UNIVERSITAT JAUME·I

CURRENT AND FUTURE CHALLENGES OF CERAMIC TILE FIRMS

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INTRODUCTION

In today's business landscape, competition is becoming more intense and dynamic, driving companies to adapt and manage change through innovation and the adoption of new technologies. These two aspects have become fundamental not only in the present, but also in the future of numerous sectors, including the ceramic sector in Spain. Aware of their relevance worldwide, companies in this industry strive to reinvent themselves and maintain constant growth, seeking the development of improved products and services and increasing their competitiveness in the global market.

That is why I decided to choose the topic of "Current and future challenges of ceramic tile firms" focusing on clusters and radical innovation, it already seems to me a very important topic not only now, but also for the future with many points to address. In the first points we will find the theoretical framework in which the cluster in general and all the factors that affect it will be exposed, to later focus on the ceramic cluster.

In this work we will not only focus on the ceramic cluster of Castellón, but we will also carry out an investigation on the other two most relevant clusters worldwide, from China and Italy. To later compare them and make a table with their similarities and differences. Although yes, we will focus more on the Castellón cluster in terms of employment and innovation, since I was born in Castellón de la Plana, part of my family is dedicated to this sector, and for this reason I find it much more interesting, apart from that I have much more information than the regions of the clusters of the other countries.

Then we will find the third part of the work that deals with innovation, focusing on radical innovation where we will find digital printing that was presented for the first time in the 2000s by the Kerajet company at Cevisama. I found it very interesting to focus on this type of innovation because apart from the fact that it was presented by a company from Castellón, it is a technological element that, as we will see in this chapter, has revolutionized the ceramic sector, providing greater differentiation and cost reduction.

Finally, carry out a survey of the Azteca company, which belongs to the ceramic cluster of Castellón to go further and find out how digital printing has affected companies first-hand. And finally we will make the final conclusions and the references.

1. CLUSTER

First of all we will introduce the definition of "cluster" since through this theoretical element we will be able to explain the most important ceramic clusters worldwide, focusing more on Spanish and the advances in innovation that have occurred, due to these geographical concentrations. of companies.

Cluster theory refers to a geographic concentration of companies that are interconnected with specialized providers, educational and research institutions, and other related entities in a specific sector or industry. The cluster provides competitive advantages through collaboration between companies in the same sector, competition, joint learning and improvement of the value chain. Furthermore, clusters can boost regional competitiveness and economic development.

1.1 Definition

This definition of the word "cluster" was created by Michael E. Porter, and to better explain this concept we will resort to the definition established by Porter (1990) in the book *The Competitive Advantage of Nations* :

Geographical concentrations of interconnected companies and institutions that belong to a certain field of activity. These clusters cover a wide range of interrelated sectors and other entities important for competitiveness. They include specialized suppliers of components, machinery, services and infrastructure.

In addition Porter argues that geographic proximity allows for a more fluid exchange of knowledge, skills and resources, which drives innovation and continuous improvement.

There is also greater integration and collaboration in the value chain of a sector or industry, since companies can specialize in different stages of the production process and take advantage of synergies among themselves to improve the efficiency and quality of products or services.

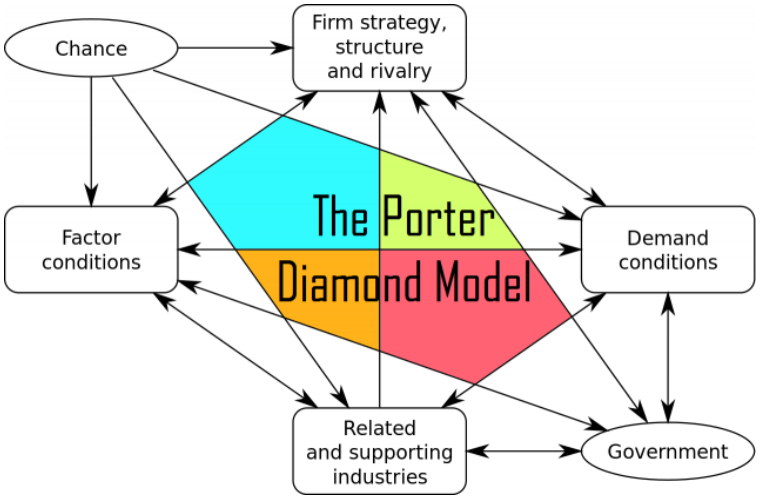
Finally, clusters not only benefit individual companies, but also the regions in which they are located. The most important clusters worldwide can generate employment, attract investment, promote economic development and improve the quality of life in the region.

1.2 Components

After the cluster definition, we analyze the components using "Porter's diamond". Porter's Diamond model is a tool used to analyze the fundamental elements that

determine the competitiveness of an industry in a national economy. According to Porter's theory, the competitiveness of an industry is based on four interconnected elements, which will be explained in more detail: "factor conditions", "strategy, structure and rivalry", "demand conditions" and "industries related and support".

Figure 1: Porter's five diamond competitive forces.



Source: CEUPE (2022)

- **Demand conditions**

The existence of more demanding consumer groups encourages companies to invest in research and development (R&D), leading their strategy towards differentiation. Consumer demands depend on local and national circumstances, distribution channels and factor conditions. Consumers require products and services for political, social, governmental, and other factors. National demand is segmented into various industries, where some areas are more important than others.

The size of local demand can depend on economies of scale and investment in R&D, and having a higher demand does not necessarily favor internationalization. However, a greater number of independent buyers and growth driven by technological advances are positive aspects. This fosters competitiveness and anticipation of competitors in other markets. Buyers can be locals traveling to other countries or multinationals with subsidiaries. During the internationalization process, it is crucial to achieve advances in research and science, based on cultural aspects and establishing collaborative alliances.

- **Factor Conditions**

Companies strive to achieve competitiveness through innovation and exploration of new markets, thus avoiding rivalry problems. Regarding the availability of factors, infrastructures and a wide range of resources, such as physical, human, capital and knowledge, play a crucial role for growth in the industry. These factors can be basic, such as weather, or general, such as roads, and they can also be advanced, such as university education, or specialized, such as specific training of the workforce.

Depending on the factor conditions, challenges may arise such as inefficient exploitation due to excessive use of resources, or innovation that does not generate profitability at certain times.

- **Auxiliary and related industries**

On the one hand, supplier industries offer competitive advantages due to quick access to efficient inputs, benefits in terms of improvement and innovation, and interest in local suppliers that are global competitors compared to foreign ones.
It is also important to name the competitive advantages of related industries. These companies coordinate and support activities and demands for complementary products and services that depend on the related products. In addition, opportunities arise to exchange information, professionals and create synergies with other industries.

- **Business strategy, structure and rivalry**

All business systems have advantages and disadvantages. Therefore, experience and knowledge are relevant, since they can influence aspects such as norms, authority and relationships between people. The goals set by companies are influenced by the business structure, motivation and culture of employees. Rewards, job relationships, training, and risks taken are also important considerations.

- **The role of governments**

The actions of governments can have a significant impact on the various factors of business development, either benefiting or harming them. Although governments are secondary actors in relation to factor and monetary markets, they have the ability to

impose regulations and establish policies to prevent monopoly and avoid unfair competition, among other aspects.

The different elements of Porter's diamond model are interconnected and depend on each other. Therefore, each of them plays a crucial role in shaping the business environment. In addition, chance also plays an important role, since unforeseen circumstances such as inventions, exchange rate fluctuations, pandemics or wars can influence the direction that business development factors take.

1.3 Cluster types

Below we are going to explain two examples of Valencian clusters, which cover a large part of the Spanish economy, especially that of the Valencian Community. And later we will explain in greater detail the ceramic cluster that is the object of study in this work and with which we are going to develop part of this work.

First of all we find the footwear **cluster** in **Alicante** which is widely recognized and one of the most important nationally and internationally. The Alicante region, as well as its surrounding regions, has earned a reputation as one of the main centers of footwear production in Spain, with a long tradition of producing high-quality footwear. The Alicante footwear cluster is characterized by a geographical concentration of companies that cover all stages of the footwear production process, from design and fit to production, finishing and marketing. This geographical proximity favors cooperation, the exchange of knowledge and creates synergies between companies, enhancing the competitiveness of the entire cluster. One of the most outstanding strengths of the footwear cluster in Alicante is its ability to offer a wide range of products ranging from casual clothing and footwear to sports, fashion and specialty footwear. The companies in the cluster are distinguished by their emphasis on quality, craftsmanship and attention to detail, the use of high-quality materials, and the application of traditional and modern production techniques. Internationalization is another important aspect of the footwear cluster in Alicante. The companies in the cluster export most of their products to different markets, both in Europe and in the rest of the world. The reputation for quality, design and versatility of footwear made in Alicante has contributed greatly to its success in the international market. In addition, the footwear cluster in Alicante is characterized by its ability to adapt to market trends and needs. The division's companies maintain close collaboration with designers, stylists and fashion professionals, enabling them to offer up-to-date and attractive products to consumers. Technological innovation plays a fundamental role in the cluster, with

companies adopting new technologies and production processes to improve the efficiency and quality of their products. Cooperation and cooperation between the companies in the cluster is promoted through associations and organizations specialized in the footwear sector in Alicante. These entities provide support services, such as training, technical advice, international promotion, and participation in industry fairs and events.

