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Digital transformation and innovative business models in the jewelry industry

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*To you, to which I dedicate everything that
I am and I will be.*

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Introduction

The main objective of this thesis is trying to understand how digital transformation is affecting the jewelry industry, what it practically means in this sector and how firms are reacting to changes.

Digital transformation and Industry 4.0 are a unique concept because one is tightly linked to the other and this notion is extremely stressed in our everyday lives. Everybody speaks about the fourth industrial revolution in general terms, about technologies that will be introduced within production processes of our firms. The reality is that these disruptive changes have already silently begun in our enterprises. Of course some sectors are more advanced, the automotive for example, and others are just starting to face this new scenario that will have an enormous impact on tomorrow's reality.

We are all already inside this vortex of innovation and technology and maybe we do not know how to manage it exactly yet, simply because there is not an example to follow. With this thesis the main aim is to explore just one piece of this huge puzzle, focusing on an extremely interesting industry that is mentally associated to the past, the tradition: jewelry. A sector that, contrary to what is usually thought, has introduced new technologies in its production process step by step and is going to grow. This is a typical example of how something that I personally consider more an "art" rather than a common job, something that everybody sees as an alter ego of an ancient tradition, strictly connected to special events such as the birth of a child or an anniversary, is able to renovate and innovate itself. It reflects a new mind setting: jewels are not exclusively for wealthy people or related to specific occurrences.

In order to understand how the digital revolution is developing within this industry, I am going to consider both the sector trends in general terms and an analysis of the national firms, both those that have adopted technologies and those which have not, in order to depict a more objective representation.

The choice of the jewelry sector is due to the fact that I am going to involve directly Italian firms and there are three significant districts in Italy: Vicenza, Valenza and Arezzo; the second reason is that this industry was one of the first to adopt technologies such as 3D

printing and laser cutting. As a consequence, there is an higher data availability and therefore a stronger basis with which to work.

The objective is to demonstrate in which areas and aspects digital transformation impacts the industry . Before focusing on the jewelry sector, I am going to analyze the historical scenario of industrial revolutions paying attention to the 4th one. I then will analyze the most important programs of industry 4.0 in European countries in order to offer an overview of the different plans. There will be an excursus of the nine technologies that are identified as enablers of digital transformation and I will then report which is the new relationship between humans inside factories and machines that are installed to collaborate with them. There are several debates regarding how the work will change and especially concerning the estimated reduction of workforce needed; I will offer the perspective of different literary sources. We will see that an increasing number of machines within factories is almost certain, but machines cannot replace humans who will have to be more and more specialized in order to deal with new technologies and set machines.

After a general overview of the context, I will deep dive in the description of the jewelry industry in great detail, analyzing how it is structured, which are the main characteristics of firms and how technologies have changed the production process, completely different from the traditional one. There will be an analysis of the two main phases affected by digital transformation: production and prototyping. The gold industry, as typical example of Made in Italy, is articulated in districts, systems constituted by groups of firms, mainly of small-medium size, that are vertically and horizontally integrated and connected by a historical tradition.

Technology is not enough to differentiate a firm from another, product innovations can be copied easily. What makes the difference is how companies are able to innovate in business model design. I will proceed the analysis considering three interesting examples of business model innovation: firms that were able to change paradigm and innovate themselves. In order to understand which is the degree of maturity of the jewelry companies from the internationalization, technology and distribution perspective, I will analyze how technologies are impacting profitability, growth and export.

To achieve this result I will split the analysis in two parts: in the first one I will elaborate data of the Fondazione Nord Est questionnaire, providing a picture of what kind of firms

characterize the districts, which is their level of internationalization in terms of national and international sales, which is their technological maturity, their business model strategies and which type of distribution channels they exploit: e-commerce for example. In the second one, I will analyze the sector as a whole from an economic point of view. I will demonstrate the different EBITDA variation among firms that are opening to innovations and technologies. There will be an analysis of both profitability, growth and export.

The last part of the thesis will be focused on a series of interviews made with companies of the three districts in order to demonstrate if the results of the first two phases will be supported by the experience of the firms.

The final scope is to show which is the correlation between innovations and business models; to understand if high growth, profitability and internationalization are characteristics of those firms that are technologically advanced and open to product customization strategies.

Chapter 1: Industry 4.0 and its challenges

The economic growth is a long cyclical process characterized by waves of innovation that could be large or short scale innovation. Large scale innovation is what we call Industrial Revolutions. The First Industrial Revolution happened at the end of the 18th century with the usage of the steam machine for the operation of production facilities. The second Industrial Revolution was focused on motor energy, electricity, chemical materials and new metallurgy in the second half of the 19th century; this led to the beginning of the mass production and the birth of the assembly line. The Third Industrial Revolution, that started in the 60s-70s, was based on computer and telematics and more generally on the exploitation of the IT to automate the production further. Nowadays the economic scenario is going to face another important and disruptive innovation era characterized by the need of an interconnection between humans and machines, physical and digital systems, complex analysis of information through Big Data: this is possible through the exploitation of so called Smart Machines, interrelated and connected with the Internet. This new wave of innovation has been defined as the Forth Industrial Revolution.

1.1. The concept of “Industry 4.0” at the international level

“Industrie 4.0” is the name that the German government gave the Business Plan presented in 2011 and realized at the end of 2013 that was focused on investments in infrastructures, schools, energy systems and research to update and renovate the German production system in order to keep manufacturing competitive at a global level.

The main initiatives born in order to propagate the Industry 4.0 paradigm are the American program “Industrial Internet”, the German one “Industrie 4.0”, the French one “Industrie du Futur”, the “High Value Manufacturing” in the UK and “Fabbrica Intelligente” in Italy. There are of course some differences between the American and European model. The former is characterized by the activities of consortiums and private alliances with the engagement of big ICT and telecommunication players (such as Intel, Cisco Systems, IBM, General Electric and AT&T) in collaboration with the most prestigious Universities. From a technological point of view the American program prefers the IOT, Internet of Things, working for the development of applications and standards with the aim of facilitating the

diffusion in the industry and services. The focus is on the adoption of sensors, the relationships machine-to-machine, big data, the cloud and the creation of platforms that allow the interoperability of producers. The latter is focused on the activities made by single member states and on the public intervention financed by the European Commission through the research program Horizon 2020. This program in collaboration with EFFRA (European Factories of the Future Research Association), composed by the most important industrial firms, forecasted a budget of 1.15 billion for research projects in order to increase the European competitiveness through investments directed at the creation of smart factories.

While Europe emphasizes the role of the smart factory, the American model prefers IOT technology. As a consequence, the EU aims at optimizing mainly the manufacturing sector and is sustained by the public sector, while the second one aims to improve also the service activities and so the economic system as a whole, and is promoted by private firms and research foundations.

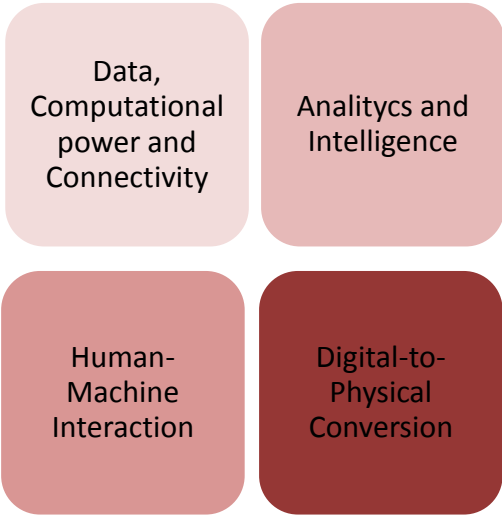
The common point between these two major programs is the integration between machines, objects and people, both in terms of workers and consumers.

Now I am going to analyze in depth the main European programs adopted by the member states starting from the most structured one. The German approach looks at systems that include automation and robotics applicable at the industrial production with productive platforms linked to the supply chains. The hardest goal to achieve is unifying the industrial hardware, traditionally a German strength point, with the new communication platforms between machine-machine and machine-human. "Industrie du Futur" in France is aimed at transforming French industry as a whole, not only introducing robotics, big data, augmented reality and IOT but also looking at new business models, at design and marketing methods, at organizational innovation and at the relationship between industry and the tertiary sector. In the UK the High Value Manufacturing wants to increase public investments for innovation that could reach 70 million per year and should be addressed to those sectors that have an international potential growth such as aerospace, pharmaceutical, chemical and electronics.

1.2. Digital technologies involved

The main reason why firms are focusing on the development of Industry 4.0 and the adoption of disruptive digital technologies is the level of efficiency that can be reached. Nowadays, time to market and customer responsiveness are key factors of competitiveness and this leads firms to reshape their organizational structure, to change the relationship with their employees but also with their customers, transforming the concept of factory. There's the need to produce more and more in a faster way in order to respond to customers' needs that are constantly changing. An analysis made by Mc Kinsey defines four main clusters in which digital technologies can be divided. Within these clusters, I am going to explain the difference between the nine main technologies that enable the digital transformation as the Boston Consulting Group defined.

Fig. 1 Classification of digital technologies



Industry 4.0: How to navigate digitization of the manufacturing sector McKinsey Digital

Big Data and Analytics: refers to those technologies that allow elaborating the huge amount of information that flows through the Internet and giving information regarding market trends, customers' needs, brand reputation and goods' demand. With Industry 4.0 millions of raw data can be analyzed to improve the system efficiency at three different levels: the speed with which data can be analyzed; the volume of data that can be elaborated; the

variety of data, coming from heterogeneous and differentiate sources. This will be fundamental to support real-time decision-making.

Autonomous Robots: robots are able to work side by side with humans without barriers. They are flexible, cooperative and autonomous. These robots can execute also the most dangerous jobs within the productive plants. They are a sort of “personal assistant”, opening the doors to new organizational models but at the same time they are revolutionizing the logistic activities especially in the automate wholesales because they are able to do everything: pick, pack and ship.

Simulation: Actually 3-D simulations of products, materials, and production processes are already used, but in the future, they will be employed more extensively in plant operations as well. Operators will be able to test and optimize the machine settings for the next product in line in the virtual world before the physical changeover, increasing quality and driving down machine setup times.

Horizontal and Vertical System Integration: Companies, suppliers, and customers are rarely fully integrated and the same is for functions within each enterprise. Even engineering itself -from products, to plants, to automation- lacks of complete integration. But with Industry 4.0, companies, departments, functions, and capabilities will become much more cohesive and enable truly automated value chains.

Internet of Things (IOT): refers to those technological devices (sensors, GPS) that can be integrated in physical objects and machines, allowing the communication with other objects through the Internet and the exchange of information. This allows devices to communicate and interact both with one another and with more centralized controllers. They allow to store instructions and learn from the interaction. The main consequences of IOT in the digital factory are the flexibility levels, the products customization and the real- time dialogue between market, design, suppliers and production. The Internet of Things will allow us to interact with our appliances or cars.

Cyber security: the growing interconnections both internal and external are introducing the problem of information safety that should not be altered by the external environment. With the increased use of standard communication protocols, the need to protect critical

industrial systems and manufacturing lines from cyber security threats will increase significantly. Therefore, reliable communications and access management of machines and users are fundamental.

The Cloud: refers to the need of implementation of all cloud technologies such as the online storage of information, the use of the cloud computing and of external services for analyzing data. Nowadays companies are already using cloud-based software for some enterprise and analytics applications, but with Industry 4.0, more production-related undertakings will require increased data sharing across sites and company boundaries.

Additive Manufacturing: refers to the production through adding material rather than removing it as was usual in the traditional approach. The 3D printing process starts with the creation of a virtual model, thanks to a software, and then the digital file will be sent to the 3D-printer that can be located also far away from the design area. This technology will have a significant impact on prototyping, allowing efficiency and saving of time. It allows the mass customization of the product, the production of complex shapes overcoming the technical difficulties of the plants, the production line flexibility, a quick answer to a volatile market giving firms the possibility to modify quantities and typologies rapidly. The mass customization enables the production of a single unit without the creation of an ad hoc mold that would increase the final price of the product significantly. The 3D printing exercises an important effect on the costs structure of production: it would be appropriate to place side by side economies of scales and economies of ones. The latter refers to the advantages obtained by the mass customization: there will be a reduction of fixed costs and a reduction of barriers to entry in the new businesses with an increase of competition and the opportunity for artisan firms to extend their production to these new market segments.

Augmented Reality: it refers to a group of technologies, generally wearable, that are able to increase the information available for the user in a real environment rather than in digital laboratories (as happened in the virtual reality). The application of this type of technologies in the industrial sector is still experimental nowadays. In the near future workers may receive repair instructions on how to replace a particular part as they are looking at the actual system which needs to be repaired. This information may be displayed directly in the workers' field of action using devices such as augmented-reality glasses.

1.3. Industry 4.0 in Italy

“Industria 4.0” means new technologies, new factors of production and new job organization that are changing the way of production and the relationship among economic actors, consumers included. The term refers to a tendency of industrial automation that integrates some new technologies to improve work conditions and increase productivity and the quality of plants. The smart factory, in which Industry 4.0 has been identified, is composed by three parts:

1. Smart Production: new productive technologies that create collaboration between all the subjects involved in the production line, humans, machines and objects;
2. Smart Services: all those IT infrastructures that allow the integration of different systems but also of different firms between each other and with the external environment;
3. Smart Energy: creation of systems that avoid the waste of energy.

In Italy the Government has developed the so called “Piano Nazionale Industria 4.0” that refers to the main strategies and investments predicted for the Italian industry development. The major advantages expected are the following ones:

- FLEXIBILITY: higher flexibility through the production of small lots at the costs of large scale production;
- SPEED: higher speed among prototyping and mass production through technological innovations;
- PRODUCTIVITY: lower set-up times and reduction of errors;
- QUALITY: better quality and reduction of wastes through sensors that are able to monitor the production in real time;
- PRODUCT COMPETITIVENESS: higher product competitiveness through the exploitation of IOT functionalities.

Before developing a plan, an analysis of the Italian industrial sector was necessary. In fact, from this analysis emerged that in Italy there are few big private industrial and ICT players able to lead the Italian manufacturing transformation and there is a limited number of heads of supply chain able to coordinate the evolutionary process of value chains. On the contrary, the Italian industrial system is strongly based on SMEs and sustained by many prestigious

Universities and research centers focused on development and innovation. The guidelines of Italian government are focused on the coordination of major stakeholders without holding a dominant role and the exploitation of existing instruments to encourage the technological leap and productivity. In addition to this they are aimed at operating on enabling these factors in a horizontal perspective rather than a vertical or sectorial one with a focus on a technological neutrality.

Which are the strategic lines of action?

