growth.

Although, the ceramic sector globally (excluding Spain) is clearly concentrated in 2 territories, on the one hand we have the well-known ceramic district of Sassuolo in Italy and, on the other hand, in Brazil in which the production is concentrated in the southeast part (São Paulo) and south (Santa Catarina) of the country.

2.2.1 National ceramic sector: Spain

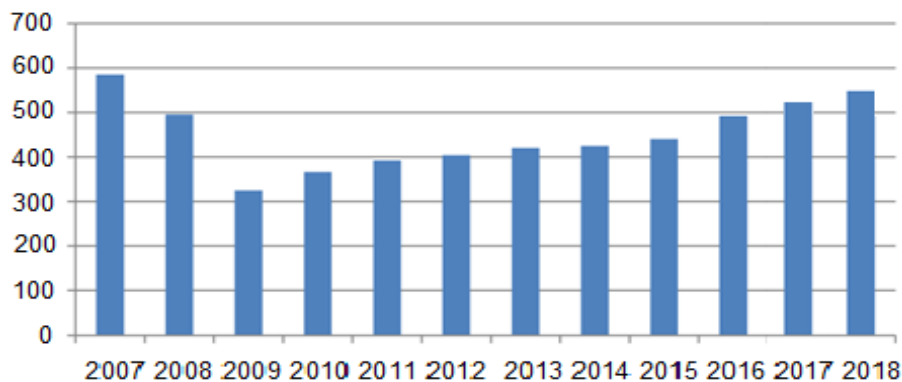
The most important ceramic sector in Spain is concentrated in Castellón and is located between the regions of Les Planes and l'Alcora and it can boast of being the most competitive in Europe and the leader in innovation together with the Sassuolo cluster in Italy.

The Castellón cluster has a turnover of around 5,000 million euros and has around 20,000 workers, making it a basic pillar in the Valencian industrial fabric. Exactly occupies the third position, behind the automotive and food industry. (Hervás, 2018)

In general, it is one of the most important and competitive clusters in Spain since there is constant innovation, a high presence of multinationals and institutions which are constantly being created to give support and collaboration to these companies such as technology centers, associations, purchasing centers etc.

In addition, it is formed by a whole network of companies also called supply chain, which is concentrated in the regions around Castellón.

Figure 11. Production of ceramic tiles in Spain 2007-2018 (mill.m2)

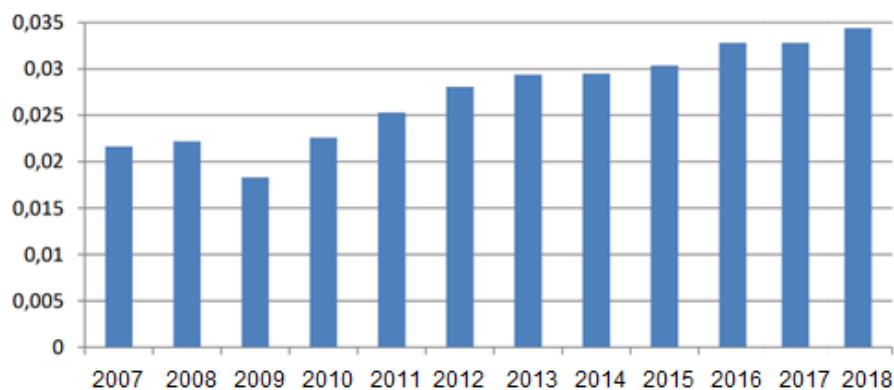


Source: ASCER (2018)

After recessions there is a tendency to increase productivity and reduce labor, and this case is not the exception, since the crisis has shown a positive trend in productivity.

In 2007, they produced 605 million square meters of ceramic tiles with a total of 26,000 employees. While in 2018, they produced more than 540 million square meters with about 16,000 employees. So productivity has increased by about 40% since 2007.

Figure 12. Productivity of Spanish ceramic companies (2007-2018)

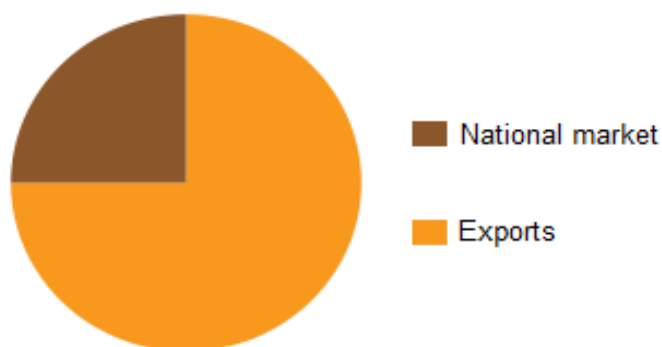


Source: ASCER (2018)

Due to the collapse of sales in the national territory, the ceramic sector had only one option: to make the leap to internationalization and implement the latest technologies in digital revolution such as inkjet printing. Currently 75% of sales are already made outside of Spain.

Figure 13. Destination of Spanish ceramic products

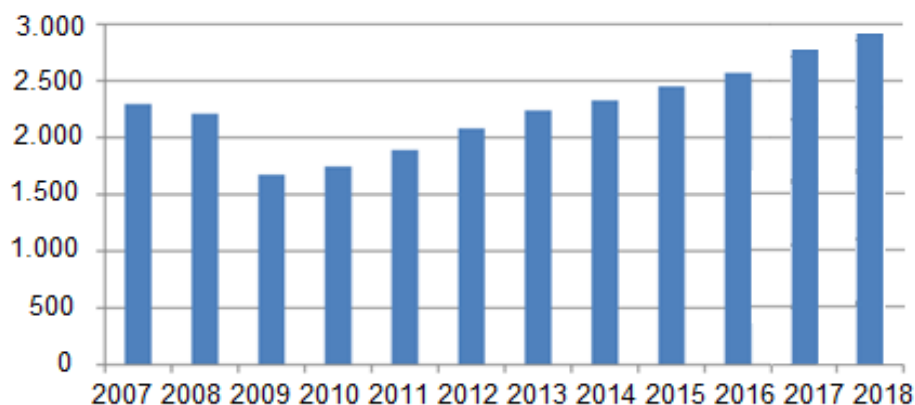
75% of sales are made abroad



Source: Own elaboration

As we can see in the following graph, since 2009 exports have been growing progressively to exceed the levels previous to the real estate crisis. In the year 2018 the export record was broken, reaching the export of ceramic products worth 2,727 million euros.

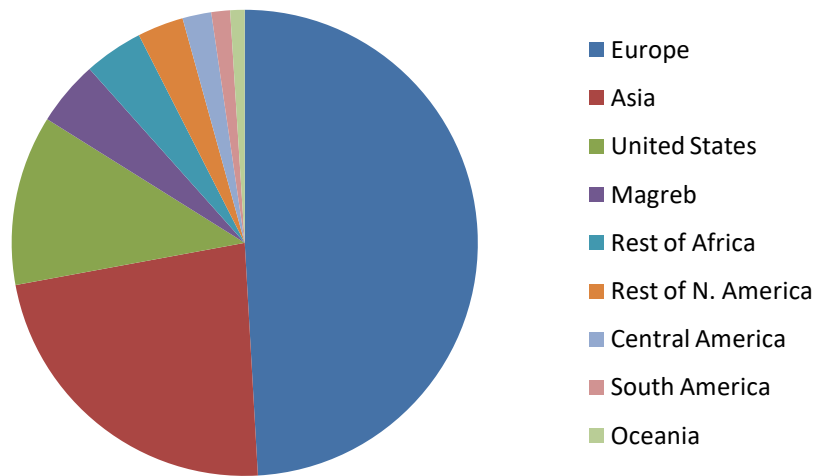
Figure 14. Exports of Spanish ceramic companies (mill.€)



Source: ASCER (2018)

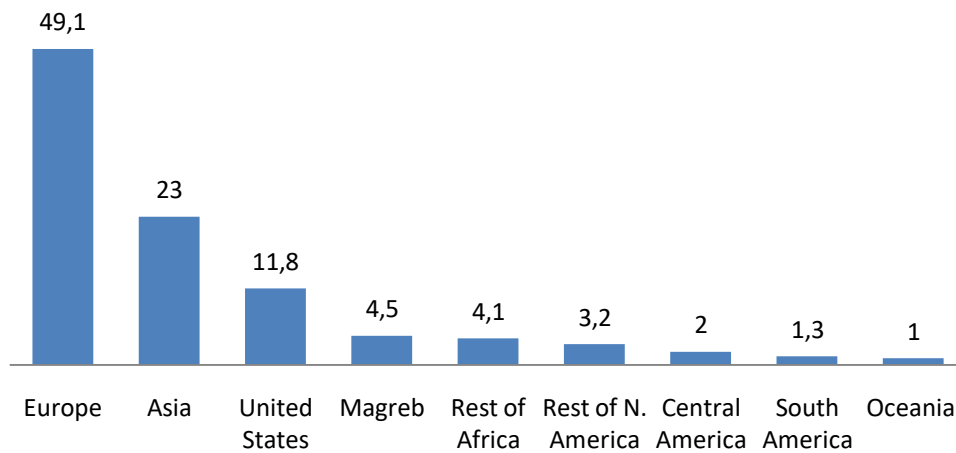
This increase in exports has been mainly directed to 3 different regions: First of all we have the European Union, which concentrates around 50% of exports, secondly we have Asia, which concentrates 23% and finally we have the region of North America, in which the United States stands out, with 11.8% of the quota.