In short, the Alicante footwear group stands out for its tradition, quality, product variety and desire for internationalization. Cooperation between companies, technological innovation and adaptation to market trends are the main factors that contribute to its success and strengthen its position as one of the main footwear clusters in Spain.

And on the other hand, **textile cluster** of **Alcoy**, located in the province of Alicante, is recognized as the leading textile production and manufacturing center in the Valencian Community, Spain. With a tradition rooted in the textile industry, Alcoy has established itself as one of the great textile poles in the region. The strength of the Alcoi textile cluster lies in the geographical concentration of companies specialized in the different stages of the textile production process, from the production of fabrics to the manufacture and finishing of textile products. This geographical proximity favors cooperation, the exchange of knowledge and creates synergies between companies, which enhances their competitiveness in the market. The companies in the Alcoy textile cluster stand out for their attention to quality and production. They have built a solid reputation by producing high-quality fabrics, using first-class materials, and applying both traditional and modern manufacturing techniques. Craftsmanship and thoroughness are fundamental values in the production of Alcoy's textile products. The cluster is constantly adapting to market trends and needs. Textile companies in the region work closely with designers and fashion professionals to develop innovative and appealing products for the consumer. In addition, the integration of advanced technologies in the production process has improved the efficiency and competitiveness of the cluster. Cooperation between companies in the textile sector of Alcoy is promoted through associations and organizations specialized in the textile sector. These entities provide support services, such as technical advice, training, international promotion, and participation in industry fairs and events. This alliance between companies promotes the exchange of knowledge and creates synergies that benefit the entire textile industry in the region. The Alcoy textile cluster has been recognized nationally and internationally, exporting its products to different markets. The quality, design and versatility of the textiles produced in Alcoi have contributed to

its success in the international market, consolidating the cluster as a benchmark in the textile industry.

In summary, the Alcoy textile cluster stands out for its commitment to quality, know-how and adaptability to market trends. Cooperation between companies, the combination of advanced technologies and institutional support are key factors in its success and consolidation as an important textile cluster in the region.

Subsequently, as has been commented, we proceed to explain the ceramic cluster in much more detail and the places where the most important ones are found.

2. CERAMIC CLUSTER

The term "ceramic cluster" refers to a geographic concentration of companies, suppliers, and related entities engaged in the production, manufacturing, and marketing of ceramic products. In this case, the cluster focuses specifically on the ceramic industry.

Ceramic companies and related organizations cluster in a certain region or geographic area, which allows them to take advantage of synergies, collaborate, and share resources and information more efficiently. This may include suppliers of raw materials, manufacturers of specialized machinery, design companies, research and development centers, educational institutions, and government organizations.

The ceramic cluster promotes the competitiveness of the companies involved by facilitating interaction and the exchange of technical knowledge, best practices, innovations and advances in the ceramic industry. In addition, it can favor the development of specialized skills, promote research and development of new technologies, and improve the ability to respond to market demands and trends.

A successful ceramic cluster can generate a series of benefits, such as shared access to infrastructure and specialized services, collaboration in the supply chain, the establishment of quality standards, joint promotion and the attraction of investments and clients.

In summary, a ceramic cluster is a geographical grouping of companies and related entities that operate in the ceramic industry. These clusters promote collaboration, efficiency and competitiveness in the production and marketing of ceramic products.

2.1 Types of products manufactured

The ceramic product is the tile. These products are flat, thin pieces made from clay, silica, and similar raw materials. They are used for paving floors and as facade and

wall coverings. They are waterproof and the support is made of red or white terracotta that is later covered with enamel (ASCER, 2022).

Today, ceramic tiles are used in many different spaces, whether indoors or outdoors, public or private. The choice of ceramic will depend on the specific use and location, whether in the bedroom of a house or on the sidewalk in urban areas. Ceramic products are very diverse and are used both in architecture and decoration. Due to the wide variety of properties and requirements they can have, we will use two classifications that summarize the most common types of large-scale ceramic products. These classifications are based on the manufacturing process and the commercial classification.

We will start with the classification according to the manufacturing process, where we can differentiate:

- According to the raw materials

White paste: It is composed of clay without dyes and acquires gray tones after firing.

Red paste: Contains coloring oxide and magnesium oxide, which gives it colors such as brown, yellow or red.

Porosity: This texture occurs when there is presence of clay carbonates.

- According to modeling

Extrusion: The paste in its plastic state is passed through an extruder that molds it into sheets. Subsequently, it is cut and perforated according to the desired size.

Dry pressed: The mass is turned into a powder and, with a moisture content between 5% and 7%, it is compacted using a hydraulic press.

- According to cooking

Cooking: Ceramic materials only undergo a firing process.

Double cooking: Ceramic materials are fired once for the support and then again for the glaze and decoration.

Third firing: Sometimes additional firing is done after glazing to reduce moisture, usually at low temperatures.

- According to the enamel

Enameled: After firing, one or several layers of enamel are applied to the piece, giving it shine and a more aesthetic appearance.

Without enameling: Firing is carried out only once, without applying glaze.

- **According to mechanical treatments**

Rectified: After firing, the edges of the tiles are ground to achieve greater precision and adjust their size.

Polished: Abrasion process that provides shine to the piece.

- According to the destination

Flooring: They are used to cover the ground, so they must be resistant.

Coating: They are used to cover walls.

Facades: Designed for outdoor spaces, they must be resistant to changes in temperature and maintain their texture and shine.

special ceramics: Pieces with a specific aspect used in decoration in a certain area.

These classifications allow ceramic tiles to be differentiated according to their characteristics and applications, providing a better understanding of the diversity of products available on the market.

And on the other hand, we are going to examine the second classification, which refers to the commercial classification of ceramic tiles. To this end, we have developed a table (Table 1) that provides an overview of the various types of ceramic tiles.

Table 1: Commercial classification of ceramic tiles.

Tipo de baldosa	Soporte	Moldeo	Medidas usuales (cm)	'Espesor (mm)	Esmalte
1. Azulejos	Poroso	Prensado	10x10 a 45x60	<10	Si
2. Pavimentos de gres	No Poroso	Prensado	10x10 a 60x60	>8	Si
3. Gres porcelánico	No Poroso	Prensado	15 x 15 a 60 x 60	>8	No
4. Baldosín catalán	Poroso	Extrudido	13 x 13 a 24 x 40	<8	No
5. Gres rústico	No Poroso	Extrudido	11.5 x 11.5 a 37 x 37	>10	No-Si
6. Barro cocido	Poroso	Extrudido	Gran Variedad	>10	No

Source: ASCER

In summary, the ceramic industry in Spain is one of the most outstanding sectors at a national level and also competes at a global level. Over the years, this industry has improved and innovated its processes and products, with the aim of providing customers with a wide variety of products and services of the highest quality. Taking

this general perspective into account, we will now focus on the ceramic cluster of Castellón

2.2 Ceramic Cluster of Castellón

The Castellón ceramic cluster stands out for its experience, innovation and quality in the production of ceramic products. Cooperation between companies, investment in technology and international orientation are key factors in the success of this cluster, positioning it as a benchmark in the ceramic industry at a national and international level.

2.2.1 Geographic location

The province of Castellón is located on the east coast of the Valencian Community, in Spain, with a privileged location next to the Mediterranean Sea. The province has high-quality ports nearby, providing easy access to markets in Africa, Asia, Europe, and North Africa and the Middle East. In addition, the mild climate of Castellón allows ceramic production throughout the year, guaranteeing a constant supply of products.

Specifically, the ceramic cluster of Castellón is mainly concentrated in the regions of Alto Maestrazgo (Castellón), Bajo Maestrazgo (Villarreal, Nules and Onda) and Alcalatén (Onda), as can be seen in Figure 2. These geographical areas are recognized for their activity in the ceramic industry and are home to numerous companies and factories related to the production and manufacture of ceramic products.