- **INNOVATIVE INVESTMENTS:** the main aim is to boost private investments on I4.0 technologies and goods, increase the private spending on research, development and innovation and strengthen the “finance” at the support of I4.0, start up and VC;
- **COMPETENCIES:** we need to spread the I4.0 culture through the creation of Digital Schools and to enable the work-related learning process. It’s fundamental to develop the I4.0 competencies through Universities and specialized high schools. This can be reached by strengthening doctorates and the creation of Competence Centers and digital innovation hubs;
- **GOVERNANCE AND AWARENESS:** the final objective is to sensitize about the importance of Industry 4.0 and to create a public-private governance.

These key guidelines have to be supported by appropriate infrastructures that collaborate at the definition of standards and IOT interoperability criteria and by public supporting instruments.

EUROPE 2020: European manufacturing has lost more than 10% of value added in the last 20 years, from 36 to 25%, with a strong reduction of margins and volumes, productivity and employment. Despite this negative trend, industry still generates the 80% of EU innovation and the 75% of exports. Italy is the second manufacturing industry after Germany and the sixth in exports at a worldwide level. In order to re-launch European competition, the main strategy is to set the incidence of industrial sector in GDP on 20% compared to the actual 16%. To reach this goal, it is fundamental to encourage investments in new technologies, improving the environment in which firms work, easing the entry to markets and loans and providing adequate competencies to workers. The slow industrial decline has to be stopped

and it is necessary to invest in research and education. The economic scenario is going to face a radical innovation in industry and services, Manufacturing 4.0, based on the interaction between human-machine and machine-machine and on a factory even more connected and flexible. The quantity of information available will increase exponentially. The Internet of things, people, services and data will change the business model, will modify radically the production processes and enable the birth of new products and services. Which will be the impact on companies? Inevitably it will have an influence on employment especially in terms of “mix” of skills required, both tech and soft.

The introduction of these new technologies enables the evolution to Industry 4.0 also for the small and medium enterprises and this is of fundamental importance; in fact the usability offered by these new services makes it possible to avoid the acquisition of new machines, creating new opportunities for SMEs too. Focusing on the Italian scenario it is noticeable that in 2013 the weight of investments in digital technologies on GDP was equal to 4,8% compared to the 6,8% of the European average.

The main criticalities in the Italian system regard two main areas:

- **Infrastructures:** the quality and obsolescence of actual infrastructures produce high consequences on the usage of the new ICT systems, such as those that are sustaining manufacturing 4.0;

- **Culture:** there is a high level of “analphabetism” both *digital*, in terms of usage of ICT technologies, and *functional*, in terms of lack of competencies necessary to adapt to the labor market transformations.

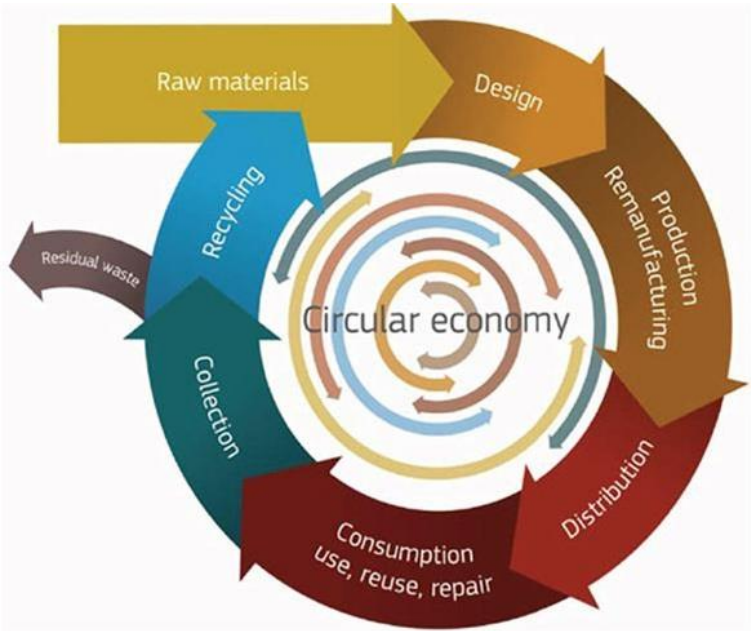
Manufacturing 4.0 means first of all investing in skills and competencies. Nowadays SMEs still do not understand that investments in the “digital factory” are needed especially in terms of new skills that can be introduced in the labor market. There is a lack of specialized figures in the quality manufacturing and for this reason it is necessary to invest in permanent training, recreating in young people the interest for manufacturing. There is an asynchrony among the university paths and the professional skills required, which are a mix of IT, design, manufacturing and marketing.

One of the major impacts of industry 4.0 will be within the supply chain, that will be in part or totally transformed, thanks to the possibility of re-localizing the production. This type of revolution could have a strategic and important role in the sustainability environment and in the green economy. In fact the transition from a subtractive to an additive production will have a substantial effect also on a new business model, the circular economy. The European Community recently underlined how the economic system should shift into a “zero wastes” production, promoting the reuse of wastes as inputs for new productive cycles.

1.4. The relationship between Industry 4.0 and Circular economy

The circular economy is composed by many phases and each of them offers opportunities in terms of cost cut, lower dependence from natural resources, improvement of growth and employment, reduction of wastes and detrimental emissions. The phases are interdependent given that companies can exchange sub-products or products can be re-built: it is important that resources will be maintained within the cycle.

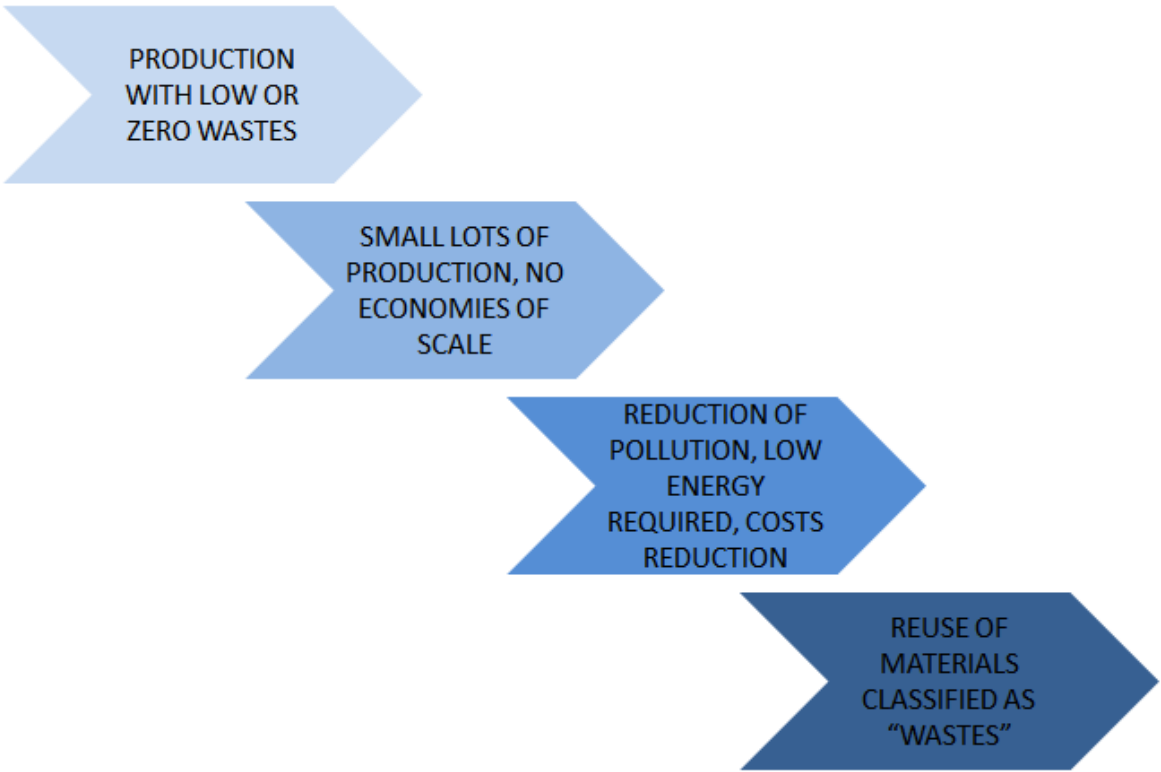
Fig. 2 Circular Economy phases



Verso un'economia circolare: programma per un'Europa a zero rifiuti – Commissione Europea COM(2014) 398 final – Luglio 2014

The environmental impact will be substantial:

Fig. 3 The environmental impact



Personal adaptation

Today’s linear “take, make, waste” economic model is reaching its physical limits given that it relies on the availability of materials, resources and energy that in the next years will be lower. These resources will probably become very scarce. This is the main reason why circular economy is growing fast and it’s a sort of alternative business that has to be explored.

The main aim of circular economy is the maintenance of product components and the value and utility of materials over time. “A circular economy is a continuous positive development cycle that preserves and enhances natural capital, optimizes resource yields, and minimizes system risks by managing finite stocks and renewable flows. It works effectively at every scale” Ellen Macarthur Foundation. If we re-think and re-manage how things are done, a world of opportunities could be born giving life to a restorative economy. The creation of a

circular value leads to a continuous flow of goods and services and this leads to a re-allocation of capitals: human, financial, social or natural. A possible solution in order to link design, manufacturing and recycling is the adoption in production of “smart materials”. These materials can communicate with the world around them, they can tell what and where they are and what needs to be done with them. In this perspective the material will become an asset that can be tracked and re-used. It will be able to control and monitor its own condition and call for repair or replacement before it fails and then provide information to allow it to be recycled. Considering that world population is growing and the economic scenario will need more and more resources, it is fundamental to change the way we do things because resources are finite. The transition to a circular economy is itself a revolution and an opportunity at the same time because it allows to see the relationship between markets, customers and natural resources in a different way and this is powered by new disruptive technologies, especially the digital ones. In fact, digital devices are changing the way we produce goods and the way we consume them through innovative business models established by innovative technologies. Circular economy, innovative business models and digital transformation will represent a huge possibility for companies to create a competitive advantage. A research made by the consulting firm Accenture indicates a \$4.5 trillion reward within 2030 for performing circular economy business models: it refers to a new concept of “waste” as something that has a value, waste not only in the sense of rubbish but comprehending all those kinds of resources (natural, products and assets) that are underutilized.

1.5. Five Circular Economy Business Models

Most companies are actually rooted in the traditional linear economic model in terms of strategies, structures, operations and supply chains. Companies seeking the advantages of circular economy will be required to develop new business models that are free of the constraints of linear zero-sum thinking.

1. Circular Supply-Chain: introducing materials that are fully renewable, recyclable or biodegradable, companies can reduce costs and increase profitability thanks to the re-usage of these materials in consecutive lifecycles. This allows companies to use

alternative stuff rather than paying a higher price for those that are environmentally dangerous or scarce.

2. Recovery & Recycling : refers to the possibility for companies to recover end-of-life products to reuse and capture valuable materials, components and energy. This business model creates a structure in which everything that is considered waste is revived for other uses.
3. Product Life-Extension : usually consumers, after a period, discard products because they don't work anymore or they are out of fashion or for other needs. The firms should be able to keep the value that those products hold. This can be reached through repairs, remanufacturing or remarketing, maintaining them economically useful for a long time. This leads to a different approach also with the product itself because firms don't merely sell it but they try to maintain it alive.
4. Sharing Platform : with the new forms of digital technologies this model creates new relationships and opportunities for consumers and firms that want to rent, share, swap or lend their idle goods. In fact up to 80% of the things stored in a home are used only once a month.
5. Product as a Service : when consumers lease or pay for products by use through the product as a service model, the business model changes: performance outdoes volume, durability surpasses disposability and companies have new opportunities of building relationships with consumers.

The transformation to circular economy means a shift from the old school approach of “take, make, waste” to a new “take, make, take, make”. As all transitions, it will require time and efforts but Industry 4.0 and digital technologies will surely play a central role in this new economic paradigm.

MADE IN CHINA 2025

The Chinese industrial plan aims at transforming China in a Manufacturing “superpower” thanks to digital innovations. The strategy is addressed mainly to those high tech industries that contribute in a sensitive way to the economic growth in advanced economies. Through

this action plan, the government would enhance the competitiveness of its enterprises not only on the domestic market but also pushing their global development. The effort for industrial modernization comes from the politic class. This plan creates a high demand for smart manufacturing products such as robots or wireless sensor networks but it requires to develop the right technologies that actually Chinese suppliers are not able to provide at their technological level. Made in China 2025 is focused on the leadership development of the domestic market in order to substitute foreign suppliers with domestic technologies in the long term: the main purpose is to generate benefits for China and to disadvantage foreign competitors. At the same time the strategy gives a look at the external environment too because Chinese investors want to accelerate the acquisition of international high-tech industries and, in order to achieve this objective, they are going to make considerable investments in core technologies abroad. These acquisitions are partly supported by the state. In this way, they would be able to absorb the lack of knowledge and replicate in the domestic market what they acquire in the foreign ones. In this perspective, there is a significant cultural influence that derives from the so called “Shan Zhai” business model that born between the end of the 20th and the beginning of the 21st century and referred originally to a bandit activity outside government control, while nowadays refers to the production of fake or pirated goods. These types of “firms” are becoming impressive market disrupters and in many cases international leaders. The best of them are flexible, innovative, open to changes and willing to take risks. For this reason, they could represent a significant rival for all European countries and especially for Italy and its recognized superiority in manufacturing. In fact, successful Shan Zhai companies then evolve into legitimate businesses with a huge portfolio of patents and in general of intellectual property, becoming disruptors in their respective sectors. Chinese ability to experiment and move speedily up the learning curve has provided domestic firms an advantage over those slowing mover foreign competitors. They are incessantly looking for “blue ocean” opportunities and for this reason they could represent a real threat.

The main aim of Industry 4.0 in China is the reduction of idle times increasing in this way the productivity, making the logistic more efficient and improving “predictive and preventive maintenance of equipment”. In addition, mass customization and the flexibility of production should be enhanced by the software integration of MES (manufacturing execution systems) and by the CRM (customer relationship management).

Chapter 2: The Relationship Human-Machine

One of the major elements that differentiates industry 4.0 from the traditional factory is the conceptual transition from ICT to digital media. It corresponds to a shift from the centrality of information technology to the centrality of an environment that enables communication, from the technologies' hardware dimension to the human-machine relationship's software dimension, where machines are going to speak the interpersonal communication language. The communication technologies, media precisely, are able to establish a relationship between individuals and the external reality and, in this regards, they are tools to act and a relationship between the individual and the collectivity, so they are social framework. The pervasiveness of digital tools is a consequence of the skills and activities used by employees in their production sectors; these skills refer more and more to digital alphabetization and the acquisition through their personal experience and less and less through the professional experience. In the transformation from automation to communication within the smart factory, the specific languages, rules, affordances of digital media have to be considered as well as the agency established between these tools and the industry 4.0 worker. The term "agency" refers to the capability of technology of enhancing the action. The worker that uses digital instruments has influenced by the limitations and possibilities of the tools used.