Figure 15. Destination regions of ceramic Spanish products



Source: Adapted from ASCER (2018)

Figure 16. Destination regions of ceramic Spanish products



Source: Adapted from ASCER (2018)

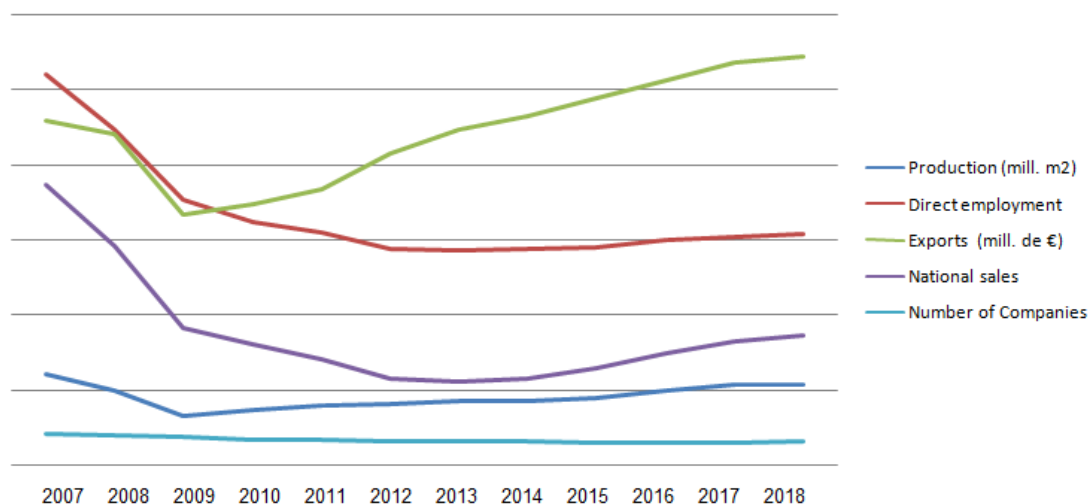
By way of summary, we can see in the following table (elaborated from the data of the ASCER report) how the main economic data have been evolving over the last years.

Table 2. Evolution of economic data for the ceramic sector 2007-2018

Year	Production (mill. m2)	Direct employment	Exports (mill. de €)	National sales	Tile manufacturers
2007	605	26.000	2.295	1.871	207
2008	495	22.300	2.211	1.460	193
2009	324	17.700	1.673	918	182
2010	366	16.200	1.747	801	170
2011	392	15.500	1.842	705	165
2012	404	14.400	2.082	575	160
2013	420	14.300	2.240	557	153
2014	425	14.400	2.328	574	151
2015	440	14.500	2.452	643	146
2016	492	15.000	2.570	746	145
2017	530	15.200	2.686	824	150
2018	530	15.400	2.727	870	152

Source: Compiled from data by ASCER (2007-2018)

Figure 17. Evolution of economic data for the ceramic sector 2007-2018



Source: Compiled from data by ASCER (2007-2018)

This recovery would not have been possible without the support of the chemical sector, especially the manufacturers of frits and glazes that are leaders in the world and whose real estate bubble has had little influence. Next, we can see according to the data of ANFFECC (Asociación Nacional de Fabricantes de Fritas, Esmaltes y Colores

cerámicos), the stability that these manufacturers have enjoyed over the years. In 2007, they had a total of 3,754 employees while in 2017 they had 3,861 employees, that is 107 more employees, slightly above the levels of crisis, so we can see that in this sector have already recovered pre-crisis levels.

Table 3. Employment and exports of frits and enamels sector (2007-2017)

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Direct employment	3.754	3.741	3.278	3.310	3.302	3.279	3.342	3.470	3.610	3.680	3.861
Exports (mil. euros)	641	700	529	640	733	768	792	845	853	843	936

Source: Compiled from data by ANFECC (2007-2017)

On the other hand, the association ASEBEC (Asociación Española de Fabricantes de Maquinaria y Bienes de Equipo para la industria Cerámica) which is made up of 71 companies, both manufacturers and repairers of machinery for the ceramic sector, is in a situation similar to that of the manufacturers of frits and glazes, it has positive levels of recovery but remains slightly below the levels of crisis.

Table 4. Evolution of ceramic machinery manufacturers 2007-2016

	Nº Companies	Nº Employees	Exports(mil. de €)	Turnover (€)
2007	70	1.805	56.000	354.500
2008	62	2.046	77.250	336.000
2009	57	1.658	67.000	182.000
2010	53	1.566	83.000	237.000
2011	51	1.640	125.000	292.000
2012	50	1.669	145.000	275.000
2013	41	1.227	113.000	300.600
2014	41	1.267	130.000	279.000
2015	42	1.347	98.500	286.000
2016	45	1.405	105.000	295.000

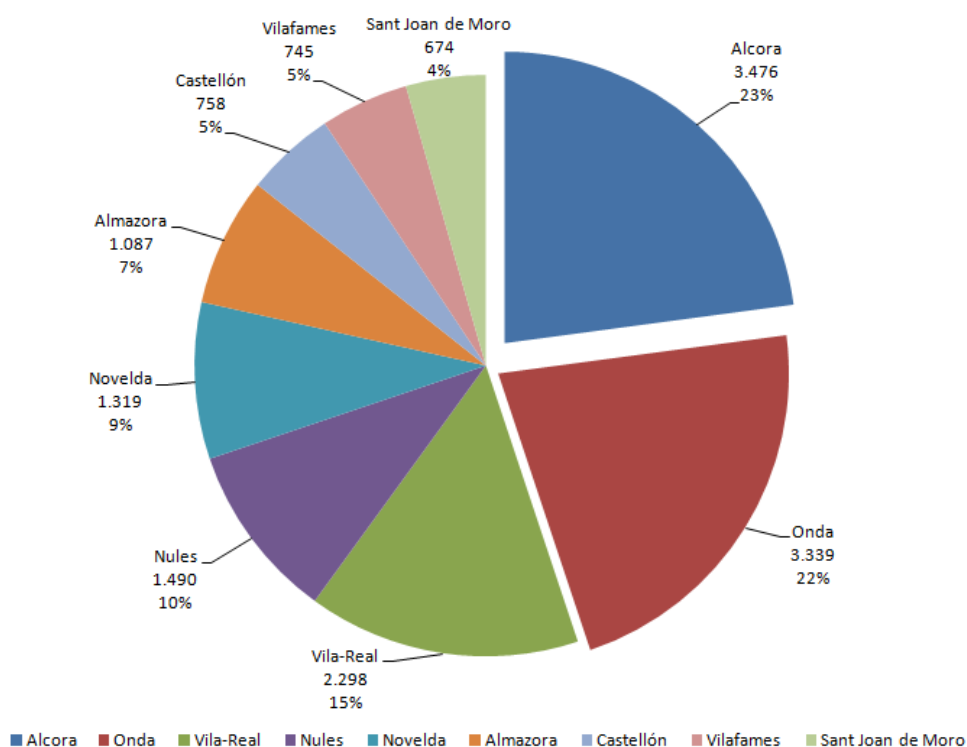
Source: Compiled from data by ASEBEC (2007-2016)

Finally, regarding the distribution of the ceramic companies by municipalities, Alcora and Onda stand out, only in these two municipalities there are a total of 6,815 occupations only in ceramic factories (without counting the auxiliary industry) and it represents almost half of the ceramic cluster (45% of the total percentage).