Figure 2: Location of the ceramic cluster of Castellón

Source: ASCER

2.2.2 Cluster history

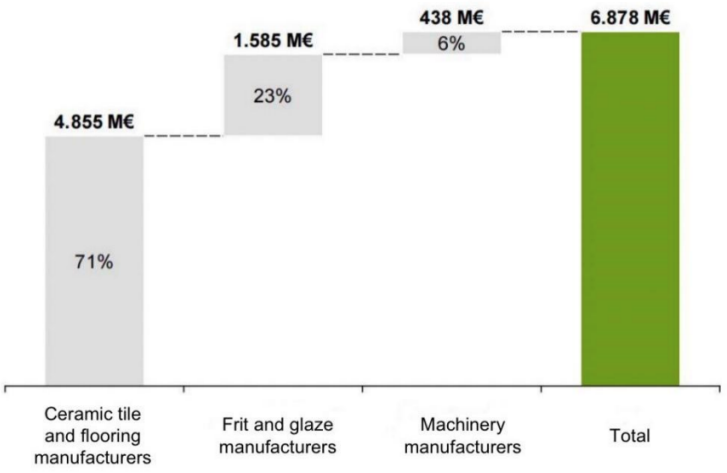
Ceramic production in Castellón has a long history dating back to Roman times. They took advantage of the local clay mines to establish pottery workshops in the area. During the Middle Ages, Moorish influences added to this tradition, creating a distinctive style of pottery. At the beginning of the 18th century, the manufacture of wall tiles in the Castellón region was essentially a family industry, characterized by its simplicity and functionality. However, at the end of this century, with the development of the construction industry and the promotion of ceramics as a durable and decorative material, the demand has increased significantly. This paved the way for the industrialization of the ceramic industry in Castellón. The combination of the region's rich natural resources and the skills of its artisans laid the foundation for it to become a major global industry in the centuries that followed. In the 19th century, with the advent of the Industrial Revolution, mechanized production began to make its way into the ceramic tile industry, resulting in a dramatic increase in scale and production. The construction of railways in the region and its proximity to the ports have allowed ceramics to become a product that is transported and marketed nationally and even internationally. In the early 20th century, improvements in technology and industrial processes increased the region's manufacturing capacity. The post-war construction boom increased domestic and international demand for ceramic tiles, prompting many companies in the region to export their products on a large scale. Over time, the Castellón ceramic cluster has become one of the most important in the world ceramic industry. As awareness of environmental issues grows, the Castellón ceramic industry is also prioritizing sustainability and implementing more environmentally friendly practices, such as the use of recycled materials and the reduction of waste, energy consumption. Today, the ceramic products of Castellón are diverse, specialized and mature. It has nearly 400 ceramic companies (ASCER, 2023) that provide comprehensive services at all stages of the process, from production to distribution, through design, marketing, and technical support. In a few words, the history of the Castellón ceramic cluster dates back to Roman times and has grown over the centuries to become the leading ceramic industry at a national and international level, with a commitment to sustainability and innovation.

2.2.3 Evolution of the cluster

The Spanish ceramic industry is distinguished by its dynamism and innovation, placing itself at the forefront nationally and internationally in terms of technological development, design and quality of service. In the Valencian Community, and

especially in the province of Castellón, the production of ceramic tiles plays an influential role in the economy, representing 19.7% of the industrial GDP of the Valencian Community and more than 23% of the total GDP of the Community. Valencian. aware. This ceramic cluster not only stimulates local economic development, but also has a significant impact on employment. Specifically, it represents 14.3% of industrial employment in the Valencian Community and 21.2% of total employment in the Province of Castellón. The ceramic cluster of Castellón is mainly made up of manufacturers of ceramic tiles and wall tiles, manufacturers of masses and glazes and manufacturers of machinery. In 2021, the cluster registered sales of 6,878 million euros, 31.1% more than in the last five years and 25.6% more than in 2019. The ceramic tile and flooring manufacturers segment was the most important , with 71% of total revenue. revenue, followed by manufacturers of enamels and frits with 23% and manufacturers of machinery with 6%. This can be seen in Figure 3.

Figure 3: Composition of the total sales of the ceramic cluster (M€)

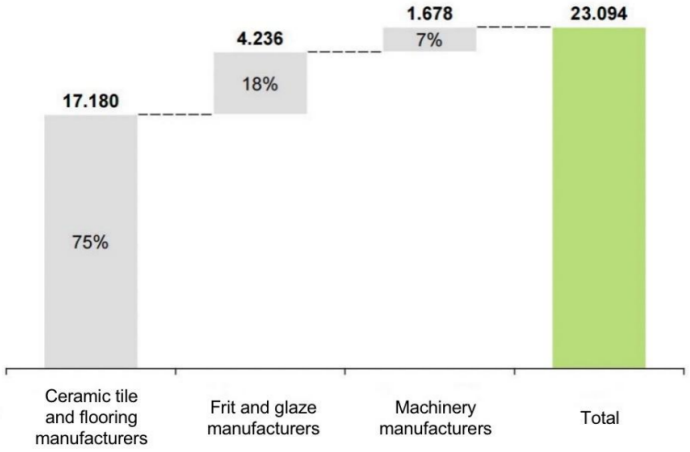


Source: ASCER

Internationalization is an important characteristic of the companies in the ceramic cluster of Castellón, demonstrating a strong export orientation. In 2022, Castellón will account for almost 75% of the total exports of ceramic tiles from Spain, worth some 3,000 million euros. In addition, the production of ceramic tiles in the region represents 97% of the total national production and 83% of the companies specialized in the production of ceramic tiles are located in this region. This cluster generates more than 20,000 direct jobs and many indirect ones (ASCER, 2022). In addition, in 2021, the Castellón ceramic cluster employed 23,094 people, 9.2% more than in 2019. And as

we can see in Figure X, ceramic tile and flooring manufacturers are the main employers in the cluster, with a 75% of the total, followed by machinery manufacturers with 7% and manufacturers of frits and enamels with 18%.

Figure 4 : Composition of total employment in the ceramic sector 2021



Source: ASCER

2.2.4 Cluster characteristics

The geographical concentration of the Castellón cluster in the Valencian Community gives rise to better coordination and collaboration between the different parts of the cluster, such as manufacturers, suppliers and design studios. It also promotes interdependence between the companies in the cluster in the different stages of the ceramic production process. There is a closer relationship between the different companies and organizations in the cluster. As for vertical integration, many of the large companies in the Castellón ceramic cluster are involved in various stages of the production process. From the extraction and processing of raw materials to the design, manufacture and distribution of the final ceramic products. However, there are also specialized companies that focus on specific areas, such as the design and manufacture of specific types of tiles or the supply of specific materials and equipment. The companies of the ceramic industry of Castellón distribute their products all over the world. They have established a distribution network that covers customers around the world, including key markets in the European Union, the United States, the Middle East and Asia. Although ceramics is the main product of the Castellón cluster, the structure of the industry allows for the production of a wide variety of ceramic products, such as sanitaryware, tableware, and other related products. This diversity allows the cluster to serve a wide range of market and customer needs.

2.2.5 Advantages and disadvantages

In terms of advantages, the Castellón ceramic cluster is recognized worldwide for its innovative approach and design orientation, giving it a significant advantage in terms of ceramic tile technology and innovation. Firms in the cluster adjust their production strategies and product types based on changes in consumer demand. Especially in the early phase of the industry, these companies have state-of-the-art technologies in enamel design and glazing techniques. Through continuous innovation in raw materials and glazing technologies, these companies drive product improvement and increase the competitiveness of both individual companies and the cluster as a whole.

Regarding the supply of raw materials and high-quality glazing technologies worldwide, the ceramic cluster of Castellón practically has a monopoly. Currently, the Castellón ceramic cluster is a mature industrial cluster that integrates the supply of raw materials, product research and development, technological training and product distribution at a national and international level.

However, there are also disadvantages, since the current increase in energy prices in Europe poses a significant challenge for the ceramic companies in the cluster. The total energy costs of our industry, including natural gas and electricity, have increased from €900 million in 2022 to €3 billion in 2023, and we have experienced a decline in production levels. Currently, many ovens are out of production and many jobs have been lost, in addition to employees temporarily laid off through the Spanish ERTE redundancy fund mechanism.
Second, ceramic tile production generally requires four raw materials: feldspar, clay, kaolin, and zirconium silicate. Ukraine is the main supplier of clay, supplying most of the clays used. However, due to the conflict between Russia and Ukraine, the ceramic tile companies in the cluster had to find new suppliers of clay. Rising prices for energy and production raw materials will increase production costs for ceramic tile companies, which represents a significant challenge, especially for those with lower profit margins.

2.3 Foshan Ceramic Cluster (Guangdong)

Foshan Ceramic Industry Cluster is located in Foshan City, Guangdong Province, China. It is recognized worldwide for its outstanding raw materials, its complete supply chain and its advanced production technology. The cluster brings together a large

number of ceramic companies specializing in various fields, ranging from ceramic tile production to bathroom fittings and ceramic decoration.

2.3.1 Geographic location

Foshan Ceramic Industry Cluster is located in Foshan City, Guangdong Province. The main ceramic tile business is concentrated in Foshan's Chancheng District. This strategic location near the Pearl River Delta in southern China and the Hong Kong and Macao regions is recognized as a highly dynamic manufacturing and economic area in China.

Figure 5: Location of the Foshan Ceramic Cluster

Source: ICEX

It also benefits from its proximity to major seaports such as Guangzhou and Shenzhen, which facilitates a strong supply chain for raw materials and finished goods. This logistical advantage obtained by its geographical location favors access to resources and exports to national and international markets, which greatly contributes to the growth and expansion of the ceramic tile industry in this area.