The relationship between technology and the person is characterized by a distribution of competencies, a cooperative relation: the final action made by the individual is the result of both his capabilities and the options offered by technology with a continuous passage between creativity and repetition, innovation and routine.

The digital media operation is based on four pillars: numeric representation, modularity, automation and variability. The automatism component of digital tools could be considered a form of alienation: the equilibrium between the employee's possibility to keep under control the process using his/her intelligence and the digital algorithms automatism that eliminate the human element from the processes analysis, is what characterize and differentiate the relationship between the worker and the work in the smart factory compared to the automatized one. An automatic process eliminates the human

intentionality totally or partially; the digital automation, represented by the algorithm, is different from the mechanic automatism because it doesn't separate the person from the action, but it shifts the decision process responsibility on the technologies users, media users.

Flexibility, complexity, connectivity are just some words that associate Industry 4.0 and the digital culture. In the digital media world, user-centered design means realization of applications and digital devices that endorse user's needs expressed through co-design practices: there is a shift from the passive user-consumer to the user- co-producer. In the smart factory world, consumer-centered means customization of products and integration of commercialization within design: the customer-centric production uses after sell feedback, so new selling strategies are put in place simply to modify the production in order to be customer-responsive.

The ideal employee in the factory of the future will be proactive and participatory compared to the "old" one, and this reflects the changes of the contemporary society and the institutions crisis; the Taylorist factory's worker built his own identity through a process based on the logical domain resistance from which he was excluded. When the employees participation and the decision processes circularity are at the center of the organization, referring to the digital network model, there is the development of the proactive or resilient worker, who is able to face traumatic events in a positive manner, reorganizing his life aware of difficulties. This new figure corresponds also to a process of subjectivism where responsibility is shared.

Between the collectivism of the resistance model and individualism of contemporary society, the labor 4.0 offers a third way represented by the team: functionality and flexibility are the main characteristics; it works with deadlines and is linked with the needs of a speed and reconfigurable production exactly as in digital networks.

The employee should be familiar first of all with those communication tools that ensure the speed of learning. In fact, digital media speak an universal language, made of standardized and global symbols; the interactive interfaces are always more intuitive, adaptive and responsive and this made the relationship human-machine easier. An important figure that

is emerging is the *team leader*, a person who coordinates the line workers, speaks with people, makes them being part of the process design, taking into consideration their observations and motivating them as a coach. For a firm, showing to their employees that it is open to innovation and new trends is itself a form of motivation, because in an “old” environment they wouldn’t find the right stimulus to become better and grow, even if the organization is advanced in plant or machines. In this new era of industry 4.0, the innovation has to be created and searched in the human capital rather than in fixed assets.

Also the approach to work is changing: if in the past the accumulation of experience and knowledge was an advantage, now the model followed by more and more organizations is based on the talent research and, under this point of view, experience not only isn’t necessary but it is considered potentially a disadvantage. Who works in a disruptive working environment is considered a “pioneer”, he/she has to show exploratory capabilities and skills in unknown circumstances. At the same time, often, in the recruiting process coexists the need to keep the skills acquired and the experience collected over time and the generational change.

2.1. The workforce subjectivity

As told before, the worker of the future will be proactive and participative and for this reason it seems that employees and collaborators’ emotional as well as functional involvement will have a growing importance. The smart factory doesn’t require only codified or technical abilities but also values, attitudes, passions, in a single word: subjectivity; the factory of the future will produce subjectivity. The skill required to workers will be the affective subscription to the company’s project. The active involvement of employees, at any level, is considered a pillar of the smart production. There is a “strategic” reason beyond the voluntary of involving employees: in this way in fact, they could signal all those things that are not in compliance or that are not optimized in the entire cycle. The advisory should be tracked and received an answer: if many people put their attention on each of the processes and stages of the cycle, it will be easier and speedier solving the problem and going on with the production, allowing in this way responsiveness and flexibility.

Nowadays, the specific objective of an organization is identifying the error, intervening also during the lot production rapidly and going back the process in order to correct the fault.

The news introduced by industry 4.0 is the acceleration of the process of creation and evolution of skills, more and more required in a working environment less and less stable. From this arises the necessity of organizing in a unique and functional way the professional competencies, and of defining a flexible modularity through which reproducing the creation and innovation of knowledge experiences.

The transformation period that everybody is living will lead to change the way in which designing, proposing and giving education with frequent updates and solutions less and less standardized.

2.2. How will the work change with Industry 4.0?

There are two types of consequences on the labor market: the first one regards tasks, times, working places and employees' competencies. The second one concerns the change of the vision of work that is the introduction of Digital Transformation within the factory. With the third industrial revolution and the introduction of IT within organizations there was a reduction of "blue collars" that are those workers assigned to mechanic and repetitive efforts typical of the Fordist assembly line. In fact, with the advent of IOT, the assembly line will require a lower manual contribution of human beings, at list for mechanical operations; people will be required for machinery settings and problem solving tasks for two main reasons:

- The smart factory products are more and more customized. The mass production, already slowed down by the so called *just in time*, seems to be only a memory. The consumer figure totally changed in the last years because he is not only the final user that buy a product but he is at the center, he is the protagonist since the beginning of the production;
- The assembly line is able to communicate among its different components thanks to the machineries interconnection allowed by IOT and to manage physics jobs in a more efficient way through the robots utilization.

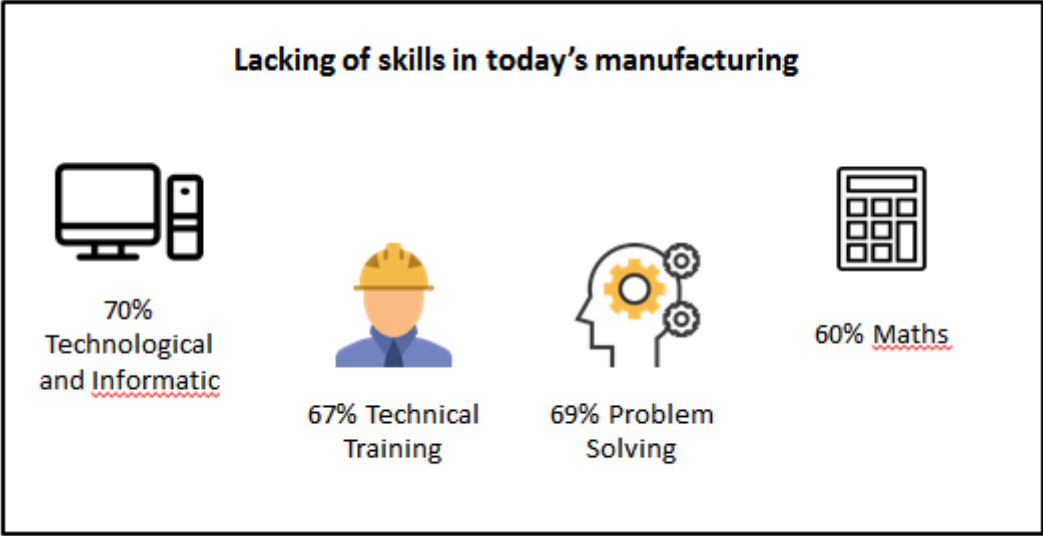
Analyzing this scenario, the blue collar figure will disappear within organizations while the "white collar", specialized workers, will have to accomplish few tasks but with a higher

degree of responsibility.

The second revolutionary change regards times and places of work. The employee could control the production remotely given that it is virtually managed, thanks to his computer at home or his smartphone/tablet. In fact, it will be possible to identify and solve problems in the assembly line without being physically present with the introduction of webcams and sensors.

This doesn't mean that the factories of the future will not be composed by persons and will be completely managed by machines, but it is almost clear that workers will interface themselves with their own tablets connected at the company's network rather than at the machine itself. Of course, this new control system will have a significant impact on workers' daily life because it allows more flexible working hours and the possibility, if necessary, to work from home or remotely.

Fig. 4 Lacking of skills



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Skills are what will differentiate one worker from another, it's all about skills. The advanced knowledge of informatics systems, the real time capability of big-data analysis and a deep understanding of cyber-physic systems will be the basis for the workers of the future. At the same time, the centrality of innovation within these sectors will require an increase in the budget spent on R&D to keep companies attractive in the market place.

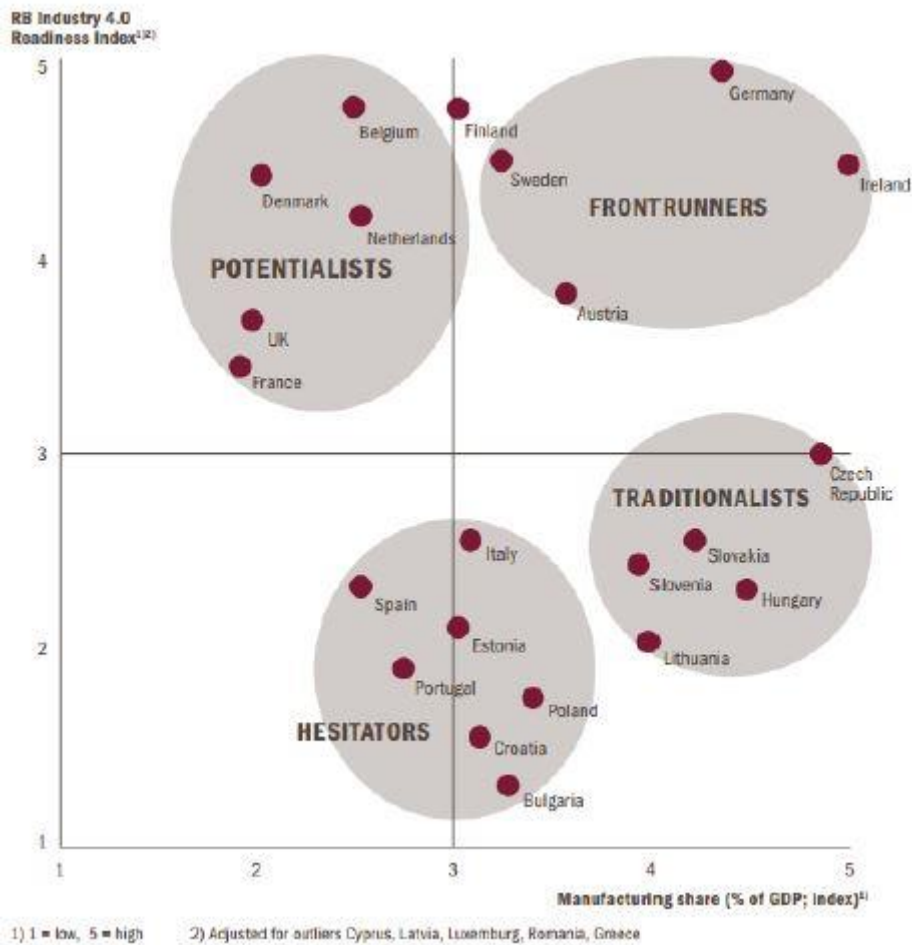
2.3. Could Industry 4.0 take back the production in developed countries?

In the last fifteen years in the USA more than five million jobs went lost in the manufacturing sector and in Europe the situation wasn't better. The main reason is the production delocalization caused by the availability of cheaper workforce, energy and by the plant proximity to the target markets. It is still difficult to evaluate if Industry 4.0 could play a central role in taking back the production even if some elements allow to establish that a slow phase of re-shoring has begun.

A BCG's analysis sustains that, as a consequence of Industry 4.0 diffusion, in the next ten years there will be an increase of 390 thousand jobs. This new productive system will be focused more on quality than quantity, as was usual in the past years: it is easy to think that the digital transformation will not lead to a significant grow of jobs available, but given that the new smart factories will be focused on a higher productivity rate determined also by the lower number of workers, the Industry 4.0 employees will receive training and qualification sessions constantly.

If, in order to increase productivity, it's necessary continuous innovation, the firm will be forced to reinvest part of their gains in training in order to ensure to itself even higher rates of innovation.

Fig. 5- Industry 4.0 readiness index



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With the introduction of these technologies, it is easy to think that the worker isn't anymore at the center of the production. The consistent reduction of his manual contribution could be interpreted as the disappearance of his value within the company and so that now the real value sources for an entrepreneur are the smart devices and machines. In the past, the concept of work coincided with the manual, physical efforts while nowadays part of these efforts are perfectly substituted by machines that are able to sustain, of course, higher weights and generally are not characterized by the human limits. This is definitely a change that will characterize more and more the work of the future.

But the superiority of individuals' work on machines is absolutely showed by the fact that humans will design new products, set machines and solve problems that they could have

during the productive cycle. A robot cannot work if a specialized worker has not set it before and even if machines, thanks to sensors, will be able to communicate each other constantly and to solve problems in an easier manner, there will be always some aspects that go beyond the technological control. Machines don't substitute workers but they shift the center from the physical and manual work to a more creative and designing one that characterizes the contemporary era.

2.4. Work-life balance: an obsolete concept

The concept of work-life balance seems to be based on a negative conception of work: work and life are different and separated things, work is necessary to alive but takes time to life, that is something different. It is important to demonstrate how the development of industry 4.0 could contribute to undermine the conceptual and space-time assumptions of this vision. First of all, as told before, times and spaces will change, there will be the possibility to control the production remotely or at home so the physical presence within the company is still necessary but with a lower, different degree compared to the past. Working from home will be quite normal as well as working remotely when being physically present will not be possible for different reasons.

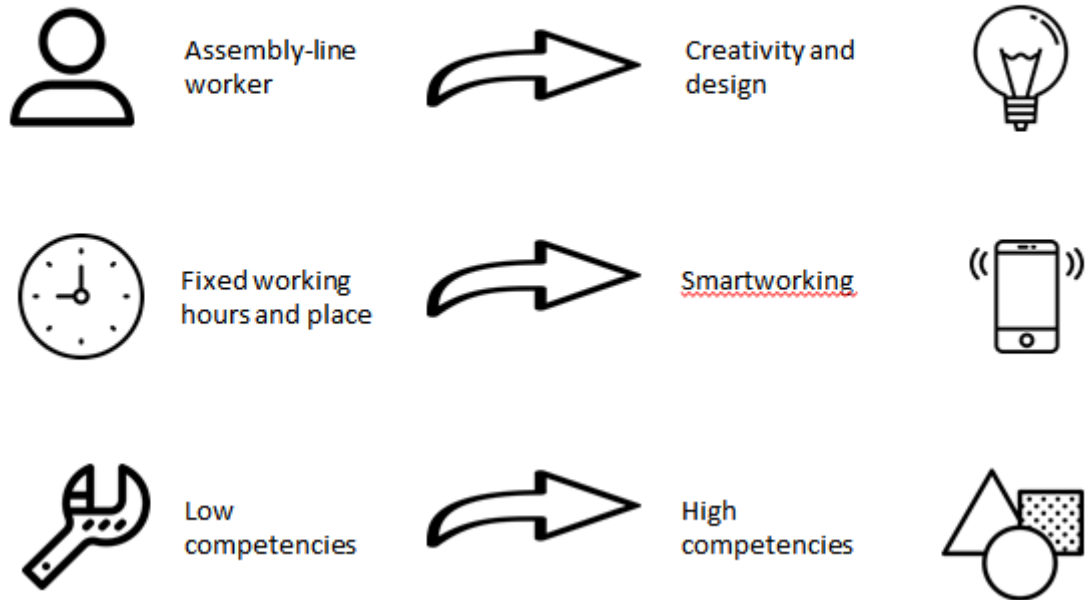
The new job, based on creativity and design, human-centric and not based on an individual's strength or physical efforts, will change also the role of work in the daily life.