In third place we have Vila-Real with 2,298 employees and it represents 15% of the total. In fourth place with 1,490 employees and 10% of the total ceramic manufacturers we have the municipality of Nules.

And finally we have several municipalities that jointly represent 30% of occupations in the sector, and that is made up of 3,825 workers. In the graph that we have next we can see it in a clearer way.

Figure 18. Ceramic industry employees



Source: *Universitat Politècnica de Valencia. Plan sectorial del clúster cerámico (2018)*

On the other hand, according to the sectorial plan of the ceramic cluster developed by the Polytechnic University of Valencia in 2018, in the coming years there will be new trends and challenges that they will have to face the companies and factories of Castellón, among which we can highlight:

- Internationalize companies, with greater and better presence in all markets of the world including emerging countries.
- Consolidate the sector, greater concentration and size to further increase competitiveness and productivity. In addition, increase cooperation and integration between larger groups.
- Increase the efficiency of companies with the help of best practices such as *lean manufacturing* and the introduction of new technology such as industry 4.0
- Consolidate the image of quality and manufacturing Spanish *Made In Spain*.

In addition, we must also mention some aspects to improve and the challenges faced by institutional entities with suppliers of large ceramic companies, mostly SMEs:

- Enhance the degree of internationalization of companies, mainly in exports.
- Increase its capacity for innovation and introduction in Industry 4.0
- Improve professional training, that is, adapt professional training to the specific needs of companies, connecting public institutions with private companies, training them in languages and digitize them.
- Consolidate and support the Spain brand *Tile of Spain* through a greater promotion focused on the international market such as CEVISAMA.
- Encourage the integration and cooperation between companies to grow in size and thus achieve greater specialization and efficiency.
- Encourage industrial renewal and support them with an agile, efficient and flexible administration, in other words, less bureaucracy.

In conclusion, the ceramic sector of Castellón is a global reference cluster that has very well positioned companies such as Porcelanosa, Torrecid, Pamesa, Kerajet, Stynul ... in which there is a constant innovation and which is characterized by being open to the world as far as exports are concerned and by providing knowledge and technology to everyone, as well as having entities such as Cevisama or Qualicer that support the entire cluster but they have great challenges ahead as we will study later.

✓ **Success stories: Pamesa**

Since the birth of Pamesa in the year 1972 to the present, Pamesa has become the first tile producer in Spain. The exponential growth of the Pamesa Group has occurred since 2008 as a result of multiple acquisitions and mergers that has led to the group currently consists of 12 companies. In 2018, it billed 643 million euros, which represents 10% more than the previous year and a sales volume of 75 million square meters.

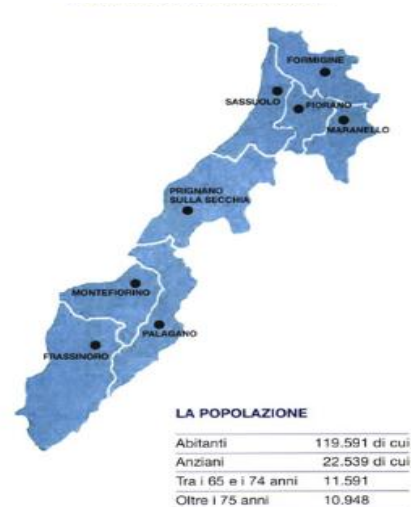
The main key of this success has been to control the entire process of ceramic production, from obtaining the raw materials to the commercialization of the finished tiles. This control of the process allows to obtain a higher profitability since the commercial margins of the suppliers and other unnecessary expenses are avoided.

Due to all this, since 2008, the business group Pamesa has tripled production and increased turnover by 130%. In addition, a large part of this increase in turnover has been due to several factors such as the use of economies of scale, improvements in productivity and energy efficiency, for example, a few weeks ago it announced the construction of the largest photovoltaic park on roof for self-consumption in Europe in its own facilities in Onda (Castellón). It will place on the roofs of its logistics centers more than 40,000 photovoltaic panels, occupying an area of 70,000 square meters. The total investment will be 15 million euros and will be completed in July 2019. (Romero, 2019)

2.2.3 International ceramic sector: Italy and Brazil

The Italian ceramic sector is located mostly in the district of Sassuolo (between the province of Modena and Reggio Emilia) which is one of the world leaders in the production of ceramic tiles. This success has been achieved thanks to the meticulous care in the aesthetic details and the efforts carried out during years in innovation and research. This district produces around 80% of the total Italian production so we can appreciate that it is along with the district of Castellón one of the undisputed leaders in ceramic production throughout Europe. (Cofindustria Cerámica, 2016)

Figure 19. Sassuolo ceramic district (Italy)



Source: Associazione Sostegno Demenze (2007)

According to Confindustria Cerámica in 2016, there were a total of 225 factories directly related to the ceramic sector, employing 24,765 employees and generating a turnover of almost 6 billion euros. Of those 225 factories, 147 are producing ceramic tiles employing 19,000 people and producing 416 million square meters per year. This is a growth of 5.4% over the previous year in 2015.

The crisis of 2008 also affected the Italian district and for 8 years saw its sales fall drastically, although it has finally rebounded increasing production to 83 million square meters (+ 3.2%) although this is only half the size of the market before the crisis. In terms of total revenues during 2016, the Sassuolo district reached 5.4 trillion euros (+ 5.9%).

Another important characteristic is that the Italian sector has a great tendency to acquisitions and mergers. Therefore, there are large groups formed by different companies and brands that are at the top of the list of large ceramic manufacturers such as the Marazzi Group (Marazzi, Alfa, Carofrance, Ragno) Concorde Group (Keope, Corona Brand, Atlas-Concorde, Caesar, Refin ..)

We can also mention the increase of exports in recent years, which have reached 330 million square meters and which generates 4.6 trillion of income from the

aforementioned 5.4 trillion. Therefore we can see how large is the proportion of income generated by Italian exports.

As for the Brazilian ceramic sector, in recent years it has consolidated itself as the third world producer and the fourth world exporter behind Spain, Italy and Turkey.

During the first half of the 20th century the ceramic industrial base was established, initially producing hydraulic tiles and glass. In the 1960s the ceramic sector focused on supplying the domestic market, as there was a great demand for civil construction. Subsequently, in the 1980s with new production processes such as fast-firing ovens, the sector went through a new period of development and began to concentrate the ceramic factories in Santa Gertrudes and Criciúma in the states of São Paulo and Santa Catarina respectively . (Qualicer, 2008)

Figure 20. Ceramic districts in Brazil



Source: IBGE. Instituto Brasileiro de Geografia e Estatística (2015)

Finally, in the decade of 90s both territories were consolidated as ceramic producers and together with the commercial opening of the economy and a great effort in innovation, it was possible to increase the production and the quality of the products.

During the following years, Brazilian ceramic companies began producing porcelain tiles, and as exports increased, they had to offer products with international quality levels. In 2006, it produced 594 million square meters, an increase of 4.5% over the previous year.

The Brazilian ceramic sector has 94 companies that have 117 industrial plants and an installed production capacity of 670 million m² / year. (Qualicer, 2008)

III CHAPTER: SWOT ANALYSIS OF THE SPANISH CERAMIC SECTOR

The goal of this work is to identify and analyze the challenges that ceramic companies must face both now and in the future.

Therefore, the methodology that we have followed to carry out this study has been, first to make a historical and evolutionary introduction throughout the years of the cluster and industrial district concepts. On the one hand, we have seen how economists Giacomo Becattini and Alfred Marshall give shape to the industrial district concept from their different perspectives. While Michael Porter, he created the Industrial Cluster concept years later.

Afterwards, we have focused how the ceramic sector has evolved since 1970 to the present, both from the perspective of the final product (such as have been the trends in designs, colors, the introduction of different sizes ...) as well as, the perspective of the tile factories (such as productivity, efficiency in their processes, technological innovations have been increasing ...)