2.3.2 Cluster history

The development of the ceramic industry in the Foshan region began in the 7th and 13th centuries, during the Tang and Song dynasties. During the 14th and 19th centuries, Foshan became one of the main ceramic production bases in China. However, due to the influence of the war, the ceramic industry experienced a period of gradual decline in the later period, with the establishment of the People's Republic of China, the ceramic industry in Foshan began to recover. In that decade, ceramic

production was mainly focused on red bricks, ceramic tiles, and sanitary ware. At that time, most of the companies were small-scale and used traditional production methods and techniques, however, a few years later, Guangdong Fotao Group led the introduction of advanced technologies by establishing the first automatic tile production line. Color glazed from Italy. Later, a modern sanitary ware production line was introduced from Germany, marking the beginning of the transition of China's ceramic industry to more modern production methods. The ceramic tile industry in China Foshan has had rapid development. Companies have begun to upgrade and modernize production equipment and apply new technologies to meet market demands and improve competitiveness. The quality of the product has been greatly improved, the designs are more sophisticated and diversified, during this time, related industry associations have also been established and ceramic industry groups have been formed in Vietnam. At the beginning of the 21st century, the number of ceramic tile businesses continued to increase and the supply chain improved, from raw material procurement to processing, research and development, sales and service. Related industries have also experienced rapid growth, such as the production of chemical raw materials, color glazes, machinery for ceramics, and advertising, which further promotes the development of the Cluster. Through participation in international fairs and exhibitions, as well as market promotion activities, the cluster has achieved greater penetration in the international market. As a result, Foshan products have been widely introduced to the international market, becoming the leading supplier to the global ceramic tile industry. Companies in the cluster continue to invest in research and development as well as technological innovation, deploying digital manufacturing, smart manufacturing and advanced robotics technologies. These advances give ceramic tile companies greater control over the production process, reducing waste of resources and energy consumption. In addition, eco-design and the use of renewable materials are encouraged, and manufacturing processes that save energy and are respectful of the environment are adopted. Waste management and recycling of resources are also promoted, all with the aim of promoting the sustainable development of the ceramic industry. In this way, this cluster is at the forefront of technology and sustainability, constantly striving to improve production processes and reduce environmental impact.

2.3.3 Evolution of the cluster

Foshan is one of the world's leading ceramic industry centers, home to a wide range of ceramic companies, ranging from small and medium-sized enterprises to large multinational companies. Foshan's ceramic industry has played an important role in

China's dominant position in the global ceramic tile market, as it is noted for its abundance of raw materials and efficient production of ceramic products, making it the leading center for ceramic tiles. world level in the manufacture of ceramic tiles. Over the past decade, Foshan has been responsible for about 54% of domestic ceramic production and 25% globally. This outstanding contribution demonstrates its dominance in the ceramic industry and its crucial role in supplying ceramic products internationally. According to a report by China Ceramic Industry Association (2022), Foshan ceramic tile industry is a major contributor to China's ceramic tile exports, accounting for a significant proportion of the total value of 28 billion in 2021. According to data in 2021, the total industrial output value of Foshan ceramic tile industry accounts for more than 40% of the output of Foshan Ceramic Industry. Chinese ceramic tile industry. In 2021, Foshan has 190 registered brick-and-mortar companies with a larger than prescribed scale, which means a decrease of 23 companies compared to 2020 and 34 companies reporting losses. Ceramic tile production in Foshan will reach 973 million square meters in 2021, up 8.3% from the previous year.

Regarding research and development, in 2021, the total number of patents in Foshan ceramic tile industry is 2193, accounting for 2.27% of the total number in the city, showing an increase of 32.27 % year after year. These patents include 729 design patents (+27.75% YoY), 1,250 utility model patents (+152.23% YoY) and 214 smart invention patents (+38.96% year-on-year). This represents Foshan's continued focus on innovation and technological advancement in the ceramic industry.

2.3.4 Cluster characteristics

Foshan's ceramic tile industry is highly concentrated geographically, mainly in Foshan's Shiwan District, where a large number of ceramic tile enterprises have been established, creating a dense and comprehensive industrial chain development. This geographic concentration has fostered an environment conducive to collaboration and knowledge sharing. Proximity between companies fosters a cluster ecosystem where complementary companies can collaborate on product development, marketing strategies, and logistics arrangements, creating a symbiotic relationship that strengthens the capabilities and overall competitiveness of the cluster.

The Foshan ceramic cluster is one of the largest in the world, accounting for about 40% of the annual production of building ceramics and 16% of the sanitary ceramics production in China. Worldwide, it represents about 25% of the production of construction ceramics and 5% of the production of sanitary ceramics. This ceramic cluster has managed to standardize and increase the scale of production, improving the operational efficiency of the companies in the cluster and reducing the cost of

ceramic products. Many companies in Foshan Ceramic Industry Group have achieved vertically integrated development, covering the entire industry chain from raw material sourcing, design, production and logistics to marketing and after-sales service. . Focusing on the production of ceramic tiles ,this cluster integrates various resources and combines labor and materials from related industries, such as raw material development, machinery and equipment improvement, decoration, and packaging. In addition, it promotes the development of related industries such as scientific research, media promotion, industry exhibitions, logistics and intermediary agencies, forming a comprehensive and multifaceted industrial integration.

2.3.5 Advantages and disadvantages

As for the advantages, Foshan has a large population and abundant labor resources, which is conducive to the mass production of ceramic tile products. In addition, the Foshan area is rich in raw material resources, which ensures a stable supply chain and cost advantages. It also has a well-established supply network, establishing close cooperative relationships with raw material suppliers, equipment manufacturers, designers, and sales channels. The cluster's products cover a wide variety of niches, from ceramic tiles to bathroom accessories and ceramic decorations. This diversification allows companies to flexibly adapt to the needs of different markets, thus reducing dependence on a single market.

And on the other hand, the disadvantages we found in the Foshan Cluster is that in the first half of 2022, China's ceramic tile production decreased by 9.04% year on year, according to the China Sanitary Ceramic Association. In the case of Foshan, ceramic tile output reached 370 million square meters, down 13.3 percent from the previous year. Monthly surveys indicate that the operation rate of ceramic brick kilns in Foshan area in 2022 is only 50-65%. In addition, from January to November 2022, China's cumulative ceramic tile exports decreased by 5.15% year on year, confirming a downward trend in exports this year. Since 2013, China's ceramic tile exports have continued to decline, recording a seven-year decline in export volume. The export volume has almost halved, although the average sales price has increased, it cannot be denied that China's ceramic tile exports face a real risk of decline. Foshan Ceramic Group accounts for 50% of China's ceramic tile exports. The continuous decline in export volumes certainly poses a major challenge for the Foshan Ceramic Cluster.

Table 2: China ceramic tile export data, 2010-2021

YEAR	Export volume (Sq.mt.Mill.)	Growth (%)	Export value (million €)	YOY (%)	Average unit price(€ /sq.m)
2010	867.2	20.96	359177	25.68	4.14
2011	1015.28	17.07	444354	23.72	4.37
2012	1086.21	6.99	593393	33.33	5.46
2013	1147.78	5.71	736108	24.2	6.42
2014	1128.1	-2	728767	-1	6.46
2015	1138.53	0.92	776502	6.6	6.82
2016	1074.07	-5.66	515839	-33.57	4.79
2017	907.94	-14.47	414875	-19.58	4.57
2018	841.6	-7.31	401458	-23.47	4.77
2019	770.49	-8.45	424856	5.83	5.51
2020	622	-19.22	383417	-9.35	6.16
2021	601	-3.4	382298	-0.7	6.37

Fuente: China Building and Sanitary Ceramics Association

2.4 Ceramic Cluster of Italy (Sassuolo)

The ceramic cluster in Sassuolo, Italy is widely recognized as one of the world's leading centers of ceramic and tile production. Located in the Emilia-Romagna region, this cluster has established itself as a benchmark in the ceramic industry, housing numerous companies specialized in the production of high-quality ceramic products. These qualities have cemented its reputation as a reference in the ceramic industry, positioning itself as a driver of innovation and development in Italy and internationally.

2.4.1 Geographic location

The Italian ceramic industry is located mainly in the district of Sassuolo, an industrial city of 41,641 inhabitants, located in the province of Modena, in the Emilia-Romagna region, in northeastern Italy. The Emilia-Romagna region is densely populated and is considered one of the most prosperous regions in Europe, with the third highest GDP per capita in Italy. Industry is one of the most important in the region, along with tourism. In particular, the ceramics sector has a strong presence in the towns of Faenza and Sassuolo. Sassuolo's geographical location also played an important role in the success of the ceramic industry in the region. The region's logistics infrastructure is well developed, with efficient road and rail connections, as well as access to the main seaports. This facilitates the distribution and export of ceramic products produced in the cluster to various destinations both nationally and internationally.