Certainly, it will not be possible to put aside fundamentals rights such as working hours, but the fact that this is fixed in rigid schemes could be a limit more for the worker itself than the entrepreneur. In this way, there is a reduction of the employee's risk of alienation from his own job, because with this new productive model there is a closer relationship between worker and product.

Also the relationship between firm and education will change, given that the central aspects of industry 4.0 are those competencies that determined the choice of a worker rather than another. The image of the "training company" will be more and more common and diffused in the future. In fact, the European country in which this new model of production is emerging is Germany, where there is a close relationship between companies and education institutions thanks to the *duale21* model.

Fig. 6 – How the work is changing with Industry 4.0

FORDIST LABOR VS INDUSTRY 4.0. LABOR



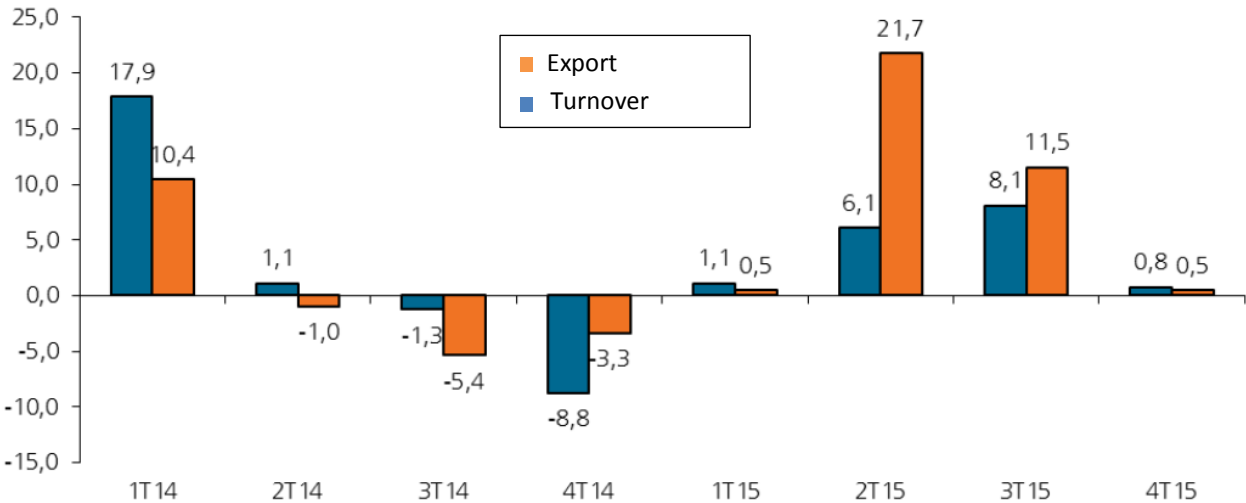
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Chapter 3: The Jewelry Sector

The Italian gold sector is usually identified in those activities and firms that are able to transform gold, silver, platinum and precious stones for the production of rings, necklaces, earrings and other decorative objects.

The variety of products that can be produced in this type of industry is really high: the several different manufacturing technics and the use of precious stones allow the production of very different objects. Therefore, the gold industry is a sector in which differentiation and flexibility could be strategic elements for the companies, even if, on the other side, it is impossible to distinguish a net classification among the commodities classes. The gold sector is recognized all around the world as an example of Italian manufacturing excellence that represents the quality of Made in Italy. Actually, it is composed by 9000 companies with a reduction of 28% compared to 2001 estimates due to the closure of more than 3400 firms. The number of the sector’s employees amounts at 32.000 persons. In 2015 the sector’s turnover grew of 3.8% compared to 2014. The jewelry firms have experienced a positive evolution in international markets, and this is reflected in the export growth of 8.8%. Imports have definitely increased too, +25.8%. Made in Italy jewels sales abroad are increased especially in Swiss (+12.9%), USA (+10.4%), France (+37.2%) and UK (+18.5%).

Fig. 7 Turnover and export of the jewelry industry



Elab. on ISTAT data

Table 1 - The development of the Italian jewelry industry – million € and var. % (estimate)

	2014	2015	Variation % 2014	Variation % 2015
Sales Volume (*)	6.857	7.118	3,4	3,8
Exports (**)	6.035	6.542	-0,2	8,4
<i>of which in precious jewels (***)</i>	5.198	5.655	-0,4	8,8
Imports	2.147	2.701	12,2	25,8
<i>of which in precious jewels(***)</i>	991	1.412	8,2	42,5
Trade balance (export-import)	3.888	3.841		
<i>of which in precious jewels(***)</i>	4.207	4.243		

Elab. on ISTAT data

The small-medium size firms that characterize this industry are highly qualified and represent the excellence of Made in Italy abroad. For this reason, exports have a consistent impact on the turnover and data testify it. Exports represent 75% of the export share, 25% more than the other fashion sectors and 35% more than the whole Italian manufacturing sector. The table below represents the exports percentage for each market abroad:

Table 2 - Exports for each country (million € and variation % on the corresponding period)

Country	2015	Weight 2015	Variation % 2014	Variation % 2015
Switzerland	1.295,4	19,8%	-0,1	12,9
United Arab Emirates	1.065,5	16,3%	-4,0	-11,4
Hong Kong	743,0	11,4%	117,9	12,9
USA	614,9	9,4%	8,7	10,4
France	614,5	9,4%	20,9	37,2
UK	206,2	3,2%	15,2	18,5
Turkey	204,8	3,1%	-1,1	10,6
Germany	156,7	2,4%	-6,9	6,2
Spain	123,0	1,9%	13,5	16,8
Jordan	104,8	1,6%	14,0	26,9
Mexico	94,6	1,4%	1,3	53,5
Israel	76,1	1,2%	6,3	-1,7
Panama	72,0	1,1%	5,9	20,9
Romania	71,5	1,1%	0,9	13,7
Dominican Republic	70,7	1,1%	25,1	59,4
Total	6.542,2	100%	-0,2	8,4

ISTAT – ATECO 321.

The gold sector is one of the most export-oriented of the whole manufacturing industry and it is fundamental to leverage the internationalization process given that the major number of new potential consumers come from developing countries - 100 billion of new wealthy people come from Brazil, India and China. Italian firms have to face new challenges and balance the efficiency / differentiation relationship.

The gold industry assumes the traditional structure of the Italian district: many small or medium size firms geographically close each other, that share manufacturing and technological tools and competencies creating different jewelry districts around Italy.

3.1. Italian Districts: Vicenza, Arezzo, Valenza

Industrial district is defined as a production system constituted by a group of companies, mostly of small-medium size, characterized by a vertical and horizontal integration tendency and a productive specialization, generally gathered in a specific territory and connected by a common historical, social, cultural and economic tradition.

In 2011 ISTAT detected 141 industrial districts in Italy, compared to 181 in 2001. They are distributed on 15 regions in a non-uniform way: Lombardia – 29 – and Veneto – 28 – represents the 40,4% of Italian districts. These are the main sectors in which they are developed and in which Made in Italy excels:

Table 3 – Italian districts distribution

				Absolute Values				
MAIN	Industrial	Total	Total	Manufacturing	Manufacturing	Specialization sector	Specialization sector	Average dimension of
INDUSTRY	Districts	Employees	Territorial Units	Employees	Local Units	employees	Territorial Units	Specialization sector
								Territorial Units
Textile and Clothing	32	1.277.893	314.275	386.335	48.278	123.839	16.195	8
Leather and Footwear	17	428.977	108.648	150.866	18.335	58.953	6.449	9
Home goods	24	551.697	131.790	179.656	19.200	65.404	7.381	9
Jewelry/ Musical instrument	4	209.440	48.049	63.217	7.353	14.918	2.350	6
Food Industry	15	243.969	63.427	62.810	7.326	17.463	1.620	11
Mechanic Industry	38	1.879.639	416.361	572.370	55.167	306.749	28.148	11
Metallurgical Industry	4	60.743	13.922	22.819	2.147	3.929	68	58
Chemical and Rubber Industry	5	155.150	36.239	45.350	4.421	13.331	520	26
Paper and board printing Industry	2	80.019	19.718	21.067	2.510	5.465	288	19
ITALY	141	4.887.527	1.152.429	1.504.490	164.737	610.051	63.019	10

ISTAT: 9° Censimento dell'industria e dei servizi e Censimento delle istituzioni non profit I distretti industriali 2011

The jewellery district : VICENZA

The gold district of Vicenza is one the most prestigious cases of art and jewelry production that grew over time. Goldsmith in practice born in II-I century b.C. even if the real launch of the sector dated back to 1800 when, in addition to ancient laboratories and small workshops, dozens of small family firms began to develop and was able to grow and innovate themselves: nowadays, those companies are capable of anticipate and accommodate the market trends, keeping a deep bond with their values.

It comprehends the area of Veneto region that goes from Vicenza to Bassano del Grappa and Trissino.

Fig. 8 District of Vicenza



https://it.wikipedia.org/wiki/Provincia_di_Vicenza

Within the district there are many small-medium size firms highly specialized that work as contractors and, at the same time, large firms highly mechanized that drive the whole district and make the products famous all around the world. Up to 2004 there were 1230 companies registered, compared to 560 of today: 80% are composed by less than 10 employees while the remaining 20% by 15 to 50 workers: approximately 5000 persons are actually employed in the gold industry of the Vicenza district.

The gold production is focused on jewelry products with high value added and excellent finishes compared to tendencies of decades ago, in which Vicenza district was specialized in the production of chains, medals and straps. This transformation is a consequence of the introduction of new machineries and new production techniques as well as the strengthening of commercialization phase.

Companies in this area were the firsts to exploit economies of scale through the use of machineries that allow the production of high quantities of products, guaranteeing efficiency and effectiveness to production. The plants are the biggest of the sector and the relationships among firms are very diffused due to a strong division of labor between sender and sub-supplier.

The district is characterized by several strengthened points. The production is distinguished by a high level of quality and flexibility that descends from the experience, know-how and competencies diffused. More than that, there is the existence of a complete supply chain that comprehends both upstream firms and research and training centers, a specialized laboratory and a bunch of competencies rooted in the territory. Finally, all the firms are export-oriented, focusing particularly on markets abroad and on the internationalization process.

The weaknesses mainly descend from the crisis and the growing competition coming from the developing countries, Turkey and China in particular, because they are able to sell cheaper products at competitive prices. Exports are in part penalized by the customs tariffs that disadvantage the export of Italian products. Moreover, "Made in Vicenza" products do not benefit of particular protection or identification that could certify the origin and excellence characteristics, and this has a negative impact on consumers choices: they are not able to distinguish the origin of a product, and for this reason they are going to buy the cheaper one, don't taking into consideration the quality differences.

Finally, there is a scarce strategic planning due to the small size of firms that often implicates a dependence from the wholesalers and importers.

The jewellery district : AREZZO

The gold district of Arezzo is located in the Tuscany region and comprehends the area that goes from Val di Chiana Arentina, area Arentina and Valdarno Arentino. The local jewelry production born between the XIV and XV century with the main aim of satisfying the internal demand. The gold art was strictly connected with the development of the religious art and for this reason it was more and more requested especially within churches. The modern jewelry born in 1900 and, after the second world war, the industrialization process started and became stronger and stronger in 1970-80s thanks to the sharing of competencies and innovations among companies.

The district was composed by 1300 small size firms that mostly work for other larger companies due to their superiority in artisanal production. The overall district was formed by 8000 employees representing the one with a higher number of both workers and firms. The major weakness was about the size of the firms: they were so small that the existence of

a famous brand was not possible, there was a scarce attention to the marketing strategies to adopt and it was difficult to establish new distribution channels. As well as the other districts, tradition, high knowledge of raw materials and territory distinction made this district one of the most thriving ones.

Fig. 9 District of Arezzo



https://it.wikipedia.org/wiki/Provincia_di_Arezzo

The jewellery district : VALENZA

The Valenza district comprehends eight close towns, all in the province of Alessandria. The traditional gold production born in 1840 and at the beginning of the first world war more than 40 firms already existed. After this period, this number reached the 300 companies thanks to the economic boom. Actually, the operative small-medium size firms are 1108 with 5500 employees, with an average of 5-6 workers per firm.

The importance of the Valenza district was clear especially in 2007 when the exports reached 13,8% of the whole Italian exports in the jewelry sector.

The companies are specialized in high quality jewels and this is one of the strengthened points

of the area as well as the presence of prestigious brands, well known and recognized at both a national and international level.

Fig. 10 District of Valenza Po



[https://it.wikipedia.org/wiki/Valenza_\(Italia\)](https://it.wikipedia.org/wiki/Valenza_(Italia))

3.2 The effect of globalization and recession on jewelry Italian districts

Before proceeding with the explanation of how digital manufacturing is affecting the production process of our firms, I would examine the evolution of Italian jewelry districts in the globalization and recession crises that have challenged them in their way to innovate, organize and internationalize themselves.

The analysis will underline meaningful differences among the three major districts regarding their upstream and downstream internationalization strategies during two periods that have signed the whole economic scenario: the increased global competition in 2000s and the world recession of 2008-2009. The examination will consider both internal and external factors such as:

- Structural differences among the three Industrial Districts, Vicenza, Valenza, Arezzo;
- Different business strategies;

- How districts and jewelry GVC – Global Value Chain – are linked together.

There are opposite debates regarding how IDs have faced these periods: from one side, theories support that the ID model was not adapted to face the globalization challenges; from the other, theories suggest that ID firms are still performing better than non-ID ones in the global market.