Subsequently, we have focused on 3 countries that stand out for their ceramic industry. In the international field we have made a brief study of the evolution of the Italian and Brazilian ceramic sector and at the national level we have carried out an in-depth study of the ceramic cluster that is located in the province of Castellón, where we have analyzed all its aspects such as the production of square meters, exports, sales, number of employees over the years, ... we have also briefly analyzed the sectors of machinery, frits and glazes.

Then, we have carried out a SWOT analysis of the Spanish ceramic sector, where we can appreciate the main challenges and aspects to be improved in the coming years, as well as the different opportunities that must be exploited both in the national and international context.

Table 5. SWOT analysis of the Spanish ceramic sector

	Strengths	Weaknesses
Internal analysis	<ul style="list-style-type: none"> ✓ Dynamic economic activity ✓ Geographical situation and infrastructures ✓ Ceramic Technology Institute (ITC) ✓ Accumulated experience 	<ul style="list-style-type: none"> ✓ Scarce workforce ✓ Organization structure ✓ Big Data and ITC ✓ Environment ✓ Marketing
	Opportunities	Threats
External analysis	<ul style="list-style-type: none"> ✓ Mediterranean Corridor ✓ US tariff to Chinese tile ✓ Industrial Revolution 4.0 ✓ New market niches 	<ul style="list-style-type: none"> ✓ Current economic and political situation ✓ Protectionism Arab countries ✓ Brexit ✓ Emerging countries

Source: Own elaboration

3.1 Weaknesses

➤ Scarce workforce

The shortage of labor is becoming a major weakness in the Castellón ceramic cluster, both skilled labor and less technical profiles. Ceramic producers have warned of the need to have professionals who can follow the growth that the sector is registering in recent years.

In 2018, the human resources company Adecco, presented a report in which shows the profiles that are becoming scarce in the labor market of each province and Spanish community, also shows the reasons for the deficit of professionals. Specifically in the province of Castellón, there are problems to find press operators, operators, electromechanical, glazing, oven, rectifier, polisher, atomizer and commercial with languages. In addition, the profiles related to ICT are also scarce (computer specialists, programmers, analysts ...). The main problem facing these profiles today is the demand for languages, apart from English and French, there are companies that need professionals with less common languages such as German, Chinese or Russian.

The tile companies also need laboratory technicians, to create new materials, analyze chemical components, optimize production and analyze the quality of the products.

That is why professional training or university degrees in this branch is so important and a great need in the province of Castellón. In addition, professionals and engineers in industrial design also have great opportunities in the ceramic sector.

In this study, Adecco warns of the need to fill these vacancies since one in seven offers could remain unfilled. Therefore, it is a situation in which companies and public administrations have to make a joint effort to generate quality employment and bet for wages linked to productivity, in addition to improving and returning the labor conditions lost during the 2008 crisis.

On the other hand, workers, unemployed and future professionals must also make an effort and bet on training, not only university, but also in deficit fields and that have a large percentage of employability such as languages or dual vocational training. (Ribes, 2018)

➤ **Organization structure**

The companies in the Spanish ceramic sector are mostly small and medium-sized companies that arise from their own capital and in which the family structure predominates. These characteristics are typical of sectors where SMEs abound and pose serious problems for the future development of the sector.

The model followed by these companies can be defined as a linear model, this model is based on the principle of hierarchy and maintenance of the command unit, which allows to maintain family control in a simple and effective way, so that the principle of authority is reinforced. This model is advisable for SMEs with simple manufacturing processes or with unsophisticated technical systems, since it is highly effective for the control of the final results and the supervision of tasks. It is also characterized as a structure with low operating costs. (Budi, 2008)

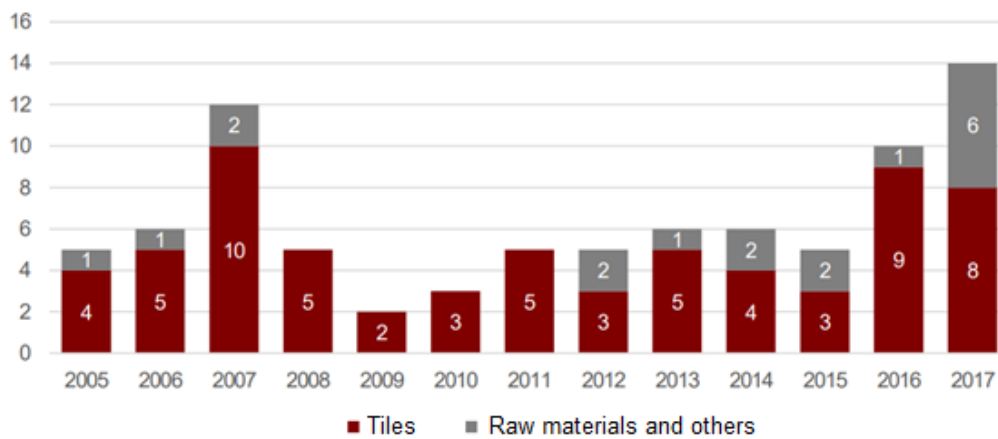
On the other hand, this structure or organizational model presents several problems, such as rigidity, excessive concentration of authority, mainly in the family structure and the lack of response and flexibility in dynamic and competitive environments.

As for the family structure, the union between management and ownership, conditions and hinders the processes of merging with other companies or long-term collaboration agreements in addition to another inconvenience such as generational continuity. Another weak point for small and medium enterprises is the difficulty they have in establishing strong commercial networks and the creation of brands. For example, in

the Italian model we can see that companies tend to merge and there are larger companies, which in many cases form business groups with a division of trading companies and producers. These characteristics allow the productive specialization, increase the efforts in the commercialization and reduce the line or range of products. (Budi, 2008)

Next, we can see a graph which shows the process of concentration in the ceramic sector between the period 2005 - 2017. During the last 13 years, there have been a total of 84 global operations of both mergers and acquisitions. (Rodrigo, 2018)

Figure 21. Corporate operations in the ceramic sector 2005-2017



Fuente: Mergermarket (2017)

Of the 84 operations, 66 correspond to tile manufacturing companies. In addition, Italy leads the ranking with 18 operations compared to 10 in Spain.

Therefore, the Spanish ceramic sector must change its mentality and focus on mergers and creation of business groups that allow them to optimize resources, especially commercial, in such a way that it allows them to better face the new competitive situation.

➤ **Big Data**

Another weakness of the ceramic sector we find it in the lack of implementation of new technologies and techniques of industry 4.0, such as Big Data.

Big Data handles a large volume of data, which through algorithms and machine learning can predict future behavior. Currently, the Institute of Ceramic Technology is developing techniques that allow processing a large amount of data for strategic decision making in a company as well as improving production processes and although great efforts are being made in this field, they could still be much more important.

Big data will allow ceramic companies to visualize the most important information for the ceramic sector and create new jobs in this field, as well as provide solutions to the existing chaos due to the large amount of data in a myriad of sources. This is why we must make an effort and increase investments in this field. (Pardo, 2018)

➤ **Environment**

One of the great weaknesses that the ceramic industry has to face is the lack of environmental management such as the reduction of pollution, atmospheric emissions, cogeneration, etc.

We can divide the process of ceramic tile production in 6 steps:

- Extraction or reception of clay
- Pressed to shape the ceramic tile
- Drying to remove moisture
- Enameled to decorate the tiles
- Cocción en un horno con quemadores de gas natural y aire
- Classification, packaging and storage of the finished product

With the exception of the last step, the rest has a great environmental impact, since they involve the production and dispersion of toxic and volatile substances to the environment. Therefore, the manufacturing steps are those that especially require various prevention systems such as the Best Available Techniques or BAT's. According to the European pollution control directive IPPC, the ceramic sector is an industry with the greatest environmental impact from the moment of extraction of the clay until the elimination of the tiles.

In terms of obtaining raw materials, it generates various consequences in the natural environment, such as blasting the mountains, transporting materials and storing them. In addition, it also produces a large amount of dust and noise that occurs when making explosions that can have negative consequences on the environment. All this produces great changes in the land and environment where raw materials are extracted that will hardly recover again.