Figure 6: Location of the Sassuolo ceramic cluster

Source: Viani

2.4.2 Cluster history

The Italian ceramic cluster, located in Sassuolo, has a centuries-old history of achievement. Located in the Emilia-Romagna region, Sassuolo has long been renowned for its artisan tradition and ceramic production.

At the end of the 19th century, the demand for ceramic tiles and decorative ceramics in Europe led to a significant growth in the Italian ceramic industry. At that time, Sassuolo and its surroundings were home to many small companies and workshops specialized in the production of ceramics.

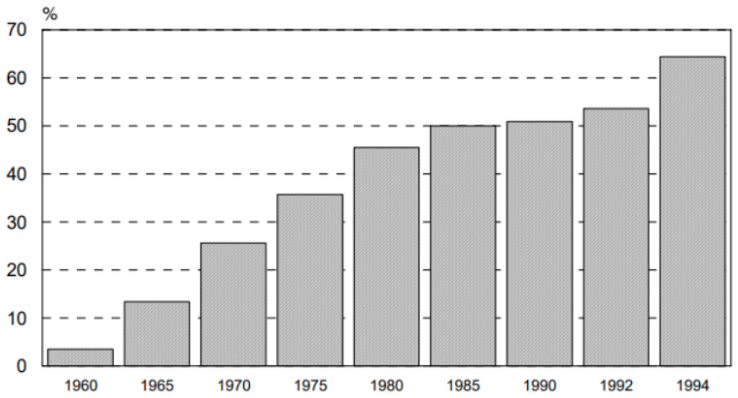
During the 20th century, the Sassuolo ceramic cluster began to take shape as these companies consolidated and developed. The combination of traditional crafts, technological innovation and business acumen has allowed the region's ceramic industry to thrive. During the 1960s and 1970s, the ceramic cluster in Italy experienced an important boom thanks to the introduction of advanced technologies in ceramic production. Investments in modern machinery and efficient production processes have increased production capacity and improved the industry's competitiveness, leading to expansion into national and international markets. In the following decades, the eastern Italian ceramic cluster continued to grow and consolidate its position as a world leader in the production of ceramics and tiles. Strong relationships have been established between the companies in the cluster, fostering collaboration, knowledge sharing and supply chain synergy. Today, the Sassuolo Ceramic Cluster is internationally recognized for its excellence in the production of high-quality ceramics. The companies in the cluster continue to invest in innovative research and development, technology

and design, helping them maintain their leadership positions in the global marketplace. The history of the Italian ceramic cluster in Sassuolo is one of growth, innovation and cooperation. Combining traditional craft skills with the application of modern technology has fueled the continued success of the ceramics industry in the region, establishing a reputation as one of the world's leading ceramic groups.

2.4.3 Cluster evolution

To understand the development of the ceramic industry in Italy since the 1960s, it is necessary to highlight the presence of metallurgical engineering companies and workshops in the region. These companies play a key role in the technical progress of the ceramic industry. They introduced innovations such as continuous motion ovens, which improved product quality and drastically reduced production times from days to hours. These improvements have also reduced costs. During the 1960s and 1970s, major technological innovations included the use of roller kilns and heavy presses. From the 1970s to the year 2000, Italian companies began to systematically explore export markets.

Figure 7: Historical evolution of tile production exports in Italy



Source: Bursi

Leading companies like Marazzi have worked hard to create a brand identity in other countries, and it is Italian tiles that make the difference in shape and variety of sizes compared to locally produced tiles in other target markets. Tile manufacturers began collaborating with outside designers and artists to create innovative designs. The Italian industry has achieved clear leadership by combining superior production technology, efficiency, design and marketing efforts, beating traditional competitors like German companies. Although the number of companies in the Italian ceramic cluster continued to increase until the late 1970s, it began to decline in the 21st century. However, the

number of employees remained more or less stable. This is due to the process of centralization that the industry has undergone since the 1980s, with several companies being acquired by other companies and the lack of incorporation of new tile producers in the region. Regarding sales and marketing, the desire to have a strong presence and create a brand that is recognized in many countries is one of the main reasons that led to the process of focusing on branding this sector since the past 1980s. In 1999, the ten The first groups represented more than 60% of the total production and two patterns of concentration were observed: mergers between companies and most of the companies were family-owned, choosing majority ownership. Italian ceramic tile manufacturers have gained a competitive advantage by maintaining large inventories, equivalent to about three months of production, and by improving distribution operations, allowing for rapid shipment. Shipments of tiles reach anywhere in Germany within a short time. from 4 to 5 days. Germany is Italy's main export market. In the first years of the new millennium, the objective of the ceramic clusters was to internationalize the companies. However, due to expansion into new markets, the companies faced new large-scale competitors. After the 2007 crisis, the Italian ceramic industry went through difficult times. Production and sales fell dramatically, with a 30% decline in production and a 20% decline in sales. However, since 2009, the situation has gradually improved. In 2016, sales in Italy had a positive evolution, reaching 82.8 million square meters. While this is only half of what the market was before the financial crisis, it is an encouraging sign of the industry's recovery. During this period, 16 subsidiaries were established abroad, belonging to 9 Italian ceramic groups. These subsidiaries have played an important role in the international expansion of the industry. They employ a total of 3,283 people and have a production of 85 million square meters. These figures show that, despite the challenges encountered during the crisis, the Italian ceramic industry has overcome difficulties and has gradually recovered. The opening of subsidiaries abroad and the increase in sales indicate new momentum and positive prospects for the Italian ceramic cluster.

2.4.4 Cluster characteristics

The Italian ceramics cluster, especially in Sassuolo, is characterized by a number of outstanding features: The cluster is located in a specific region of Italy, in the province of Modena and the Emilia-Romagna region. This geographical concentration facilitates cooperation and the exchange of knowledge between companies in the ceramic sector. Italy's ceramic industry has a long tradition of craftsmanship that goes back centuries. This artisan heritage has been passed down from generation to generation and is still

appreciated and combined with modern technology in the production of high-quality ceramics. The Italian cluster has been a pioneer in the introduction of advanced technologies in the production of ceramics. Innovations such as continuous motion furnaces and heavy presses have improved efficiency and product quality, allowing for faster production times and lower costs. The Italian ceramic industry is distinguished by its emphasis on design and creativity. Tile manufacturers have partnered with outside designers and artists to create innovative and attractive designs that allow them to differentiate themselves in the global marketplace. The Italian ceramic cluster has actively sought the internationalization of its companies. They have explored new export markets and established subsidiaries abroad, which contributes to their global presence and international competitiveness. The Italian ceramic industry is known for focusing on the quality and excellence of its products. The combination of traditional craftsmanship with state-of-the-art technology and strict quality standards has made the Italian industrial cluster a leader in the production of high-end ceramics. Together, these characteristics have contributed to the success and recognition of the Italian ceramic cluster throughout the world, consolidating its position as a benchmark in the sector and a source of creativity, innovation and quality in ceramic production.

2.4.5 Advantages and disadvantages

Regarding the advantages of the Italian ceramic cluster, the concentration of ceramic companies in a limited geographical area facilitates cooperation, knowledge sharing and synergy between companies. This drives innovation, the development of joint projects and continuous improvement in the ceramic industry.

Italy has a long tradition in the production of ceramics, which leads to a level of experience and knowledge in the field. The companies in the cluster benefit from this rich heritage, which allows them to produce high-quality ceramic products using exquisite artisan techniques.

The Italian ceramic industry is distinguished by its emphasis on style and aesthetics. The companies in the cluster have invested in partnerships with renowned designers and artists, which has allowed them to create cutting-edge ceramic products with innovative and attractive designs.

The Italian ceramic cluster has applied and developed advanced technologies in ceramic production. This includes state-of-the-art machinery and equipment, sophisticated quality control systems, and efficient manufacturing processes. Technological innovation improves competitiveness and productive efficiency.

The division benefits from a strong supply chain, with specialized suppliers in the ceramic industry. In addition, the location near important seaports creates favorable conditions for the import and export of raw materials, finished products and logistics in general. 6. International prestige: Italian ceramic products are recognized worldwide for their quality, design and craftsmanship. The Italian ceramic cluster's reputation as an industry leader has led to strong demand for its products on the international market.

Although the Italian ceramic cluster has many advantages, it also finds some disadvantages such as because the Italian ceramic cluster is highly developed and recognized worldwide, there is tough competition, both nationally and internationally. Companies must constantly strive to maintain their market position and face competition from other ceramic clusters, as well as companies from countries with low production costs. In general, manufacturing in Italy tends to be more expensive than in other countries. High labor costs, regulations and tax pressures can affect the competitiveness of companies in the Italian ceramic cluster, especially in terms of sales prices.

Italy's ceramic industry is linked to the global economy, which means it faces fluctuations and economic cycles. During an economic recession or financial turbulence, the demand for ceramic products may decrease, affecting the companies in the cluster.