An empirical literature emphasizes the transformation of industrial districts, mainly forced by external dynamics such as the rise of new global competitors, that have led them to change their structural characteristics and internationalization strategies (Rabellotti et al., 2009; Chiarvesio et al., 2010). However, the literature does not explain if such transformations are impacting IDs in divergent or similar ways, and the extent to which these external factors may explain their economic performances. I am going to report a comparison made to understand if and how their models of insertion in the global markets affect their competitiveness, and if the entrance of exporters from emerging countries have contributed to develop diverging export strategies in the face of the globalization crisis in 2000s and the recession crisis in 2008.

In the analysis of IDs there is an integration among the ID literature and the GVC framework, in order to understand the transformation of industrial districts starting from some GVC-related variables; this will highlight how upgrading opportunities are shaped by external linkages to global industries.

The jewelry districts have been analyzed in the period 2001-2010 “using trade data, secondary information and interviews with district firms and industry experts” (De Marchi, Lee, Gereffi, 2014). The scenario in 2010 was characterized by 72% of 2010 Italian jewelry exports made by the three districts, making Italy the largest exporter of jewels. From a GVC point of view, this sector has been influenced by growing international competition and changing consumer markets, and this has a meaningful impact on ID performance.

For many years IDs had an important impact on Italian economy, especially representing an excellent example of Made in Italy craftsmanship. They depicted a good alternative to the Fordist model thanks to their embeddedness in the socio-cultural context, the face to face interactions and the advantage of highly skilled local workforce.

With the changes in global economy, their competitive advantage originated in the local dimension was going to collapse, and this forced firms to change their structural

characteristics and internationalization strategies as well. In fact, while in the past firms internationalized through the export of final goods, now an increasing number of ID companies are outsourcing part of their manufacturing activities and, in few cases, also distribution and branding ones (Nassimbeni & Sartor, 2005; Belussi & Sammarra, 2010). At the same time, ID firms have dealt an influx of FDI (foreign direct investment) by multinational enterprises (Sammarra & Belussi, 2006). These opposite outward and inward forms of internationalization have developed different outcomes among IDs. In some districts, internationalization led to the development of a more skilled workforce and an economic upgrading of firms, while in others it has obstructed the competitiveness. In this perspective, the GVC framework developed since the middle of 1990, offers a valuable framework that analyzes how global firms in different international industries impact local development prospects (Gereffi, 2005). The GVC analysis embraces different dimensions, such as an input-output structure of all the activities of the supply chain, their geographical configuration, the governance that coordinates GVC networks and the institutional context in which they are rooted. Italian ID jewelry firms participate in GVC in multiple ways, in fact they have adopted two types of internationalization. The “upstream” trajectory refers to importing jewelry parts and components for domestic processing; the “downstream” path involves exporting final goods or establishing marketing channels abroad. The intensity of internationalization depends on the type of GVC they are rooted in. As a consequence, ID firms that are facing strong competition will be more inclined in outsourcing a high percentage of production abroad, while high-quality districts will continue to develop local manufacturing skills with limited delocalization of the activities.

3.2.1 Globalization and the Jewelry GVC

As outlined above, the ID and GVC dimensions of the jewelry industry have faced numerous changes over the last years. Distributors and retailers are those actors of GVC that capture the highest share of value produced, and their presence acquired importance as the consolidation of jewelry chains and the vertical integration of retailers and suppliers happened in the global gold industry. In addition to this, there was a high diversification of retail channels and an increasing importance of non-store retailers and non-jewelry

discount chains, such as on line jewelries, that forced companies to develop new strategies (Gereffi & Lee, 2008).

Due to the rising price of gold, the global demand for gold jewelry decreased of 45,5% in 2000-2009, and this reflected a reduction in consumption and forced consumers to change their tastes and habits: that’s the reason why there was an increase demand for silver jewels and items that mix together different elements.

Meanwhile, the global gold industry faced a dramatically increase from \$16 billion in 2001 to \$44 billion in 2010. The global consumption and production of jewels changed effectively also from a geographical point of view (Table 4).

Table 4 - The world’s leading jewelry importers and exporters, 2001-2010

Top five exporters				Top five importers			
2001		2010		2001		2010	
Italy	22.3%	Italy	10.4%	US	33.6%	Switzerland	15.4%
Thailand	7.8%	China	10.3%	UK	11.0%	US	14.6%
US	7.7%	India	10.2%	UAE	8.9%	UAE	13.8%
India	7.3%	US	8.2%	Japan	7.2%	Hong Kong	13.6%
Hong Kong	5.9%	France	7.5%	Hong Kong	6.4%	UK	7.0%

V. De Marchi, J. Lee & G.Gereffi

From this table is evident how from the supply side, Italy, that in 2001 had a dominant position with 22,3% market share, faced a significant decrease to 10,4% in 2010, surpassed by the advantage and competition of developing countries such as India and China that reached 20,5% market share in 2010, compared with 13,0% in 2001.

On the demand side, the most significant change is given by the market share reduction of US market, passing from 33,6% in 2001 to 14,6% in 2010 which was counterbalanced with the emerging economies such as UAE (United Arab Emirates), Switzerland and Hong Kong. It is evident how Italy suffered the globalization growth and the international competition, as well as the economic recession, despite having been the world’s leading exporter of jewels for years.

The globalization crisis in 2002-2003 and the economic recession in 2008-2009 impacted the jewelry GVC in different ways. The first regards a supply side effect characterized by the

entrance of new emerging country exporters; the second involves a demand side change entailing a reduction of consumption in export markets.

3.2.2 Patterns of GVC integration and the Globalization and recession challenges

Italian jewelry districts started entering international markets in the '50s and '60s and thereafter they became one of the most meaningful center for jewels production worldwide, in fact they continued grow through the '90s. Starting from 2000s, we have seen that the global economic scenario presented numerous challenges that undermined districts competitiveness. These changes impacted the three most important jewelry districts in three different ways. In the period 2002-2010 in fact, according to ISTAT and Chamber of Commerce data, all three districts registered a reduction of number of firms: 22,5% in Arezzo, 24,0% in Valenza and 38,6% in Vicenza (Table 5). Simultaneously, there was a significant reduction of employees too. While in Valenza district the average size of firms remained more or less the same, a significant change characterized Vicenza and Arezzo, where the number of employees decreased faster than the number of firms, pointing out a downsizing process. Despite the overall downsizing throughout the three IDs, their internationalization strategies and export performance diverged significantly: they differed in terms of upstream and downstream internationalization during both the globalization and economic recession periods.

Table 5 - Changes of Italian jewelry districts, 2002-2010

	Valenza Po	Arezzo	Vicenza
Number of firms (2010)	879	1220	713
Variation, 2002–2010	–24.0%	–22.5%	–38.6%
Number of employees (2010)	6767	9077	6547
Variation, 2002–2010	–25.8%	–35.5%	–43.9%
Average number of employees (2010)	7.7	7.4	9.2

3.2.3 Downstream Internationalization

Vicenza district was the worst performer in jewelry exports, with a reduction of -8,8% of market share in the period 2001-2010 (from 35,5% to 26,7%). The exports fell in value by 27,2% in 2001-2004, and by 20,3% in 2007-2010. During the globalization crisis, Valenza district, oppositely, was the best performer registering a lower reduction in exports compared with the pre-crisis levels – 13,9% in 2001-2004 – but during the economic recession in 2008-2009, it lost ground to Arezzo. Indeed, during this period in which Vicenza and Valenza registered a decrease in exports, Arezzo records an increase of 6,4% (Table 6).

Table 6 - Export performance during globalization and recession crisis

	Valenza Po	Arezzo	Vicenza
2001	465	1756	1980
2004	400	1143	1441
2007	646	1440	1531
2010	562	1532	1220
2001/2004	-13.9%	-34.9%	-27.2%
2004/2007	61.4%	26.0%	6.2%
2007/2010	-12.9%	6.4%	-20.3%

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Analyzing the export destinations it is possible to find the existence of both inter and intra districts heterogeneity: the IDs changed their international trade partners and followed different export strategies in the face of the recession crisis as compared to the globalization one. Each district seems to have direct its exports in different geographical areas: Valenza focused on advanced economies in Europe such as Switzerland, UK and France, and Asia while Arezzo and Vicenza increased the exports market share in emerging economies (Table 7). Also China became one of the most important export destinations especially for Arezzo and Vicenza, but generally for all firms in the three IDs, forced to change their strategies in front of the global recession crisis.

Table 7 - Italian IDs downstream internationalization strategies

	Valenza Po	Arezzo	Vicenza
Top export markets			
2001	Switzerland (23.4%)	US (32.2%)	US (39.6%)
2004	Switzerland (35.8%)	US (31.4%)	US (26.8%)
2010	Switzerland (47.7%)	UAE (31.9%)	UAE (14.3%)
% of developing economies among the top 10 export markets			
2001	0%	13.0% (Panama, French Antilles)	3.1% (China)
2004	0%	8.4% (Panama, Turkey)	12% (China, Jordan)
2010	0%	14.6% (Turkey, Panama, Tunisia)	19.4% (China, Libya, Jordan)
Fastest growing export destinations			
2001–	Central-western Europe	Central Asia (+334%);	Central Asia (+123%);
2004	(+37%); Central Asia (+16%)	Central-western Europe (+47%)	Mediterranean Area (+102%)
2007–	Mercosur (+305%);	Central Asia (+251%);	Northern Africa (+153%);
2010	Central Asia (+265%)	Mercosur (+236%)	Mercosur (+133%)

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3.2.4 Upstream Internationalization

Upstream internationalization refers to those activities of the jewelry value chain that took place in the upstream segments, such as producing or importing parts for further processing. The table 8 reports three types of import variables: the total imports of jewelry and their parts; the part of these imports reserved for further processing within Italy and not for final consumption (IfP) and the ratio among imports for production and export.

Upstream internationalization rose in all the three districts, considering that the IfP increased between 2001-2010.

Table 8 - Italian jewelry districts' imports

		Total imports	Imports for production (IfP)	IfP/exports
2001	Valenza Po	298	284	61.0%
	Arezzo	34	18	1.0%
	Vicenza	106	66	3.3%
2010	Valenza Po	430	412	73.2%
	Arezzo	98	92	6.0%
	Vicenza	129	94	7.7%
2001/2004	Valenza Po	-16.9%	-18.8%	-5.7%
	Arezzo	1.8%	21.3%	86.4%
	Vicenza	33.7%	59.8%	119.6%
2007/2010	Valenza Po	-3.9%	-2.8%	11.7%
	Arezzo	95.0%	156.0%	140.6%
	Vicenza	-46.8%	-55.0%	-43.6%

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Import patterns are variable from district to district. The imports from foreign suppliers decreased for the Valenza firms during both crisis, while increased in Arezzo district especially during the second crisis period. Vicenza's pattern is characterized by a mix: it increased during the globalization crisis and decreased during the recession, and this reflected also changes in the quality of imports. Also the analysis of the ratio import/export confirmed the growth of upstream internationalization: the market share generally grew between 2001-2010.

The dynamicity that characterizes our districts is confirmed by the analysis of the main exporters to Italy's jewelry districts. The variety of importers and their respective importance changed dramatically through the past decade. As well as for exports, developing countries are assuming a more and more important role as suppliers of Italian districts, particularly in Vicenza (Table 9).

Table 9 - Upstream internationalization strategies

	Valenza Po	Arezzo	Vicenza
Top import markets			
2001	Belgium (54.9%)	US (21.0%)	Switzerland (23.6%)
2004	Belgium (49.5%)	China (15.4%)	Hong Kong (13.9%)
2010	Switzerland (45.5%)	France (28.6%)	Belgium (12.7%)
% of developing economies among the top 10 import markets			
2001	9.0% (India, Thailand)	44.3% (Turkey, China, Thailand)	33.6% (Thailand, China, Turkey)
2004	8.5% (India, Thailand, China)	61.6% (China, Turkey, Jordan, Thailand, India, Romania)	33.8% (Thailand, China, Turkey)
2010	10.3% (India, Thailand, China)	33.3% (Tunisia, China, Jordan, Thailand, India, Romania)	58.8% (India, China, The Philippines, Thailand, Turkey, Romania)
Fastest growing import markets			
2001–2004	Africa (+22,990%); Oceania (+1278%)	Central-western Europe (+296%); Central Asia (+232%)	Central-western Europe (+1010%); Africa (+965%)
2007–2010	Mercosur (+147%); European non-EU (+66%)	Mercosur (+1469%); Europe (+756%)	North-Africa (+4842%); Central Asia (+335%)

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3.2.5 The heterogeneity of Internationalization Strategies

The trade data analysis shows good heterogeneity in the internationalization strategies of firms in jewelry Italian districts, even within the same country and sector (Table 10). As explained above, during the two periods of crisis, districts have changed their export and sourcing destinations in many directions.

Valenza Po seems to be the only district where leading firms are still maintaining local organizational structure and the internationalization strategies remained solid during the crisis periods (Unicredit & Federazione Distretti Italiani, 2011). However, exports and production are concentrated on the hands of the main leading firms with steady increase: Crova-Bulgari and Damiani. These companies during the recession periods, decided to increase the selection of suppliers, investing in order to develop their capabilities. More than these, they relied on other suppliers in Italy, within the other districts. In general,

entrepreneurs in Valenza are rooted in the territory and enjoy the presence of strong local institutions.

Table 10 - The different jewelry districts responses to the two crisis

Internationalization	Globalization crisis (2001–2004)				Recession crisis (2007–2010)				
	Valenza Po	Arezzo	Vicenza	Valenza Po	Arezzo	Vicenza	Valenza Po	Arezzo	Vicenza
Downstream									
Export ranking	1 (-)	3 (-)	2 (-)	2 (-)	1 (+)	3 (-)	2 (-)	1 (+)	3 (-)
Main export markets	Advanced	Advanced and developing	Advanced	Advanced	Advanced	Developing and advanced	Advanced	Developing and advanced	Developing and advanced
Upstream									
Import for production (IFP) ranking	3 (-)	2 (+)	1 (+)	2 (-)	1 (+)	3 (-)	2 (-)	1 (+)	3 (-)
IFP/export ranking	3 (-)	2 (+)	1 (+)	2 (+)	1 (+)	3 (-)	2 (+)	1 (+)	3 (-)
Main import suppliers	Advanced	Developing	Advanced and developing	Advanced and developing	Advanced and developing	Advanced and developing	Advanced and developing	Advanced and developing	Advanced and developing

Overall, Valenza district seems to follow a double path: a majority of firms are not performing good, maybe those that have a lack of managerial or marketing skills, and few others that are competing on international markets.

Arezzo was forced to restructure itself during the 2000s, due to the delocalization of Uno-a-Erre, the district's leading firm, that had to face a fierce competition. While many small firms are still living a period of decline, especially those that have not invested in innovation and branding, a dynamic group of SMEs is emerging for the positive results in international markets. These successful firms have invested in product innovation, brands and in retailing to target higher-end markets. This means that Arezzo faced what is so called *qualitative upgrading* and the move to lateral specializations.