In terms of gas emissions, it is also a very damaging factor for both the environment and workers. Since the transport and handling of raw materials generates a large amount of atmospheric emissions as well as the cooking and drying processes, in which different gases are used that can be volatilized. During the manufacture of the ceramic tiles, different solid waste is also generated, such as lubricants, grease and ceramic residues. In addition, one of the most harmful stages is the process of enamelling and the gas in the furnace, since it emits harmful substances, heavy metals, fluorides and oxides. (Cerem, 2016)

Occasionally, the surrounding waters of a ceramic factory are also damaged as they can carry toxic particles in suspension, heavy metals, boron compounds and organic fiber. For all these factors, ceramic companies must be aware that applying preventive measures and good practices improves both the environment and the health of their employees.

That is why the ceramic sector must make an effort to avoid environmental impact and respect the BAT's to prevent and control pollution, in addition to Law 16/2002 that seeks to minimize emissions in the most harmful industries. (Cerem, 2016)

For each industry specific BATs are elaborated and in the case of the ceramic industry the techniques to be applied are:

- Avoid excessive noise level, such as enclosing the noisiest machines and using soundproofing materials.
- Reduce energy consumption, such as cogeneration.
- Reduce the polluting gases emitted through the help of filters.
- Avoid emitting dust particles during material handling

➤ **Marketing**

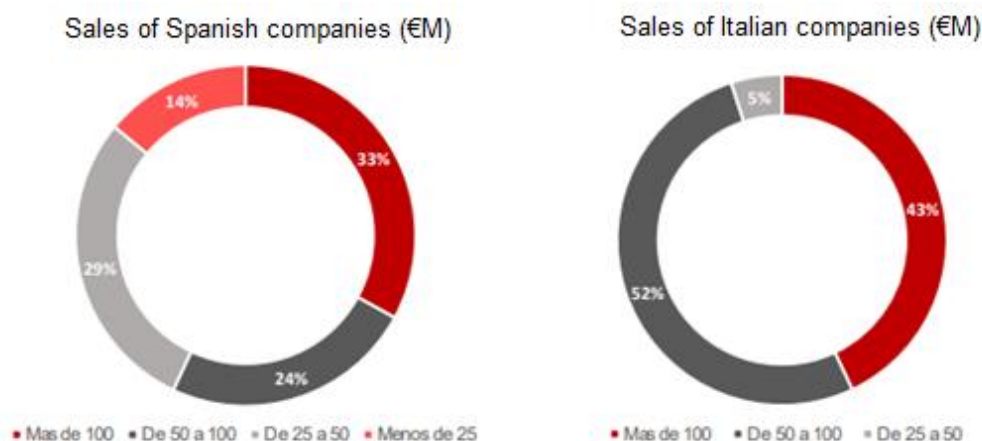
One of the biggest problems facing the Spanish ceramic product is the lack of marketing and know how to market it. Compared to our largest European competitor Italy, we remain at a disadvantage compared to them, which we can only solve by gaining size and concentration.

Spain and Italy have a similar share in exports, Italy also produces less ceramic tile than Spain, however, the Italian ceramic sector far exceeds the benefits to the Spanish sector. This is due to the fact that the average sale price of the Italian finished product is € 13.10 / m² compared to € 6.90 / m² of the Spanish product. The reason for the Italian success is the ability of its manufacturers to know how to market and bring greater value to the same product, through its famous model of selling fashion and design they turn the same product into an exclusive product. (Probuen, 2017)

The main cause of this lack of marketing is the smaller size of Spanish companies compared to Italian, so they are forced to compete on prices. Only 16 manufacturers have more than 250 employees, of which 6 groups have more than 500 employees. In production of square meters of ceramic tiles stands out the Pamesa Group and in sales and billing Porcelanosa Group.

According to the KPMG report of 2018, which compares the 21 leading Spanish and Italian ceramic companies, the average turnover of Italian ceramics is 129.5 million euros compared to 83.7 for Spanish ceramics. In addition, 43% of the 21 leading Spanish ceramic companies invoice less than 50 million euros while the Italian companies are only 5% of the total companies.

Figure 22. Spanish and Italian companies sales (€)



Source: Vargas, B. (2018) *El sector del azulejo en España*.

On the other hand, we must point out that 9 Italian ceramic companies have factories in other countries, while in Spain only Pamesa has a plant in Brazil and Roca in four countries. (Vargas, 2018)

This difference is due to the different competitive strategies that both countries have followed. Spanish ceramic companies have focused on competing in price and productive efficiency, in addition to producing a high quality product. While the Italian ceramic companies have followed a strategy of differentiation and exclusivity focused on sales and marketing in markets with high added value, under its brand *Made in Italy*.

In Europe, where nearly 50% of Spanish ceramic exports are concentrated, families live mainly in rented houses, which means that the owners carry out reforms in their homes to make their investment profitable, in a period of 15 to 20 years. In addition, new trends in the market, such as the disappearance of open and spacious bathtubs and kitchens, are helping to increase sales, but important marketing campaigns are needed to sell the product as a use in the rest of the house. (Probuen, 2017)

In conclusion, Spanish ceramic companies should improve the aspects related to the commercialization of the product so that the perception and exclusivity of all its products increase and thus increase the average price.

3.2 Threats

➤ Current economic and political situation

The Spanish ceramic sector suffered a slowdown in his sales in 2018 due to a series of factors and uncertainties existing both nationally and internationally. Among the main causes we can highlight the protectionist measures, the economic situation of certain countries that represent a large percentage of exports and Brexit. In addition, the year 2019 is expected to continue or even increase the uncertainty that will affect investments and consumption.

This decrease in ceramic activity is already affecting other activities related to the sector such as the production of inks, glazes, chips and even the transport of goods.

In addition, this economic situation is also causing the decrease in the arrival of capital and foreign investment, which has led to a wave of purchases and millions of sales in the last 2 years, such as the purchase of Keraben ceramic company located in Nules

(Castellón) by a British investment fund called Victoria. The purchase-sale took place in November 2017 and reached a whopping figure of 274 million euros. (Ribes, 2018)

Although we are witnessing a reduction in investments, it should be noted that the ceramic industry continues to be one of the most attractive sectors for foreign investors and that only in 2017 sales were closed for a value exceeding 1,000 million euros.

On the other hand, the ceramic sector has been protected from external difficulties thanks to the takeoff of the Spanish market, since the Spanish economy is improving and represents a large percentage of total sales volume. Above all, sales are increasing for the house rehabilitation market, not for new constructions.

But this Spanish economic recovery is not enough to reassure the sector, in which ASCER employers agree that they have to continue doing what the 2008 crisis taught them: control costs, train employees and constant innovation.

➤ **Brexit**

Commercial relations between the United Kingdom and Spain have always been characterized as good and mutually beneficial within the European Union, but these relations are currently influenced by the uncertainty of Brexit and its possible consequences. In 2016, Spain was the ninth country that most exported to United Kingdom and the eighth country to import products. Therefore, we can appreciate the magnitude of the relations and flows of products between both countries. In addition, Spain was the ninth country to receive investments from the United Kingdom.

This possible separation of the United Kingdom from the European Union, would affect the commercial relations and the economy of both parts. According to official sources of the British Government, the possible exit of the United Kingdom would cost between 4 and 6% of the GDP while for the European Union it would affect between 0,2-0,5% of the GDP according to statements of Pierre Moscovici, commissar responsible for economic and financial affairs of the European Union. (Matías, 2018)

Currently, the British economy, in terms of GDP, is the sixth largest economy in the world and the third in Europe, behind only France and Germany, which surpassed the United Kingdom in the last quarter of 2017. Its privileged position has largely won over its services sector, which represents 75% of its GDP, which highlights the banking sector and the finances located in the "City" of London. This banking sector, is the

As we can see, Catalonia and the Valencian Community are the autonomous communities that export the most to the United Kingdom and therefore would be the most affected in a possible separation. The main exports of the Valencian Community to the United Kingdom are, among others, cars, ceramic products and agricultural products, such as fruits and vegetables.

As for the ceramic sector, the United Kingdom is the third country that purchases more ceramic tiles and Spanish products only behind France and Germany. In 2017, the United Kingdom purchased ceramic products worth 168 million euros. (ASCER, 2017)

In the case that a hard Brexit is approved, different tariffs would be established for Spanish imports, among the most important we can highlight a tariff of 12% for the textile sector, 10% for vehicles and 5% for the Spanish ceramic sector. Therefore, it would be a serious blow, which would be added to the already increasing protectionist measures that other countries are taking with respect to the Spanish ceramic sector, especially in the Arab countries.. (EFE, 2019)

➤ **Protectionism**

The Spanish ceramic industry is currently facing different challenges, among them the escalation of protectionism and anti-dumping investigation in some countries such as the United States, China, the Persian Gulf (Arab Emirates, Kuwait, Qatar and Saudi Arabia)

Especially in the Persian Gulf an investigation was opened in 2018 against imports of ceramics from Spain, China and India.