While tradition and experience are important advantages, there is also a danger that the Italian ceramic cluster clings too closely to traditional methods and techniques, without being agile in its application of new technologies and trends. This can limit the ability to innovate and adapt to market changes.

Although the Italian ceramic cluster has a strong presence in the international market, it can also generate a certain dependence on foreign demand. The volatility of demand from other countries and possible trade barriers may affect the export of Italian ceramic products.

Despite these limitations, the Italian ceramic cluster has managed to maintain its leadership position in the industry thanks to its capacity for innovation, product quality and international recognition. Collaboration between the companies in the cluster and a focus on differentiation and added value remain key strategies to overcome these challenges.

2.5 Castellón cluster compared to the Guangdong and Sassuolo cluster

Table 3. Comparison of ceramic clusters.

Castellon	Foshan	Sassuolo
Existence of ceramic crafts	Existence of ceramic crafts.	Existence of ceramic crafts
Production of 587 million square meter	Production of 973 million square meters	Production of 415 million square meters
Export of 414 million square meters	Export of 601 million square meters	Exports of 328 million square meters
Its powerful subsector is ceramic frits and glazes	Lack of powerful subsector	Its powerful subsector is machinery and equipment
Traditionally focused on coatings	Traditionally focused on wall and floor tiles	Traditionally focused on pavements
Much support from ASCER ANFFECC o ASEBEC	Much support from CBMF, CCIA and Foshan Ceramic industry association.	limited support of ASSOPIASTRELLE, CERACOLOR and ACIMAC
Less recognized brand	Less recognized brand	Most recognized brand
More than 90% produced in the same territory	Less than 90% produced in the same territory	More than 90% produced in the same territory

Source: own elaboration

2.6 Importance of the cluster

Previously we have made a description and comparison of the most important clusters worldwide, and now we are going to see in much more detail the importance of the ceramic cluster of Castellón in Spain, both in GDP and in the number of jobs created by the companies of which this cluster is composed. Thanks to the information and data provided by ASCER, we will be able to see this great impact of the ceramic industry in our territory much more clearly and visually.

During 2021, the tile and ceramic flooring manufacturing sector made a significant contribution to the economy of the Valencian Community. According to data from ASCER (Spanish Association of Tile and Ceramic Floor Manufacturers), this contribution amounted to 3,787 million euros, which represents approximately 3.6% of the region's Gross Domestic Product (GDP).

Within this contribution, it should be noted that 1,288 million euros correspond to the direct impact generated by the sector, which represents around 34% of the total impact. However, the indirect impact plays an important role, since more than 52% of the total impact, equivalent to 1,972 million euros, derives from the expenses incurred by suppliers in the Valencian Community.

In addition, the ceramic sector also has an induced impact on GDP, through household consumption as a result of wages and salaries generated both directly and indirectly. This induced impact represents almost 14% of the total impact, with a value of 527 million euros.

These data reflect the economic relevance of the ceramic cluster in the Valencian Community, showing its contribution both in direct terms and in the generation of employment and indirect economic activity through its supply chain and domestic consumption.

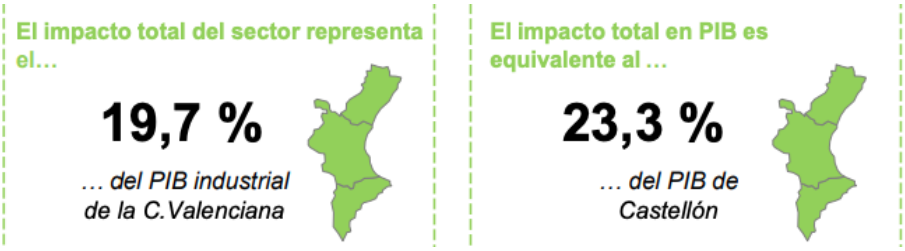
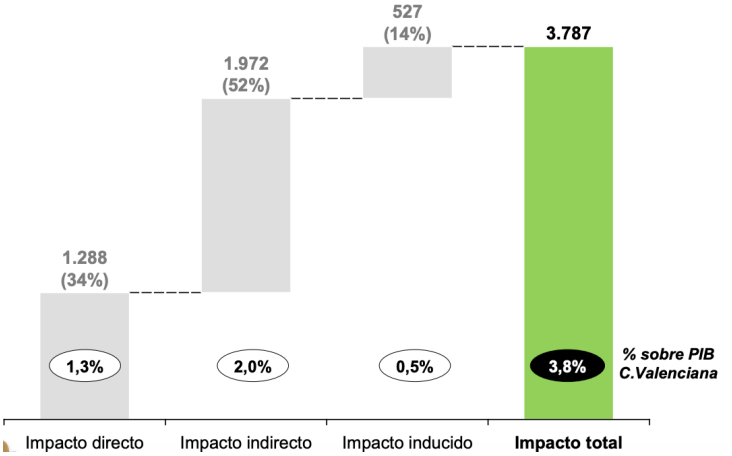


Figure 8: Total impact on GDP by type of impact (2021, M€)



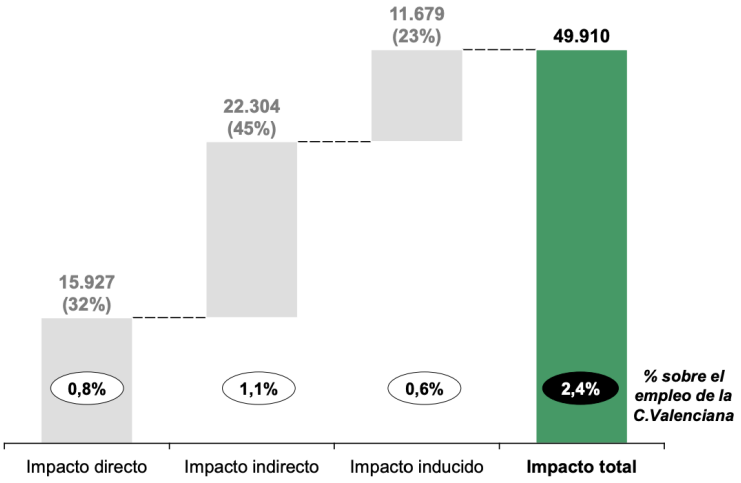
Source: ASCER

In relation to employment, the tile and ceramic flooring manufacturing sector had a significant impact on the generation of employment in the Valencian Community during the year 2021. According to data provided by ASCER, it is estimated that the sector contributed a total of 49,910 jobs. , representing approximately 2.4% of employment in the community.

Of these jobs, 15,927 correspond to direct employment in the Valencian Community, which is equivalent to 32% of the total employment generated by the sector. It is important to highlight that the indirect impact also plays a relevant role, since 45% of the total impacts of the sector in the community, that is, 22,304 jobs, come from said indirect impact.

Likewise, the induced impact generated by the additional consumption derived from wages and salaries generated both directly and indirectly, represents 23% of the total employment generated, which translates into 11,679 additional jobs.

Figure 9: Total employment impact by type of impact (2021, jobs)



Source: ASCER

It is important to mention that the employment generated by the ceramic sector is characterized by its stability, due to the resilience of the industrial sector in the face of crises, such as the one derived from the pandemic in 2020.

These data reflect the importance of the tile and ceramic flooring manufacturing sector in generating employment in the Valencian Community, both in direct terms and through the indirect impact and additional consumption generated by wages and salaries. In addition, the stability of employment in this sector contributes to its relevance in the labor panorama of the region.

3. INNOVATION

As a second theoretical part we have innovation, which is being a key factor for the development of the business world, more specifically for clusters, which is the element that we have previously analyzed, due to the fact that we find ourselves in an increasingly demanding and competitive environment (del Corte, 2015).

Innovation plays a crucial role in the business world for several fundamental reasons:

The ability to innovate allows companies to stand out from their competitors by offering unique and superior products, services or processes. This gives them a competitive advantage in the market and attracts the attention of customers.

In an ever-evolving and dynamic business environment, innovation enables companies to adapt and respond effectively to changes in customer preferences, market trends, technological advances, and economic conditions. Those organizations that do not innovate run the risk of becoming obsolete and losing relevance in their industry.

It also drives business growth by opening up new market opportunities and enabling expansion through new product development, penetration into untapped segments, or entry into new geographic markets.
Innovation is not just limited to products or services, but also encompasses improvements in work processes and methods, so it can increase a company's operational efficiency and productivity, resulting in higher production levels, reduced costs and improvement in the quality of the products or services offered. And finally, it is also a key element for the creation of value both for the company and for its customers.

3.1 Definition

The term innovation is very extensive and many authors have defined this concept in many different ways. One of the definitions in which we can better understand the real and clear meaning is the one we have in the*Manual Oslo,*written by the Organization for Economic Co-operation and Development (OECD) in the publication*Measurement Of Scientific and Technological Activities*:

Innovation is the generation of a new idea or a product (good or service)
new, or significantly improved, process, new marketing method, or new organizational method, in internal company practices, workplace organization, or external relations.