Vicenza is characterized by many unbranded companies that work as subcontractors and that were very strongly hit by the crisis. Their competitive advantage derived from the economies of scale rather than product differentiation. However, in the last decade a group of dynamic firms born that have invested in process and product innovation, targeting low-end products. The big leading firms of the district such as Roberto Coin and Muraro have not a strong connection with local producers. In fact, during the recession, reacted by downgrading their production, for instance substituting gold with silver, while others committed in partial upgrading, improving products and processes but not carrying out value added activities such as design and marketing. One of the main causes of the crisis is the small dimension of firms that do not allow them to make investments.

In conclusion, it has been showed that there is a growing heterogeneity within the Italian gold jewelry districts and have been identified few dynamic firms that played a significant role in the districts' performance in internationalization, thanks to their upgrade in product design, branding and retailing, highlighting the importance of functional upgrading to downstream activities.

3.3. Digital manufacturing process vs Traditional manufacturing process

The productive process of a jewel is that thing that allows us to understand how technology can transform something non-existent in a diamond, something that is “forever”. At the same time, the manufacturing aspect is fundamental, is that condition that differentiates our Made in Italy product from the fakes. Here below an analysis of how the traditional manufacturing art and the new technologies 4.0 can coexist and be complementary, simplifying and reducing the efforts.

The modern productive process is articulated in 7 main phases:

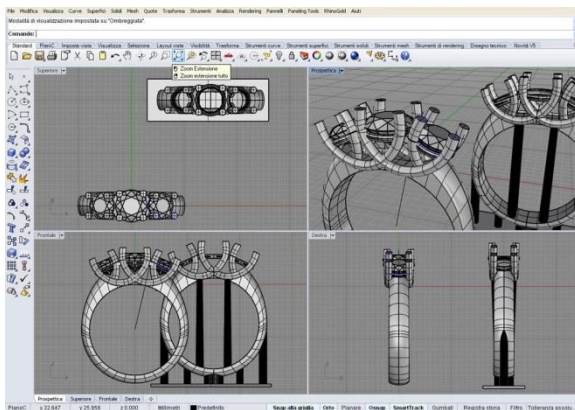
1. DESIGN: this is one of those phases that cannot be replaced by machines. It consists of hand-drawing the ideal jewel on a paper, usually by a stylist or a designer, taking into consideration trends, fashion styles and the culture.
2. COMPUTER DESIGN: after the hand-drawing of the jewel, it will be translated in computeristic terms. There are two main software used to make this transformation, Cad Design and Rhinoceros 5.0. In this way, every single detail will be revealed in the system that is able to produce a three-dimensional image of the final product.
3. PROTOTYPING: the file produced by the design programs will be transferred to a 3D printer and the sketch becomes tangible. This 4.0 technology allows to reproduce perfectly the jewel in every detail. The file passes from the computer to the printer and the result will be a wax mold. (yellow wax)

Traditionally, after the hand-drawing, the wax was injected in some rubber molds. The figure of the pattern-maker, that nowadays has disappeared, was responsible of melting the metal and creating a single prototype, refining it and producing a rubber matrix for the series production. (blue wax)

4. LOST WAX CASTING: the different wax molds printed by the 3D printer will be put into a furnace in which the wax melts and the space will be occupied by gold or generally by the metal chosen for the production.

5. FINISHING: this is the phase in which the artist makes the difference. It is a step that cannot be replaced by machines, that requires experience and attention to details, that allows the product to become an artisanal product and maintains the made in Italy value. Practically speaking, the artist has to smooth the jewel: this is the true goldsmith job.
6. SETTING AND BUFFING: precious stones are wedged in and then the final touch consists in polishing the jewel, making it perfect before selling it.

Fig. 11 Digital manufacturing process



2. Computer Design

<http://www.adrianagioielli.it/creazioni.html>

3. Prototyping

<http://www.selltek.it/settore->



4. Lost Wax Casting

<https://www.creteau.eu>

3.4. Digital transformation in the jewelry industry

Up until now I spoke about digital transformation in general terms, referring at the new technologies that could be applied in order to increase efficiency and reduce wastes, each of them with a specific objective.

Since now, only the technologies that regard the jewelry sector will be taken into consideration. It will be analyzed, as anticipated above, which phases of the production process they are going to impact and how they are going to do that: the analysis will take two directions.

From one side, it will be analyzed in depth the digital transformation's impact on the **manufacturing process** of a product that traditionally requires high handcraft capabilities and is recognized for its craftsmanship; from the other one, it will be demonstrated how the vast majority of the companies operating in this sector, even though they are small size firms, became aware of the fact that they had to develop their **websites** and consequently the **e-commerce** sales in these last years.

3.4.1. Digital transformation's impact on manufacturing

After some interviews with people working in the sector and numerous researches, it is interesting to describe how the companies, working in the same market, adopt different strategies and have different organizational structures.

In this business there is the existence of two major kinds of firms. The first one is referred to the middle size firms that are vertically integrated and are able to control the entire product process. This is possible because they own "in house" those new technologies that allow them to eliminate the presence of the contractor. Within this cluster of firms there are both companies that once entrusted the management of some phases of the production to contractors and actually they are self-made, and companies that since their birth, following their business vision and mission, are vertically integrated.

As described above, the production process of a jewel will never be fully mechanized because there are some phases that must be completed by humans. The introduction of digital appliances regards mostly the *computer design* and *prototyping* phases. Through the use of design software such as Cad Design or Rhinoceros, nowadays is possible

to translate in informatics terms what the stylist or designer hand-drew on the paper. These programs allow to have in preview a vision of how the jewel will be, thanks to the three-dimensional image that they are able to reproduce. It is easy to define the minimum details, to virtually rotate the product, establish the thickness and weight based on the different type of metal used. This is fundamental in the jewel business because the product should respect both the principles of *beauty* and *functionality*. Of course the product cannot be too heavy or doesn't respect the geometries and through these software it is possible to verify all these things in advance. After the creation of the Cad/Rhino model, the file will be sent to the 3D printer that receive the information from the software and start to produce the prototype. This is a typical example of additive manufacturing: the printer will add material responding to the information sent by the software. In this way the costs are reduced, wastes are reduced and it's possible to create also a single model of a jewel, reducing the final price that otherwise would be extremely high. This leads to what is called mass customization. The 3D printer would be able to produce several prototypes, different from each other, and the company will be able to produce also one piece of that specific model without increasing costs and prices. In addition to this, the firm through the exploitation of these digital tools can increase the responsiveness to their customers due to the rapid creation of the prototype and the reduction of response times, an aspect that cannot be undertaken in a fast changing world in which everybody is looking for solutions that allow to reduce wastes of time and are "easy".

The second kind of firms are those companies that give these phases of the production process to an external service. Usually they are small size firms composed by 5-10 employees that are typical of our Italian districts and that for several reasons prefer or are forced to give to a contractor part of the production.

The company could provide the service with their drawings and models and give them the task of making the computer design and then the prototype or they could just explain to a designer which is the idea of jewel they want and leave to him the responsibility of designing and then prototyping it. Of course, this type of firms has to face a real problem: they have a limited control over the intellectual property of the jewels. One of the hardest difficulty they faced in the last years regarded the problem of being copied: once the company transmitted the idea or drawing to the external service, this last dropped off the patent and became the

intellectual owner of the idea. For this reason the Chamber of Commerce of Vicenza developed the “Deposito Preventivo Telematico dei Progetti Orafi”.

This system, reserved for the jewelry projects, consists in the certified management of the process of online transmission and archiving of drawing files combined with a format of standard storage that defines the title of the project, the typology and the attachments. It allows to receive and archive the project, guaranteeing the paternity and presentation date through the exploitation of the **digital sign** and the **PEC**. The project born from the need to defend a product with high stylist content that has short life for its nature and so it needs forms of protection that are immediate. Defending the innovation, the copyright and patent are onerous and long-lasting and the companies don't have at their disposal so many tools to defend their innovative products. Here below an overview of the cases in which the Deposito Preventivo could be vital:

-Industrial Inventions : The right to get a patent for an industrial invention is reserved to the author of invention, the one that solved for first a technical problem in an innovative way. At the inventor is reserved not only the economic exploitation that derives from it but also the moral right to be recognized as the author. For this reason, being in possess of a document with legal value subscription and a date opposable to third parties is fundamental.

-Knowhow : it refers to secret information and the Deposito Preventivo is able to ensure the absolute secretiveness. In fact, it is an efficient tool to whom intends protecting their organization's secret know-how against possible illegal actions.

-Drawings and models : it refers to the protection of the external aspect of a product – design – that allows the model's inventor to require the registration within 12 months, after the disclosure of the model itself.

-Copyright : in this case the Deposito Preventivo will act whenever the author of invention didn't behave with the copyright registration, in order to demonstrate the paternity and the date of creation.

The Deposito Preventivo Telematico represents an efficient tool for those companies that invest in innovation and creativity. It allows to get a legal proof ascribable to its author,

having a specific date opposable to third parties with a demonstration of both the paternity and the era of creation of the invention.

3.4.2. Websites' evolution

A common character among both small and medium size firms in the jewelry sector regards the importance given to the website. Nowadays, could be obvious that a firm has its own website where customers could find information about the production process, or better, could find imagines of the goods produced. As anticipated above, the aesthetic aspect is fundamental in this business.

The creation of structured websites is, in some cases, a diversification strategy: those firms that are not vertically integrated, have invested a lot in this kind of service. The reason is that they all want to offer a service to their customers, they want to be responsive. In the last years, the website development has accelerated but there are several reasons why this type of service has developed so late compared with other industries. From the interviews made with professionals of the sector, companies know that being present is fundamental but at the same time it is onerous and there is a lack of competencies in the labor market for what concerns the management of the website itself.

3.5. The effects of 3d printer on business competitiveness

The 3d printer represents a technological innovation that in the last years is creating more and more interest on manufacturing firms, especially because it has been study as a process innovation rather than a product innovation. It will be verified if the introduction of the 3d printer in the jewelry companies will determine the typical effects of the process innovations such as fostering product innovation, improving productivity and competitiveness. Will 3d printer improve the competitiveness of jewelry manufacturing firms?

3.5.1. The innovation process on manufacturing firms

The process innovation is fundamental for the performance and survival of firms. The introduction of innovative products and processes increases the ability of companies to enter in new markets, satisfying the clients' demand. This is a key requirement to sustain a competitive position in contexts more and more technologically advanced. The acquisition of new information and knowledge is fundamental in this sense to create new products or services. At the basis of the innovation process for the development of products and services resides the use, identification and exploitation, by the top management, of novelties and changes regarding this process. As a consequence, it is clear how innovation impacts both on organizational relationships and behaviors, strategies and business processes.

The literature distinguishes the administrative innovation from the technical one for what concerns the organizational process; product innovation from process innovation for what concerns the specific object of innovation; incremental innovation from radical one for what concerns the level of technological advancement that it imprints to the organization. Especially the second distinction is relevant for the achievement of competitive advantage: products innovation are usually referred to new products and services introduced in the market to satisfy latent customers' needs; process innovations refer to the introduction of new elements in the mode of operation and in the productive processes. Focusing on the 3d printer phenomenon, after the design of innovation and so the introduction on the productive process of a new operative tool, there will be single incremental innovations deriving from information provided by stakeholders external at the firm, such as the implementation of software or informatics systems more and more innovative. For these

reasons, it is plausible considering the 3d printer a process innovation that impacts on corporate competitiveness.

The process innovation on manufacturing firms is quite different from the same innovation in the service firms. Sirilli and Evangelista (1998), comparing the characteristics of innovation process in these two types of companies, observed that in the service firms the process innovations were the most diffused, while in the vast majority of the manufacturing firms the product innovation was considered the most important. Another important difference regards the costs of innovation: in the manufacturing sector innovation costs triple. However, some studies highlight how these two types of innovation are interdependent, strictly connected (Martinez-Ros, 1999). Therefore, disregarding the process innovations could weaken a firm's capability of exercising product innovations and compromise the entire innovation process.

The process innovation increases firms' productivity and determines the achievement of competitive advantages especially through the reduction of the production costs and the growth of the productive flexibility.

The Evangelista et al. (1997) study, referred to the Italian manufacturing firms, underlines the existence of two innovation models: the large companies model based on R&D investments and the SMEs model characterized by innovative informal activities. This last kind of firms do not have at their disposal large quantities of money and human resources for R&D investments. The main difference among firms regards the fact that, while large firms make investments in R&D, SMEs invest in the acquisition of new machineries and plants to favor innovation. In particular, for SMEs innovation is fundamental to contrast the weaknesses that derive from the globalized context in which they operate. To create value it is necessary for them to innovate and exploit new opportunities to maintain a sustainable competitive advantage in the long term.

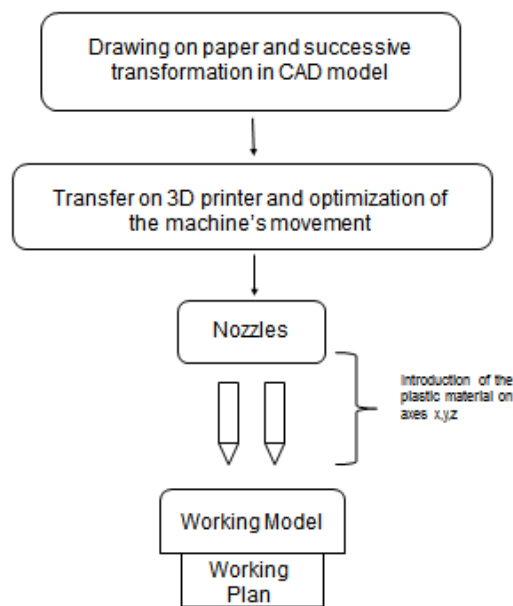
3.5.2. 3d Printer: prototyping and production

This type of innovation refers to the acquisition of new machineries such as 3d printers that could be used in the prototyping or production phase, both for the production of semi-finished products or finished ones. Three fundamental methodologies exist through which it is possible printing a 3d object: Stereo Lithography (SLA), 3D-Plotting (3DP) and the Drop on

Demand System (DOD).

The first one is based on the polymerization of liquid resin through laser. The laser creates from top to bottom the entire object through the stratification of the material. When the object is completed, it will be put into an ultraviolet oven in order to harden the material. The second one works as a normal ink printer with the difference that the material solidifies on several layers. The machine starts leaving a first layer of material and then it moves in the three directrices creating the 3d object: it is ready to be used or colored. For each type of manufacturing, it is necessary to develop in advance the product's design through modeling systems such as CAD or Rhino, as anticipated above.