Dumping is a measure practiced for the commercial defense of a country that is carried out when there is a suspicion that a foreign company sells the products at prices lower than those applied in their own country of origin. This practice aims to exercise a monopolistic position and penetrate the market in a faster and more competitive way.

Therefore the anti-dumping investigation against Spanish tile imports is a serious blow after the recession that has just passed.

We also have to take into account that only Saudi Arabia is the ninth largest customer in the world that acquires the largest volume of Spanish ceramic tiles and the main recipient of ceramics in the Persian Gulf. As a result of this research, exports to this country have dropped by 40% in the last year. Which translates into a sales decrease

of 92 million euros to about 57 million. In addition, this research is added to the increase in tariffs and barriers to the importation of the entrance of ceramic products due to the requests and the pressure exerted by the producers of the area, since the local companies that produce ceramics were seeing their sales decrease. (Ribes, 2018)

This decrease in sales volume has affected the Castellón cluster, which must adapt by reducing production and harming around 300 workers.

In conclusion, this is just a clear example of the boom that is being experienced worldwide protectionism on the ceramic sector but especially in Arab countries such as Algeria, Tunisia and Egypt that come to affect and hamper Spanish ceramic imports with almost 100 types of tariff and non-tariff barriers. Therefore, we must take into account future restrictions in countries where ceramic production is increasing considerably, such as China or India.

➤ **Emerging countries**

The fast industrialization of emerging countries or "BRICS" (Brazil, Russia, India, China and South Africa) makes them go from being consumers of products to manufacturers of products. Especially in China and India there is a rapid conversion of the working classes that have traditionally devoted themselves to agriculture to the manufacturing industry and the service sector. This situation, sooner or later always happens and could be clearly seen in the last Cevisama fair in 2018, where the president of the association Ascer, confirmed that the country that will most harm the Spanish ceramic industry in the future will not be China, but India.

This was reflected in the halls of the fair in which the Indian Prime Minister Narendra Modi wanted to position his country as a reference worldwide and turn the Asian country into an industrial power under the slogan "*Made in India*"

India went from position 142 to 100 between 2014 and 2017 in the world bank's ranking of facilities for doing business and reached position 40 in the global competitiveness index in 2017. In addition, it is the third country that has the most scientists and technicians by inhabitant and in 2018 the Indian government announced investments of 1.5 trillion dollars for the next 20 years dedicated to improving all the infrastructures of the country, such as railways, highways, ports, industrial corridors and smart cities. (Laguens, 2019)

India is the second largest producer of ceramic tiles worldwide, second only to China. Currently, 955 million square meters are produced per year and the ceramics industry has been growing at a constant rate of 7.5% in recent years. Almost all the manufacture of ceramic tiles is concentrated in the city of Morbi, in the province of Gujarat. We can divide the companies in the area into two large groups.

The first group consists of a few large companies with high production levels and a market share of 40%. In addition, in 2017 they invoiced more than 900 million euros. The second group consists of 600 small businesses approximately and that represent 60% of the market share and they invoice around 1,620 million euros per year. In total, the ceramic sector in Morbi creates some 600,000 direct and indirect jobs. (Laguens, 2019)

As for imports, India imported Spanish ceramic tiles worth 8.3 million euros, which represents a market share of 15%. This places Spain as the third country behind Italy and China in imported tiles. It should be noted that although the future prospects are favorable for export to the Asian country, Spain has been reducing exports to this country to the benefit of others. So in 2015, India was the 27th country as a destination for Spanish ceramic products, and two years later in 2017, it ranked 63rd.

Regarding tariffs, India has imposed a tariff of 30% on imports of European ceramic tiles. In the case of China, tariffs have been imposed between 30 and 69% of their value, which has caused that Chinese ceramic products have decreased by 87% between the 2011-2016 period. (Alonso, 2018)

Although imports of Indian ceramics to Europe are still very small, each year they are doubled and follow the same policy of low prices as China, which it was already sanctioned with tariffs ranging between 25 and 70% depending on the product and the company until November 2022.

In the case of China, the domestic consumption of the country represents approximately 60% of its economic growth and the Chinese government has applied important measures to stimulate the growth of the industrial sector and to achieve less dependency on the exterior, even with sectors such as the ceramic, where a few decades ago, they were mere consumers, now they triple the production of tiles in Spain.

China is the world leader in ceramic production, representing between 50% and 70% of the total volume of ceramic products sold in terms of art exhibition, construction and daily use. China can be defined as the largest producer in the world, but it is not a

powerful ceramic country, since its specialty is the production of medium and low-end ceramics, whose prices are much lower than the international market average. In addition, this price represents only a small fraction if we compare them with ceramic countries such as Spain and Italy.

In 2018, China produced 10.18 billion m² of ceramic tiles, while the value of exports of ceramic products as a whole was 21.1 billion USD. In addition, the exports have increased exponentially over the years especially in the area of the Middle East, which the construction industry has developed rapidly in recent years. For example, Saudi Arabia is the largest contracting country for projects in the Middle East, since to date it has invested 350 billion USD in the construction of large-scale projects.

On the other hand, the salary is increasing rapidly in China, being currently, 4 times higher than the average salary in India and may lose its advantage in terms of labor costs, but in terms of competitiveness, China has an indisputable advantage. Since the Chinese producers have access to a more complete and sophisticated industrial chain, in addition to infrastructures far superior to those of India, which allows them to reduce their costs and increase efficiency.

China also stands out in the production of equipment to be used in the ceramic industry. At present, Chinese companies export machinery and equipment to India in bulk, and they account for 80% of the Indian market.

With this, we can see how important and competitive India will become in the coming years, and together with China will become the main manufacturing center of the world and a challenge that must face the Spanish and international ceramics companies.

3.3 Strengths

➤ Dynamic economic activity

At present the province of Castellón has an employment rate lower than the national average. According to the INE the second quarter of 2018 left a positive balance in the labor market of Castellón since the number of unemployed descended to 2500 people and created around 5000 jobs. (INE, 2019)

With this increase in jobs the number of unemployed in 2018 in the province of Castellón was 43,000 persons , in other words, an 15.58% unemployment rate. Therefore, we can see how the province of Castellón is recovering favorably and has a dynamic economy. In addition, the province of Castellón has a large human capital and highly qualified people who can quickly cover new jobs, thanks in part to the Universitat Jaume I.

As regards the ceramic sector, it is suffering a slight slowdown due to the stabilization of the Spanish economy but it is still growing in exports. According to the report presented by the *Direcció Territorial de Comerç de la Comunitat* in January 2019, the ceramic sector exported 200 million euros worth only in November 2018, which represents a 1.8% increase in year-on-year rate compared to the previous year. In addition, Ascer tile employers announced that the ceramic sector will continue to grow in the coming years but more modestly than previous years. (Vicente, 2019)

The province of Castellón, it exported products worth 7,260 million euros while it imported goods worth 5,130 million euros. What leaves us a positive balance in the entire province of 2,130 million euros. So we can say that in the province of Castellón, there is a dynamic economic activity that is continuously in the process of transformation

➤ Geographical situation and Infrastructures

The ceramic industry of Castellón is located in a privileged position as it is located in an area where there is a large flow of goods, from the south of Spain to the north of Europe. In addition, this Mediterranean slope is well connected by both roads and ports.

Among the main roads and land accesses, we can highlight the AP-7 highway and the CV-10 road, these two routes are the most important in Spain and those that connect

the entire Mediterranean coast. In addition, there is also the N-340 road that connects several locations between them, without the need to take the highway, although at present it is very congested since its traffic has doubled in recent years.

In addition, almost 50% of the ceramic exports are destined for the European Union, therefore in the absence of a good railway infrastructure these roads are essential for the proper functioning of the logistics chain.