From this definition we can extract two keywords such as improvement and new, which perfectly cite the term innovation.

3.2 Types of innovation

As we have been able to observe in the definition set forth above, the concept of innovation is very extensive and for this reason we are going to focus on the classification of innovation based on the **nature of innovations** (del Corte, 2015).

Product innovation Focuses on creating or improving existing products or services. It involves introducing new features, functionality, or technologies into a product, as well as creating entirely new products that innovatively address market needs.
The key to being successful in product innovation, whether creating a new product or modifying an existing one, is to exceed customer expectations. This requires having trained and updated professionals, as well as creative and visionary minds. Creativity

plays a fundamental role in the innovation process, allowing the generation of new and original ideas.

Second, **process innovation** focuses on improving or reinventing an organization's production methods, internal operations, or delivery systems. Their goal is to increase efficiency, reduce costs, improve quality, or speed up the production and delivery of products or services. Not only is it limited to creating something completely new, but it also involves enough modifications to generate a totally different process than previously used. These changes are usually related to the techniques used, the production software or the equipment used. It is important to note that innovation is not considered if productivity and performance are equal to or lower than previous processes. Any change made should improve the production capacity compared to existing processes, since it aims to improve the competitiveness of a company in the market, without assuming as many risks as in product innovation.

On the other hand, **organizational innovation** has to do with the implementation of internal changes in an organization with the purpose of improving its efficiency, adaptability and performance in general. It seeks to optimize the way in which the organization operates, organizes itself and makes decisions, and this may imply the restructuring of departments, the implementation of new management policies, the adoption of more advanced information systems or the introduction of collaborative work practices. The main objective is to improve the efficiency and effectiveness of the organization, also helps the company to adapt to changes in the business environment, such as new regulations, technological advances or changes in customer preferences.
Apart from this type of innovation, it can also have a significant impact on the corporate culture by fostering creativity, innovation and the entrepreneurial spirit within the organization. Likewise, it promotes continuous improvement and the constant search for new opportunities for growth and development.

And fourthly the **marketing innovation** refers to the implementation of novel ideas, strategies and techniques in the marketing activities of a company. Their goal is to gain a competitive advantage, attract customer attention, and generate greater value for them. This implies the creation and implementation of new forms of promotion, sales and communication with customers. It can include aspects such as market segmentation, the development of innovative distribution channels, the use of digital

tools, the creation of creative advertising campaigns and the personalization of the customer experience.
It seeks to break with traditional approaches and explore new opportunities to reach the target audience more effectively, this will serve to differentiate yourself from the competition, increase the visibility of your brand, generate greater demand for your products or services and encourage customer loyalty. the clients. In addition to improving communication and the relationship with customers, providing unique and personalized experiences.

It is important to note that innovation can occur in different areas of an organization and that several types of innovation are often combined to drive growth and competitiveness.

Apart from those named above, we can mention another type of innovation that is based on **degree of novelty of innovation,** distinguishing between radical and incremental innovation (Jaume I University, 2021).

Radical innovation is about the introduction of significant and disruptive advances that completely transform an existing industry, product or service. Its main characteristic is the creation of new markets, the displacement of traditional competitors and the change in established practices. This type of innovation can involve creating entirely new products or services that fill unmet needs or provide innovative solutions to existing problems. Achieving it requires having a long-term vision and being willing to take risks. Organizations that successfully implement radical innovation can gain significant competitive advantages and transform their industry. However, it also comes with challenges, such as resistance to change, technological barriers, and adapting to an ever-changing business environment.

And on the other hand **incremental innovation** refers to the gradual and progressive improvement of existing products, services, processes or practices within an organization. It focuses on making adjustments in specific areas to achieve incremental and evolutionary improvements. It is characterized by its perspective towards the optimization and improvement of existing products or processes, but it can also imply the incorporation of new features, the optimization of efficiency, the reduction of costs, the improvement of quality or the simplification of processes.

This approach to innovation is common in companies that seek to stay competitive in their industry and that take advantage of customer feedback and market trends to make incremental improvements to their products and services.

And finally, according to **innovation planning** could be programmed innovation in which a systematic and planned approach is taken to drive innovation within an organization. It is based on the implementation of specific processes and structures that encourage the generation of ideas, research and development, as well as the achievement of innovative solutions. Businesses or organizations that use it set clear goals, allocate adequate resources, and develop detailed plans to drive creativity and innovation in all areas of the business.

And **unscheduled innovation** refers to innovative advances that emerge spontaneously or unanticipated within an organization. Although it lacks a structured process, it can have a significant impact on both the company and its industry, and to make the most of the opportunities that present themselves, flexibility and adaptability are required.

3.3 Innovation versus creativity

Creativity plays a fundamental role in the innovation process (del Corte, 2015), since it involves generating new and useful ideas. It can manifest itself both individually and in groups, but its implementation and transformation into innovation depends on the organizational environment. This environment is in charge of carrying out the implementation of the ideas generated, turning them into innovation.
On the other hand, **innovation** refers to the voluntary implementation of ideas associated with the transformation and implementation of these ideas into new or improved products, services, or processes. While creativity is an essential part of the innovation process, it is not enough. Often ideas are created that need additional people or specialized resources to fully develop. Creativity and innovation are key factors in the innovation process of a company and are influenced by the organizational environment. Companies that encourage employee creativity, allocate resources for it, and create a work environment conducive to creativity are more likely to achieve innovative results. Several studies by Çokpekin and Knudsen (2012) have shown a positive relationship between creativity and innovation. For example, it has been found that the most creative people in an organization can contribute to knowledge sharing and more learning opportunities, fostering innovation. In addition, a work environment

that encourages creativity has been shown to be associated with more creative changes within the company. However, it is also recognized that the context and environment in which a company operates influences its innovative results. In this sense, the territory or cluster where the company is founded can be a strategic element for the development of creativity. The physical and cognitive proximity between the companies in a cluster favors communication and interaction, and fosters creativity and innovation. Likewise, proximity facilitates the transmission of information and knowledge, which directly contributes to the innovation results of the companies in the ceramic cluster. Therefore, we conclude that creativity and innovation are closely related in the business innovation process. Creativity generates new and useful ideas, while innovation involves taking them and turning them into a product, service, or process. Creativity and innovation are influenced by the organizational environment and are nurtured in those environments that encourage creativity and promote communication and interaction between companies.

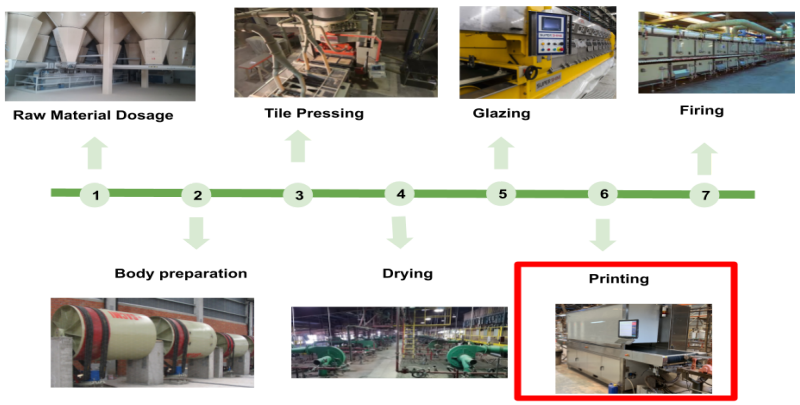
3.4 Digital printing as radical technological innovation

In the ceramic industrial cluster of Castellón (Valiente Bordanova, 2019) there has been a remarkable development and diffusion of a radical technological innovation in the first decade of the 21st century. We are referring to the introduction of a revolutionary technological change that allows the same product or service to be offered on the market, but in an improved way, using a method completely different from the traditional one.

In this case we refer to the digital printing of tiles as an option to traditional printing. This innovation had a great impact on the ceramic value chain, since it was the first step in the digitization of ceramic flooring production lines. In addition, we see how this places the Castellón ceramic cluster at the forefront of global technology in the ceramic industry, surpassing the Sassuolo cluster, the Italian technological leader. Ceramic digital printing is based on new machines that use inkjet technology, previously used for non-industrial products such as graphic arts. Basically, this decoration system consists of a device (called a print head) that spreads ink on the screen and computer software that controls it. Kerajet, a company specializing in the production of machines for the ceramic industry, presented this printer in 2000 at the Cevisama International Congress. Since then, this innovative ceramic system has replaced many traditional ceramic printing machines around the world. Older printers are based on an older and more efficient analogue technology that involves layering and pressing ink into a cavity-shaped drum that contains the design to be printed. The difference between the

two systems goes beyond a simple conversion from analog to digital technology. Traditional systems are bad in many areas, including productivity, material cost, labor cost, usable print quality, print variance, and expense. In addition, the new system can manage all aspects of digital documents, also remotely, for example, easily managing the Internet from another country or city, wherever you are. This advancement in mechanical printing is considered state of the art technology as it changed the way ceramics were produced by breaking the old system and creating a new set of products. To get an idea of how it works, Figure 9 shows the process of making ceramic floor and wall tiles. Of the seven stages of the ceramic process, the digital image surrounded in Figure X is considered one of the most important for two reasons, firstly because this part is more expensive than the others and because most of the added value is due to the printed design. which is the most visible part for the average consumer.