Fig. 12 3d printer development process



Personal adaptation

In general, it seems that the use of 3d printers within development process of a product allows the reduction of costs, the increase of development speed, having a positive impact on the time to market, and favor a high customization of the product itself.

Chapter 4: How to create value through Business Model Innovation

Up until now, I spoke about product and process innovation and the relative benefits or costs that could derive from this. It is fundamental to say that nowadays these innovations are quite common between small-medium size firms that need to survive in a challenging environment, but are they really creating value for their customers and their firm at the same time? Are they just surviving or innovating in order to create something stronger for the future? Are product and process innovations enough or is it necessary a disruptive business model change?

The main reason why companies invest in product and process innovation is to increase the revenues growth and to maintain or improve profit margins. As anticipated above, investments require a huge amount of money to innovate in products and processes and are time-consuming; it is necessary a consistent upfront investment in research and development, new plants, equipment or specialized resources and even entire business units. Investments in innovation are well planned, and all the benefits that could derive from them are the focus and the main reason of the investments themselves even if they are absolutely uncertain.

This is what encourage firms to develop or complement the product and process innovations with innovative business models.

From a recent global interview made by the “Economist Intelligence Unit” on more than 4,000 senior managers, emerged that 54% , the vast majority, prefer to innovate developing innovative business models rather than investing in product and process innovations as a source of future competitive advantage: “the overall message is clear: how companies do business will often be as, or more, important than what they do”.

In a similar global interview made by IBM on more than 750 companies and public sector leaders, researchers found that “competitive pressures have pushed business model innovation much higher than expected in CEO’s priority lists”. They believe that business model innovation is where the greatest benefits and faster growth lie, that it is not enough to invest in product and process innovation to make the difference. Everybody in your same sector or business, sooner or later, could reach that grade of quality on the product or

production scale or delivery readiness and for this reason, innovating in areas where your competitors does not act is what is needed.

Why business model innovation matters to managers, entrepreneurs and researchers? There are several reasons. First, it represents very often a source of future value that is under-utilized and exploited. Second, speaking in strategic terms, it could be a real way for a firm to differentiate itself among the others, making the imitation of an entire novel activity more difficult than a single product or process innovation for competitors. Considering that eroding the returns deriving from a single novel activity is easier, the business model innovation sometimes could translate into a sustainable performance advantage. Third, because of its huge potential of being a competitive tool, it is fundamental that managers are aware of the competitors' efforts in this area. They should consider that, most of the time, competitive threats derive from outside their traditional business boundaries but they have to be ready to search and exploit them.

Up until now I didn't describe what a business model is, in general terms. A company's business model is "a system of interconnected and interdependent activities that determines the way the company "does business" with its customers, partners and vendors. (..) A business model is a bundle of specific activities – an activity system – conducted to satisfy the perceived needs of the market, along with the specification of which parties conduct which activities, and how these activities are linked to each other."

Managers should not substitute their actual business model in every case; they should just consider the opportunities to complement innovations in products and processes. Business model innovation could resolve the trade-off between benefits and costs of innovation, for example, by involving partners in new value creating activity systems.

4.1. How to Innovate in Business Model Design

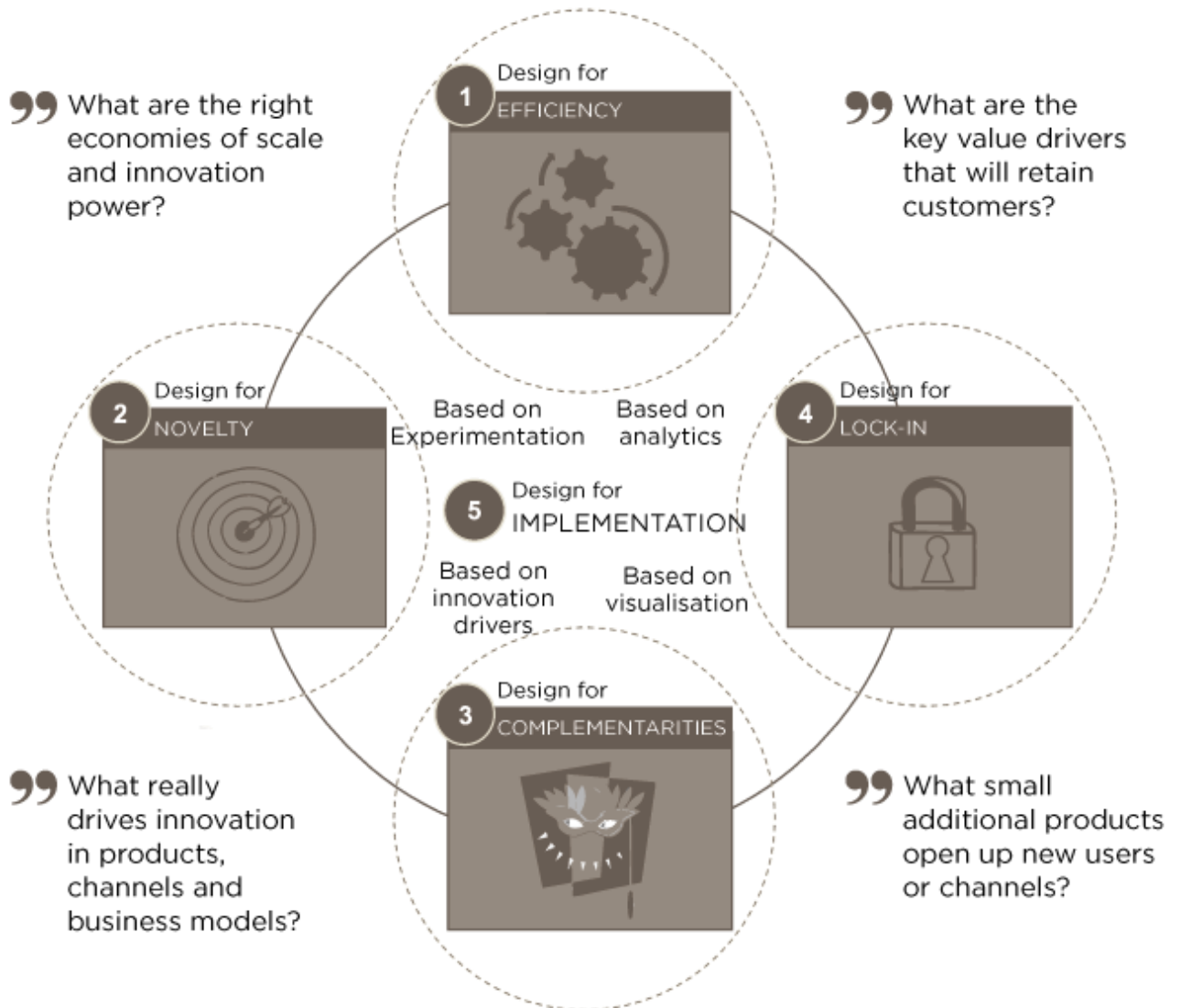
As anticipated above, a new business model can either open new markets or allow a company to exploit and create new opportunities in the existing ones. It is not important that the change would be disruptive or completely innovative, it can create value and yield benefits to the innovator even when the changes do not have the potential to disrupt an

industry.

For this reason, there are countless ways to innovate in business models but each company's business model has characterized by three design elements: content, structure and governance.

1. *Content of an activity system.* A company can innovate its own business model adding novel activities and integrating them. It refers to those activities that have to be performed. For instance, Bancolombia, Colombia's largest bank, developed some activities in order to exploit the market needs of the 60% of Colombians that did not have access to the microcredit. The bank trained its top management, hired new staff and linked new activities to the existing ones.
2. *Structure of an activity system.* It describes how the activities are linked and in what sequence. For instance, Priceline.com, an online travel agency, has established a link with credit card companies, airline companies and the central reservation system among others. In this way they created a reverse market in which clients establish a price and the platform through the interaction among all these companies is able to communicate to the client if his/her proposal would be accepted by the entire system.
3. *Governance of an activity system.* It describes who performs each activity. A possible approach to innovative activity system governance is franchising: it can be the way to unlock value as happened for 7-eleven in the Japanese market. It was an ideal response to the strict regulations imposed by the government on retailing outlets.

Fig. 13 How to innovate in business model design



Implement Consulting Group

Some researchers identified four major value drivers of business models: novelty, lock-in, complementarities and efficiency.

- a) *Novelty* catches the degree of business model innovation that the activity system embodied;
- b) *Lock-in* refers to the business model activities that create switching costs or improve incentives for participants to stay and transact within the activity system. For instance, Nespresso, a division of Nestlé Corporation, developed a low cost espresso maker that uses the Nespresso capsules. When the customer have bought the

Nespresso machine, he/she is forced to buy also the capsules and in this way the company created a lock-in that allowed Nestlé to benefit twice: from the Nespresso machine and their capsules.

c) *Complementarities* refer to the creation of value thanks to the effect of the interdependencies among business model activities. For example, eBay is a platform that conducts sales among different individual buyers and sellers of new or used products over the Internet.

d) *Efficiency* refers to cost savings thanks to the interconnections of the activity system.

Managers and entrepreneurs create interdependences in business models in several ways: when they select the set of organizational activities they consider fundamental to satisfy a specific market need, when they established the links among different activities within the system and when they shape the governance mechanisms that hold the system together. Managers should also take into consideration the interdependencies between business and revenues model. The latter refers to the ways in which the company means to create revenues generation for both the business and its partners.

In conclusion, the greater is the value created by the business model innovation, and the greater a company's bargaining power, the greater will be the value that the firm can appropriate. The higher will be the propensity to innovate, the higher will be the benefits.

4.2. The emergence of new networked business models from technology innovation

As everybody knows, technology does not have an intrinsic value but it is possible to exploit it in order to obtain competitive advantages and transform it into profits through the adoption of business models that select and apply suitable resources and are based on the utilization of competencies and dynamic capabilities.

Focusing on the most mentioned technology up to now, the 3d printer, this kind of innovative technology seems to be dependent in some sense on business models that are able to integrate and structure different inputs, crowdsourcing processes and market distribution networks. Design enterprises are those that most use this kind of business model because, through the adoption of 3d printing technology, they want to enrich their service portfolio or create totally new business lines. Now I am going to analyze how in

design enterprises the adoption of 3d printing technology is strictly associated with suitable business model components. To do this, I am going to exploit a qualitative analyses of three cases from the “International Entrepreneurship and Management Journal” and then I will focus the attention on two more international cases discovered by myself during the researches.

Design has a strategic relevance and there are different ways in which it can be employed to gain competitive advantage. Especially the design management has been studied and explored from different and numerous perspectives and by several disciplines: as a tool to manage strategic renewal (Ravasi and Lojcono 2005), as a bridge to transfer technology among sectors (Hargadon and Sutton 1997), as a way to establish new forms of and languages in technology breakthroughs (hargadon and Douglas 2001). We can definitely say that design is used more and more as a lever for value creation.

As a consequence, the figure of the designer within a manufacturing industry is changing because they are “interpreters” (Verganti 2003,2008) of cultural and social factors who turn the research, vision and innovative features proposed by firms into functional models. The emergence and introduction of innovative technologies such as 3d printing, of course is having a great impact on the design enterprises business model and in general on the manufacturing industry as a whole; this is the main reason why designers are acquiring an increasing central role within these industrial systems. Despite the likely future pervasiveness of 3d printing technologies, there is a lack of research to show how this technology may be inserted in a business model.

I am going to describe the main features of the business models of those design enterprises that are based on 3d printing technology. The analysis made by the Journal is framed on the concept of the open business model (Chesbrough 2006) considering that 3d printing firms rely on external sources of creativity.

The first three study cases analyzed by the authors are based on two new ventures and an established company. The authors have developed some suggestions on the relationship between radical technological innovations and the changes to industry’s business models. The industry’s experts have taken into consideration and examined the technical aspects related to material experimentation and the integration between prototyping and other

systems such as the CAD.

From Berman (2012) it is possible to summarize the technical aspects of 3d printing in:

- Complete integration of 3d printing with CAD (Computer Aided Design), software that allows a totally integrated design-cum-production activity; in this way it would be possible the sharing of the technical codes of the product through the web and reproduce it wherever you are, at any moment and with different printers.
- The chance of using different kind of materials on the same printer: aluminum, steel, ceramics, titanium etc.
- Customization of products: it allows responding quickly to customers' needs and preferences in order to personalize the product itself or to perform edits by simply making some adaptations using CAD software.
- The significant reduction in inventory management thanks to the ability to produce goods "on demand".
- The reduction of wastage and materials in producing a single product unit.

Berman suggested that: *"3D printing employs an additive manufacturing process whereby products are built on a layer by layer basis, through a series of cross-sectional slices. While 3D printers work in a manner similar to traditional laser or inkjet printers, rather than using multi-colored inks the 3D printer uses powder that is slowly built into an image on a layer by layer basis. All 3d printers also use 3D CAD software that measures thousands of cross-sections of each product to determine exactly how each layer is to be constructed."*

Of course, we have to consider also the limitations that derive from the utilization of these technologies such as the difficulty of producing high volumes and so exploiting potential economies of scale, a lower precision compared with other manufacturing technologies or the impossibility of employing some specific materials as leather for example. A first result is that 3D printing is changing the relationship design-production.

The literature on open organizations (Chesbrough 2006) seems to be pertinent for analyzing 3D printing based companies and exploring their business models and asset management strategies. Chesbrough's open organization model comprehends organizational features that are appropriate for managing innovations, embracing the process of acquiring and integrating new ideas within the company and marketing them. Precisely, firms can market

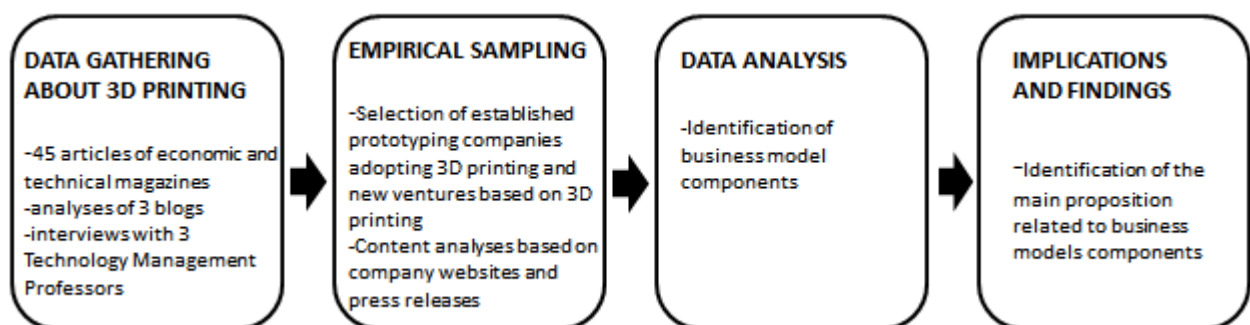
internal ideas through channels outside their current businesses to create value for the company or vice versa. The main vehicles to achieve this goal regard the firm’s ability to establish relationships with external actors in order to absorb different kinds of knowledge (Ahuja 2000), improve performance (Hagedoorn and Schakenraad 1994; Shan et al. 1994) and grow quickly (Powell et al. 1996; Stuart 2000).