As for maritime ports, we can highlight the sea port of Castellón or "PortCastello" which is the fifth most important port in Spain in import and export traffic and it managed to be the fourth in movement of solid bulk in 2018. In addition, the tile sector represents 37% of the total merchandise traffic of this port. (Anónimo, 2019)

In 2018, *PortCastello* moved a total of 7.7 million tons of products linked to the ceramic sector, which represented an increase of 8.3% over the previous year. In addition, it has representatives that are present in the main ceramic fairs such as Cevisama, to present their latest developments and attract even more the merchandise traffic. Currently it moves around 850,000 tons of solid bulk.

As a novelty in 2019, PortCastelló will lower its rates by 10% on merchandise and 5% on that of the ship, thus placing it among Spanish ports with lower rates. (Anónimo, 2019)

In addition, in 2019 they began to improve rail connections with the port, so that an intermodal station will be built within the same port, which will increase efficiency and reduce costs and unnecessary traffic, since it can be loaded and download directly from the ship to the freight train and *vice versa*. In addition, they will also increase the supply of land for storage and logistics in the south dock, which once completed, the works will involve an additional 100,000 square meters available in concessions, in which tiles and other companies can be installed.

The new intermodal station will be ready in 2021 and will increase the traffic of both solid bulk and new merchandise.

Therefore, we can see how the port of Castellón is becoming competitive and attractive for the ceramic industry and how there are more and more companies that are betting to be located within the port or in its surroundings.

➤ **Accumulated experience**

One of the great strengths of the Spanish ceramic sector is the industrial experience that has accumulated over the years. From its beginnings at the end of the 19th century and the beginning of the 20th century, production was consolidated in Manises and Onda, where there were already training centers to date, a series of advances have been made in all fields: technological, in human resources, productivity, efficiency

In addition, an ecosystem and a series of entities and organizations have been created which they have helped to boost the growth of the ceramic sector. Among which we can highlight: ASCER, ANFFECC, ASEBEC, QUALICER, ATC, ALICER, QUALICER, CEVISAMA, ITC y la Universitat Jaume I.

Also, we find in human resources field, the existence of very qualified technicians thanks to the training that is taught in the *Escuela de Formación Profesional* (Specialty of Industrial Ceramics) and in the *Escuela de artes aplicadas* (Design of Ceramic coatings). In addition, the Jaume I University offers the title of Industrial Engineer and Chemist specializing in the ceramic industry.

➤ **Technological Institute of Ceramics or ITC**

One of the main entities whose mission is to support and strengthen the ceramic industry is the Technological Institute of Ceramics or ITC. It is a research center located in Castellón that responds to the needs and requirements of the ceramic companies of the Spanish cluster and is characterized by close collaboration between companies and universities. This research center helps especially small and medium-sized companies because they have the most difficulties to generate their own technology and create new products. So ITC's mission is to conduct research and take action in R & D.

ITC has more than 200 associated companies and develops around 100 R&D projects per year. It also has an area of 8,000m² for the development of its activities, has scientific equipment worth 9 million euros and has about 100 highly qualified professionals, of which 20% are professors of the *Universitat Jaume I* de Castellón. For example, in the year 2018 the ITC has developed a coating that is applied on the surface of ceramic tiles are able to clean by themselves only with environmental humidity and sunlight thanks to the creation of new materials formed by nano particles. This coating can be applied to any ceramic surface and reduce the cleaning tasks in addition to slowing the deterioration of the tiles. (ITC, 2019)

3.4 Opportunities

➤ Mediterranean Corridor

The Mediterranean corridor consists of a double high-speed railroad that starts from the Algeciras port and reaches the French border where it connects with the rest of Europe, thus uniting the most important cities of the Spanish Mediterranean coast such as Murcia, Málaga, Alicante, Valencia, Castellón and Barcelona. To carry out this project it is necessary to develop new technologies that allow trains to adapt to the different European rail gauges, which remain an obstacle to the free movement of goods by rail.

In Spain, only 5% of goods are transported by rail, compared to Germany and France, where 23% and 17%, respectively, of the total merchandise are transported by rail.

The Mediterranean corridor will join the great axis "FERRMED", which consists of an extensive railway network linking the major economic activity areas of the European Union, as well as ports and airports. Once this network is completed, it will connect northern Europe with the south through 3,500 kilometers of roads and will also connect 54% of the population as well as 66% of the continent's GDP, thus boosting the competitiveness of the Spanish industrial sector. (Pérez, 2018)

Figure 24. Situation of mediterranean corridor in 2018



Source: Trincado, B. (2018)

One of the great challenges for the construction of the corridor are the railway width systems. In the case of freight traffic from Spain to Europe, it has required the application of new technologies to solve the problem of width such as axle and wagon exchange systems, for which is necessary the construction of multiple strategically positioned facilities. So that to move from one network to another is necessary to change the platforms or axes which presents two problems: the change of axes is a slow process that takes between 10-15 minutes and also has a high cost since you need to hand of specialized work and installations in different strategic points. All this causes a considerable increase in the logistic cost. (Pérez, 2018)

The most promising system to date is the variable width, which allows the axles of the wagons to be adjusted automatically to the different rail widths. This adjustment is made at low speed and it is not necessary to stop the train.

The Mediterranean corridor will mean for the ceramic companies an increase in competitiveness and a saving of 30% in transport costs.

Among the main benefits of the corridor we can highlight:

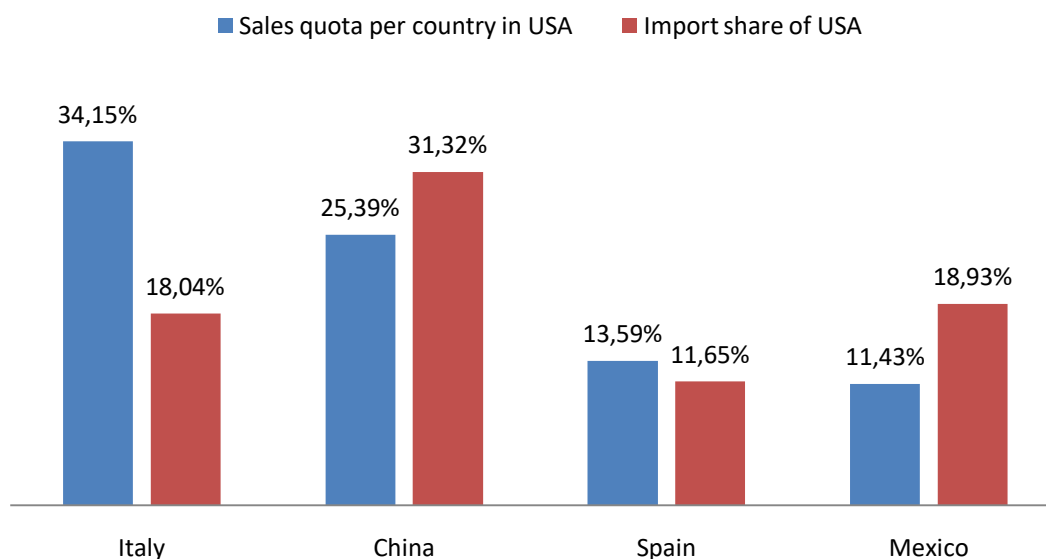
- Halve transport times between the main cities of the Mediterranean coast in addition to increasing the frequency of trains.
- Improve competitiveness. It will connect the ports and airports of the Mediterranean coast and its main industrial and logistics areas, creating employment opportunities along the entire route.
- The train is a much more energy efficient transport so it will reduce pollution and emissions from road traffic, in addition to decongesting roads.
- Increase international trade and exports to the interior of the European continent.

➤ **United States tariff to Chinese tile**

United States is a country that is clearly an importer in terms of the market for ceramic tiles, that is, its consumption is satisfied with almost 70% of imports. Only in the year 2017 imports reached 1,800 million dollars, which represents an increase of 4.5% over the previous year. The United States imports tiles mainly from 4 countries: Italy, Spain, China and Mexico. Only these 4 countries have a share of 84.56% of the US market.

In 2017, by sales volume we can classify Italy as the winner with 34.15% of the total, China in second place with 25.39%, Spain surpassed Mexico with 13.59% and finally Mexico with 11.43% of the share of sales value. Regarding the volume of imports, China leads the ranking with a share of 31.32%, Mexico in second place with 18.93%, Italy 18.04% and finally Spain with 11.65%. But it should be noted that of the 4 countries mentioned above, Spain is the country that has registered the highest growth in the volume of imports, exactly 32.9% more, compared to 2016. (ICEX, 2018)

Figure 25. Sales and Imports share per country in USA



Source: Compiled from data by ICEX (2018)

We must also mention the segmentation of the tile market that exists in the United States, since Spain and Italy occupy the upper segment, while China and Mexico occupy the medium-low segment.