Figure 10: Schematic description of the ceramic manufacturing process.



Source: own elaboration

It can be said that digital printing has brought about a radical change in the method of printing ceramic tiles and coverings. It is strongly influenced by developments in the ceramic industry. In the end, its impact must be assessed not only at the value chain level, but also at the cluster level as an entity.

3.5 Advantages and disadvantages of digital innovation

Ceramic digital printing has several advantages and disadvantages compared to traditional printing methods. Next we will show the most relevant ones.

Regarding the advantages:

Design flexibility: Ceramic digital printing allows for the creation of complex and highly customizable designs. This gives manufacturers the ability to offer a wide variety of complex design, pattern and texture options to customers in order to adapt to the latest market trends and meet their demands.

Reduced production time: With digital printing, the time it takes to prepare designs and implement changes in production is reduced. This allows for faster and more flexible production, which can speed up delivery times.

Cost and material reduction: Digital ceramic printing improves ink application precision and control, reducing material waste and minimizing associated costs.

Better print quality: Digital printing technology provides superior print quality compared to traditional printing methods, as they are more capable of withstanding daily wear and tear. And it also allows a more accurate reproduction of details, colors and textures, resulting in high-quality ceramic products.

Personalization and adaptability: Digital printing facilitates the customization and adaptability of designs. Manufacturers can offer unique products tailored to individual customer preferences, increasing customer satisfaction.

On the other hand the disadvantages:

High initial costs: The investment in ceramic digital printing equipment can be significantly higher than in traditional equipment. This can be a financial challenge for some businesses, especially smaller ones.

technology dependency: Digital ceramic printing requires sophisticated equipment and advanced technology. This means that ongoing maintenance and equipment

upgrades are required to ensure proper operation, which may require additional investment.

Limited production speeds: While digital printing offers advantages in terms of flexibility and customization, production speeds can be slower than with traditional methods. This can limit the ability to produce large volumes in a limited period of time.

Skills and Training Requirements: The successful implementation of digital ceramic printing requires specialized technical knowledge and skills. Operators and technicians must be properly trained to effectively use and maintain printing equipment, which can require additional time and resources.

In conclusion, despite the drawbacks mentioned above, digital ceramic printing has revolutionized the industry by offering significant advantages in terms of design, quality, and versatility. Its application continues to grow in the ceramic industry due to the benefits it brings to manufacturers and customer satisfaction. And although it has significant initial outlays, in the long run it produces a reduction in costs that provides a differentiation in the market compared to other companies that do not have this radical technological innovation.

3.6 Evolution of the implementation of digital innovation

The history and development of digital ceramic printers go back to the last decades of the 20th century and they have made important strides ever since. In the late 1980s and early 1990s, the first experiments and developments in the field were made, and digital ceramic printing began to appear. Inkjet technologies, similar to those used in other industries such as graphic arts, have been explored. Inkjet technology was developed, during the 1990s, manufacturers of machinery and equipment for the ceramic industry began to develop digital printing systems specifically suitable for use on ceramics. Improvements have been made to inkjet technology to ensure precise and controlled ink application to the ceramic surface.
In the early 2000s, the first commercial digital ceramic printer began to hit the market, companies like Kerajet, EFI Cretaprint and Durst are pioneers in the production and marketing of these printers. These first digital printers offer high-resolution printing and more design flexibility. As technology has improved, there have been significant improvements in print quality and speed. More advanced print heads were introduced,

allowing for higher resolution and more precise ink usage. In addition, more efficient drying systems have been implemented, which speeds up production times.

On the other hand, in recent years, there has been a convergence between digital ceramic printing and 3D printing technology. This enables the printing of more complex and personalized three-dimensional ceramic objects. The combination of both technologies has opened up new possibilities for the design and manufacture of ceramic products. As digital technology develops, digital ceramic printing with digital control and automation systems has become more and more integrated. This allows for greater precision, efficiency, and repeatability in the printing process, as well as greater design control and customization.

In summary, the history and development of the digital ceramic printer is characterized by the gradual and continuous evolution of technology, which has resulted in significant improvements in printing quality, speed and flexibility. Integration with 3D printing and digital automation has further fueled the development of this technology, opening up new possibilities in manufacturing high-quality custom ceramic products.

4. CONTACT WITH THE COMPANY

To find out a little more about the impact and development of innovation in the province of Castellón, I have made a questionnaire to the Production Manager Pedro Calpe, of the Azteca company located in Alcora. As explained above, it is located in one of the areas where the vast majority of the companies that make up the Castellón ceramic cluster are concentrated.

As for the company,Azteca is a company specialized in the manufacture and sale of high-quality ceramic tile solutions that offer significant added value, combined with their excellence in design and quality, positions them as leaders in the sector and allows them to satisfy the needs of their customers. and prescribers worldwide.

And now we proceed to expose the questions and answers of the questionnaire made in a summary. This text answers whether they currently have digital ceramic printers in their facilities, when they started, whether they are leaders in innovation and what effect the implementation of this innovation has had in terms of costs and differentiation.

Azteca Cerámica, a Spanish company specializing in the production and marketing of ceramic wall tiles, has been recognized for its ability to innovate in the sector. As for digital ceramic printing, Azteca Cerámica has been a pioneer in its adoption and has invested in state-of-the-art technology to deliver high quality and design products.

Although the exact date when Azteca Cerámica launched digital printing is not known, it is known that the company has been using the technology for several years. Digital ceramic printing allows for more flexible designs and patterns, as well as more accurate reproduction of details. By adopting digital printing, Azteca Cerámica has achieved greater efficiency in the production process, reducing production time and minimizing the costs associated with traditional methods of ceramic decoration. In addition, digital printing has allowed Azteca Cerámica to offer a wide variety of designs and customizations to its clients, giving them a competitive advantage in the market. The implementation of digital printing has allowed Azteca Cerámica to differentiate itself from its competitors by offering unique and attractive ceramic products. The ability to create innovative and custom designs has helped the company respond to changing customer needs and adapt to market trends. In summary, Azteca Cerámica is one of the leading Spanish companies in the application of digital printing in the ceramic industry. This innovation has a significant impact on production costs and product differentiation, allowing the company to offer customers high-quality custom designs.

Since 2012, production in the sector has grown compared to previous years, but in 2019 it fell to a much lower level due to the covid situation. This also affected another of the most relevant factors, which is exports, which had a very significant drop and with it employment. An ERTE was produced, which is still in force today, since most of the production was not sold and therefore a smaller workforce was needed. By not having so much economic capacity, innovation was also affected, and during those years from 2019 until now there was not much technological innovation.

CONCLUSIONS

After analyzing the case of the ceramic cluster, we can conclude that it is a successful model today. This cluster is a powerful industry in the Castellón area, and its geographical location has been key to its development, which has allowed it to grow in terms of data and infrastructure and obtain a significant part of the benefits of the sector at a national level. At the international level, the cluster is also recognized as a benchmark, although it competes with countries such as Italy and China.

The competition between these three clusters has led to an exhaustive comparison between them, analyzing their history, evolution, characteristics, advantages and disadvantages. This has allowed us to identify the deficiencies in the development of the Foshan ceramic cluster, and through the analysis of the Castellón ceramic cluster, we understand that its success is closely linked to technological innovation, international cooperation, commercialization and sustainable development.

In the future, the successful experience of the Castellon ceramic cluster can serve as a guide for the development of the Foshan ceramic cluster. This involves establishing partnership relationships with international designers, architects and retailers, expanding distribution channels and enhancing brand image. In addition, market marketing and brand building must be strengthened through the design of differentiated products, innovative promotion strategies and active participation in fairs and international activities of the ceramic industry.

As for Castellón and Sassuolo, they present similarities in the generation of GDP for their countries and the importance of ceramics in their respective regions. Both clusters have experienced significant growth in recent decades and are poised to continue growing. Although the machinery subsector in Italy is more powerful than in Spain, this does not mean that the Spanish subsector is inferior. In fact, Spain mainly imports kilns and presses from Italy, but has companies like Kerajet that produce enamel machinery.

We have also highlighted the innovations that have occurred in the clusters, focusing especially on ceramic digital printing. This innovation has had a remarkable impact on the industry, offering a greater variety of designs, mass customization, production efficiency and quality improvement. Ceramic clusters have adapted to this technology to stay competitive and meet changing consumer demands.

And finally, I would like to end by saying that the Castellón ceramic cluster, with its focus on innovation, is a clear example of an industry that seeks to improve every year and maintain its prestige. This has led more and more young people to be interested in working in companies located in the cluster.

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