On the other hand, the United States has always been one of the main destinations for Spanish exports, since it is a country with a large market size and high purchasing power. In 2017 it became the second destination country for Spanish ceramic tiles just behind France. During the period from 2013 to 2017, Spain is the country that most grew its exports to the United States in terms of volume, exactly 32.9% while the average for the rest of the countries was 5.6%. (ICEX, 2018)

The American country is also the largest importer of ceramic coverings and pavements in the world. In addition, it has penetrated the format of large tiles in which European manufacturers are leaders.

In addition, the Chinese ceramic companies are paying tariffs of 10% to export their products to the North American country but from January of 2019 it has been increased to 25%, which is a hard blow for the Asian manufacturers that dominate especially the west coast, by proximity. On the other hand European companies are well positioned on this side, and will benefit from these circumstances to gain market share and increase their presence on the west coast.

All these factors have helped Spain to recover market share in recent years as well as increasing the perception of the value of the exported product..

➤ **Industrial Revolution 4.0**

The fourth industrial evolution or industry 4.0 is the name that the community of scientists and engineers has given to the implementation of technology and digitization of production, manufacturing and supply chains through artificial intelligence, Big Data, virtual reality and the internet of things. In this way, it is achieved that the machines communicate with each other and with people, in order to achieve a greater optimization of production processes, reduce costs, improve the quality of the final product and improve communication between producers and final consumers, which results in greater customization to the specific needs of each client.

The ceramic sector is making great efforts to adapt to this new digital era, for which the TECEM project was created in 2014. This project is being jointly developed by the Technological Institute of Energy (ITE) and the Technological Institute of Ceramics (ITC). Among its main objective is to improve the energy efficiency of all the productive processes of the ceramic industry with the help of renewable energies. In 2019, we can say that TECEM has successfully implemented new energy analysis and optimization technologies in the ceramic tile manufacturing processes while respecting the environment. In particular, it has been possible to develop membranes that are installed in the chimneys of the factories and capture the CO₂ which they emit, transforming it later into electricity, which has optimized the use of energy resources and reduce energy losses. (ITE, 2019)

At present, the ceramic sector uses almost 30% of the electricity generated in the Valencian Community, given that it is a very intensive industry in the consumption of electricity, these small advances along with others, represent a very significant savings in energy savings and therefore a decrease in the environmental impact.

Another example of industrial revolution 4.0 are smart warehouses. These warehouses consist of several trans-elevators, conveyor belts and robotic arms that allow to increase the efficiency and productivity of the merchandise storage process. The clearest example of the implementation of smart warehouses in ceramics companies can be seen in the Porcelanosa group, where it has been betting for this system for several years.

This automatic system is composed of stacker cranes for pallets that automatically carry out the entry and exit of goods, while the reception, dispatch and picking are carried out with the help of a complete circuit of conveyors and shuttles. With this type of system, the Porcelanosa group has been able to achieve the desired performance

and efficiency in each and every one of its centers, as well as provide an agile and efficient service.

The last warehouse that has been built in the Porcelanosa group is the one in Venis, which measures 35 meters high and occupies more than 25,000 m², although to date only 8,000 m² have been occupied, leaving the rest ready for future extensions. Therefore it consists of 10 aisles of 23 floors with shelves of simple depth on both sides and through the center circulates the stacker crane which regenerates 15% of the energy when it descends. In total it has a capacity of 65,320 pallets, which implies double the capacity of a conventional warehouse.

So we can summarize the benefits of Industry 4.0 in:

- ✓ Decrease in costs in production processes
- ✓ Optimization of tasks and greater efficiency
- ✓ Substitution of the man by the machine
- ✓ Automation of processes
- ✓ Remote tracking
- ✓ Demand for new professional profiles
- ✓ Greater customization to the needs of each client
- ✓ Decrease in energy consumption

➤ **New market niches**

Before we talked about how emerging countries like China and India are a threat to our sector, but they can also be a great opportunity if we learn to manage it. Currently, both countries are the most populated on the planet, China has 1.389 million inhabitants and India 1.329 million are also industrializing and urbanizing rapidly, so the increase of the middle class is exponential.

Focusing on China, in 2018, it had 69 million households that belonged to the middle class and 53 million middle-upper class families. The Chinese government is making great efforts to improve the quality of life of its inhabitants and each year is adding 40 million more people to the middle class. So we can appreciate the magnitude and potential of the Asian market that is no longer seen only as a place with cheap labor but also a market of opportunities for the sale of products. (Veral, 2019)

Currently, 70% of the luxury products bought in China are acquired from abroad, so China is becoming a market for the sale of high quality and luxury products in which tastes are also being refined and in the which appear more and more consumers who see European products and design as a status symbol.

Therefore, in the coming years new potential markets will emerge, mainly those that make up the *BRIC* (Brazil, Russia, China and India), so knowing how to manage the Spain brand will be essential to penetrate these markets in a successful way status symbol.

IV CHAPTER: CONCLUSIONS

This study has been based on the evolution over the last years of the ceramic sector, which has allowed us to have a global vision of the trends of the sector and the challenges that it will have to face in the future. In addition, since the crisis of 2008, the ceramic industry has had to face many challenges such as adjusting its profitability, becoming more efficient and adapting in prices and quality to compete in a much more demanding market.

As we have seen in this study, the ceramic sector has been able to face the challenges that have been presented in previous years and has also been able to increase sales and profitability. However, the increase in the presence of large multinational groups, globalization, the digital economy, innovation and specialization, talent management, productive efficiency, among other factors, show an environment in which the ceramic industry should anticipate to very competitive scenarios. To face these new scenarios, companies must continue with mergers and acquisitions as well as increase collaboration between companies that will allow them to achieve a sufficient size to make the leap to the international market with guarantees and be able to compete with large multinationals.

In addition, Spain is in an intermediate place in terms of price / quality. The most important characteristics of the Spanish ceramic industry are its great production capacity, being the first European producer, the second European exporter and the third largest exporter in the world, as a result of the efforts in the development of its products. However, the current price of ceramic products is lower than in the past and it takes marketing effort to increase the price of the final product and be a reference in quality by promoting *Made In Spain*.

On the other hand, Italy is the ceramic industry that is in the first position in the quality / price segment. It has the recognition of being the first country to obtain a higher global income in reference to tile sales due to its differentiation strategy, the second European producer behind Spain, the first European exporter and the second largest exporter in the world .

In reference to China which is the emerging country with more power, is in the low price segment but it must be taken into account that it is the leader in export, manufacturing, production and consumption. The big problem that arises is the low added value that the ceramic tiles have and, as a result, they get a low price, it is the consequence of the imitation and the use of low cost materials as commercial

strategies. The lack of innovation and creativity as a business model is also an integrated feature in the Asian country. Its main advantage is its labor market with low wages and long hours of work, which allows companies to obtain greater profitability. Although at present, workers demand higher wages and labor improvements that could destabilize the current economic model.

In addition, the ceramic sector must increase its efforts in innovation, digital transformation and industry 4.0. These technologies will allow them to open new channels with customers and gain competitiveness and profitability. For example, Inkjet technology has allowed an increase in environmental efficiency and the ability to perform endless finishes and creative possibilities. These printers inject an exact amount of ink on the ceramic surfaces and also allows to reproduce reliefs without the need for molds. In addition, with this technology it is not necessary to mix the inks separately so that it reduces the consumption of raw materials, electricity and water.

In conclusion, the ceramics sector faces great challenges as we have just mentioned, such as the labor framework, the ease of doing business and the legislation for which it will need the support of public entities, but it will also have to face other external challenges as the rapid globalization and industrialization of large economies and emerging countries, such as China, which we can only cope with betting on quality, innovation and marketing.

Regarding the limitations we have had in developing this work, we must consider that it has been based on a study of secondary sources, such as web pages of official entities or consulting reports. So it has been difficult to find internal information of the different companies that make up the ceramic industrial district of Castellón. In addition, we consider interesting for future research to perform an analysis of two or more companies such as Pamesa or Porcelanosa through internal interviews, which stand out as success stories for their study.

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