The open innovation model in design enterprises has been identified in the double relationship between manufacturing and designers firms, attributing the production function to the former and the creativity activity to the latter. Of course, this is a limiting perspective considering that nowadays manufacturing firms comprehend self-production model and a “making culture”, where users can create by themselves products for their own use. The 3D printing companies analyzed, have been evaluated against the following components of business models (Johnson et al. 2008):

- *Customer value proposition*
- *Key resources*
- *Key processes*

Adopting the open business model framework, it will be analyzed the new network-intensive business models in the manufacturing sectors, that have adopted a radical technological innovation such as 3D printing. The research selected three cases in order to provide a stronger base for theory building while a single case could only highlights an isolated phenomenon. The research is based on interviews with three professors in technology management from Stanford University, Westminster University and University of Turin with the aim of understanding the 3D printing phenomenon from different perspectives.

Fig. 14 Main phases of the analysis



4.2.1. Three explanatory cases: Quirky, i.materialise, Fab-Lab

Quirky

Quirky is an American design company of consumer goods founded in 2009 that, exploiting a manufacturing process based on 3D printing technologies, is able to turn crowd-sourced inventions into retail products. The entire process involves different actors, from the idea to the final production of the good. How does it work? Every week a community of “hobby inventors, students, retirees and product-design enthusiasts” (Tumblr 2012) votes the two most popular ideas. These ideas are then sent to an in-house team, composed mainly by designers and engineers, to research and prototype in order to transform an idea in something tangible. The team and the founder then try to find possible patent conflicts or production problems and finally establish the winner of the week. At every design process stage (such as the design of the name or logo), the community is called to help the company to set a price for the good. Even when a product gets the community’s approval, it will not be produced if enough pre-orders so that production costs are covered have been received. “This is where we find out if a good idea is a good product” (Parade.com 2010). Thanks to the access to a knowledgeable community, the company can collect a high variety of multi-disciplinary skills, necessary to transform an idea in something concrete. All the necessary skills such as electrical engineering, marketing, design are all to be found in Quirky’s community. The manufacturing process occurs in a small factory with 3D printers, milling machines, a laser cutter and other equipment necessary to develop the prototypes. Users can contribute to its final packaging, marketing and design through an online review. After the creation of the prototype, the company looks for suitable manufacturers.

i.materialise

It is a Belgian company that responds to the needs of those people that would like to express themselves in a world where standardization is becoming the normality. The company’s mission is to offer “everybody the possibility to turn ideas into 3D reality”. The main scope is to keep the 3D printing technologies more and more accessible and allow more people to become inventors and designers. Despite this, the firm puts itself at the higher quality end of the sector, focusing on the use of both high quality materials and processes and

“demanding” designers.

The designer uploads the file with the project (3D file, pictures and text description) to the service, then selects the material, size and quantity following a template. It will receive a quote and, after having obtained online confirmation and payment, the good will be produced and delivered.

The designer can also sell its projects and earn a percentage of the subsequent sales. i.materialise gives the possibility to sell the designers’ products on its worldwide distribution network and, from the other side, potential buyers can have access to only a single piece or a large variety of unique products that can be produced.

Fab labs

A Fab Lab – *Fabrication Laboratory* – is not a big company such as Quirky or i.materialise but is a small scale workshop that offer digital fabrication facilities to individuals. They are normally constituted by a variety of flexible computer controlled instruments that cover different materials and scales. The tools at which we refer is represented by equipment that usually is designed for mass production. For example in a Fab Lab we can find laser cutters, CNC routers, laser scanning technologies or 3d printers as well as a team of product or mechanic engineers.

Fab Labs are a network worldwide diffused; nowadays there are more than 150 labs open, which allow people to share ideas, brainstorm and collaborate. The Fab Labs contribute to develop and test prototypes of the customer’s ideas, that could then be commercialized. An important asset of this process is education: Fab Labs make several workshops in schools in collaboration with universities to educate potential users in the technical skills needed to being manufacturing entrepreneurs of the future.

4.2.2. Data Analysis

The research made by the International Entrepreneurial Management Journey collected data about these three organizations’ business models from different sources:

- The companies’ websites;
- The reports and articles in Table 1 and 2 which discussed 3D printing in the case firms;

- Three 3D design related blogs, Table 13.

Focusing firstly on the websites analysis, it has been used the Computer-assisted content analysis (CATA) that examines word usage, similarly to human coding schemes (Morris 1994). The research presumes that insights on organizations' business models can be recognized in the frequency and periodicity of those concepts that are normally used to define it (Carley 1997; Short et al. 2010). In this analysis, the concepts – the business model block – have been identified from a set of words from the Chesbrough's (2006) explanation of that concept (Table 13).

Table 11 - List of articles used to define the practice cases and develop content analysis

Magazine	Date	Title	Practice cases cited
Business week	June 29, 2012	Crowd-sourced in the U.S.A.	Quirky
The Economist	April 21st, 2012	The third industrial revolution	Quirky
The Economist	April 21st, 2012	The gentleman manufacturer	Quirky
Wired	09.11.12	A start up that turns the ideas filling your head into products filling shelves	Quirky
The Economist	Jun 9th 2005	How to make (almost) everything	Fab-Lab
Wired	September 2005	The dream factory	Fab-Lab
Business week	May 01,2005	Destop factories	Fab-Lab
The Economist	Apr 21st 2012	Solid print	i.materialise
The Economist	Dec 10th 2011	The shape of things to come	i.materialise
Wired	October 13, 2010	Spime watch:Materialise	i.materialise
Wired	02.16.11	The secret world of printing concept cars in 3D	i.materialise

Table 12 - List of articles analyzed through content analysis

Magazine	Date	Article Title	Emergent Issues
Business week	April 26, 2012	3D Printers: Make whatever you want	Manufacturers and companies that are users of 3D technology The functional logic of 3D printing technology Main sector involved in the use of 3D printing
Business week	May 09, 2012	Bre Pettis: 3D printing's first celebrity	Producers of 3D printing technology Contexts of application
Business week	May 03, 2012	How about Them Gams: 3D printing Custom Legs	Integration between design and prototyping Potentials for customization
The Economist	Feb. 10, 2011	The printed world	Manufacturers and companies that are users of 3D technology The functional logics of 3D technology Prototyping companies using 3D technology
The Economist	April 21, 2012	The third industrial revolution/ solid print	Manufacturing scenarios Facts and figures about 3D printing technology The functional logics of 3D technology Manufacturers and companies that are users of 3D technology
Wired	Sept. 05, 2011	An industrial revolution in Digital Age	The functional logics of 3D technology Sector mainly involved in 3D printing use Manufacturers and companies that are users of 3D technology
Make	Feb. 2010 Vol. 21	Your desktop factory - - 3D Manufacturing at home	The functional logics of 3D technology Producers of 3D printing technology

International entrepreneurial Management Journal- 19 Feb. 2014

Table 13 - Selected blogs with 3D technology used in content analysis.

Blog	Topic/Title	Posts/Comments
The Economist	The Third Industrial Revolution	164
Business week	3D Printers: Make Whatever You Want	8
Wired	Cube indoors and outdoors	33

International entrepreneurial Management Journal- 19 Feb. 2014

The three companies examined above has introduced the 3D printing technology in two different ways: Quirky and i.materialise as an additional service to the already existent activities of prototyping for the clients firms; FabLab as a newcomer through the creation of a new kind of organization. In these cases, 3D printing is used with a double scope: to offer a high quality prototyping service to manufacturing firms and to create new business services

for digital platforms consumers, where potential designers or clients in general can create the product they want with the intention of producing, using or selling it.

These platforms are mostly used and supported by three types of users:

1. Customization-driven designers: refer to those designers who want to produce their own ideas and sell the products through their own network and personal channels;
2. Market-oriented designers: refer to those that offer their own creations and sell and market them on the platform;
3. Customization-driven users: refer to consumers that are looking for something not standardized and “common” or sold on an industrial scale.

There are some characteristics common to all these organizations. Usually they have:

- A small number of creators: for instance, Quirky has 8 designers on a total of 40 employees;
- Specific knowledge resources required for ideas selection and product management when the ideas belong from external sources: Quirky makes a double evaluation, both from the community and the staff members;
- Despite their own limited creations, they are able to support the 3D printing technology potential: for instance, FabLabs lend their technological devices to people that are educated to use them properly and that can prove at the same time their abilities.

In all these organizations, the open innovation begins with the dis-integration of business processes' conception, conceptualization, engineering, production, sales activities chain. The decomposition of integrated value chains (Porter 1980) has created the emergence of more and more firms specialized in micro-activities and of “knowledge brokers” and “bridging ties”.

In these specialist organizations, the employment of 3D printing is thus associated with the creation of a market place in which it is possible to find both products developed by external or internal creative sources and are available to be sold.

Both activities of conceptualization and production are covered by the connection between the external creative resources and design crowdsourcing processes and physical capital,

such as machines and 3D printers.

The authors suggest the following propositions:

“P1: 3D printing technology encourages the creation of open business models such as new market or online design shops using crowdsourcing”.

The large variety of products generated by the 3D printing is entrusted with the management of different strategies and distribution channels. These characteristics exist both in those established prototyping firms and the new design enterprises. For example, Quirky and i.materialise are focused on the concept of creating a market for ideas and so a creative community; they have created the conditions to offering a place where consumers can buy goods produced by independent users and designers, an on-line shop. In particular, Quirky combined a platform for their own products with a retail network for goods. Some retailers where Quirky’s crowd-sourced designs are available are Safeway, Amazon or Target, so companies specialized in organized distribution.

Another possible business model is the open design shop. FabLabs are spread at a global level with over 150 laboratories open to users that would like to experiment or personalize their products such as toys or accessories but also to designers and production self-learners. Paradoxically, their innovative element is the territorial presence that allows the establishment of relationships with local socio-cultural resources, allowing the direct involvement of end-users bypassing intermediaries in the distribution channel. The client then becomes both the buyer but especially a significant tester of product effectiveness or of ideas created in the laboratories. In other words, we can say that there is not a structural relationship among technologies, distribution policies and strategies.

“P2: 3D printing technology allows for the development of different distribution strategies: direct e-commerce, alliances with organized distribution, and new types of retail channels such as open design shops.”

As anticipated above, the 3d printing technologies allow the production of reduced quantities of goods and without any technological or complementarity of consumption among them. Also for this reason, the 3d printing firms are characterized by an extreme heterogeneity in the types of items produced and sold. The firms’ portfolio is absolutely wide: musical instruments, jewels, toys, fashion accessories, shoes, lamps and interior design

goods. Exactly for this reason, the major problems related to 3d printing regard the different exploitable materials.

Considering the absence of production scale and volume economies and the absence of links and technological complementarity with potential products, it is clear that are necessary skills in order to manage an heterogeneous and wide product portfolio. High levels of profitability are achieved through low quantities sales but high number of product lines (Kekre and Srinivasan 1990; Amit and Zott 2001; Osterwalder and Pigneur 2010). This is a typical feature of open business models, where creating new solutions is more than just sharing aesthetic or technological links but, at the same time, breaking these links could reduce the brand power of the goods and we all know that in specific industries such as the jewelry one, the purchase is mainly brand-driven: in the case of 3D printing the brand value is replaced by the customization power.

“P3: the open business model induces 3D design companies to achieve a profit-able product portfolio through providing a wide variety of customized and low volume products with no technological complementarities, in which the management of the community prevails over the management of the brand.”

I told before that technology does not have intrinsic value (Teece 2010) and that in order to obtain a competitive advantage and turn it into a profitable firm, specific competencies and the capability to transform resources into value for the consumers are needed. Considering the great dynamism that characterizes the open innovation models, capabilities are mainly referred to firm’s knowledge and the management of relational ties. Three main activities are considered central to the successful management of 3D printing organizations:

- Creative networks and crowdsourcing management;
- Selection and management of projects, taking into consideration their visibility and sales promotion;
- Market and/or distribution channels management.

The new technologies adopted by the companies are promoting new competitive mechanisms depending on different business models. Particularly, services, design and creativity are creating a new competitive field: a new scenario is emerging in which the competitive advantage derives from open, distributed creativity.

A new trend is growing and we can say that 3D printing enterprises are key accelerators of this new approach to business where there is a growing seek to develop open business models such as open design shops and marketplaces that are centered on communities. In conclusion, the empirical analysis made by the authors suggests that different distribution strategies could be developed both from new design firms and established prototyping companies thanks to 3D printing technologies. In this expanding context, products do not need to have technological complementarities or branding relationships because, despite some limitations, 3D printers are able to produce almost every type of good.

4.2.3. Two jewelry cases: My Forevermark Fitting, .bijouets

More than the three cases analyzed by the authors of the International Entrepreneurial Journal, in my opinion is interesting to examine more in details two successful cases of business model innovation applied to the jewelry industry.

Examining many jewelry websites and magazines, I have selected the two most interesting ones: The De Beers “My Forevermark Fitting” and .Bijouets.

“My Forevermark Fitting”

De Beers is a jewelry that was founded in 1888 and, since 125 years, the company remained the world’s diamond leader with unrivalled expertise in the exploration and mining of diamonds throughout the world. In 1939, the company introduced the first diamond grading system introducing the 4C: this is a classification process that is still used today and consists of four qualities that a diamond has to have. Carat – Cut – Clarity – Color. The company recognized the importance of verifying diamonds and bringing an understanding to their unique traits. In 1947 it introduced the most popular slogan that nowadays is still associated with diamonds: “A diamond is forever”.

Despite a long history, the company opened the first international store in Tokyo in 2003 and started growing globally. De Beers has always been open to innovation and experimentation; in fact, they began to develop a new approach to diamond jewelry design with a particular collection called The Talisman in which for the first time rough diamonds were set uncut into a contemporary design. This is one of the things that testify the will of growing, unifying already developed competencies with new ideas, responding to customers

actual needs. In the most recent years, they introduced a service of personalization and from this project born “For You, Forever”, a new engagement ring service. This allowed clients to create their rings by themselves. In my opinion, the only limitation was that it was an exclusive on store service in which it was possible to find some Brand Ambassadors and through the use of an iPad App, customers could customize the jewels. As a consequence to this new unusual service, considering the long tradition, the company understood in real time the market trends and decided to launch a global campaign to celebrate women that are masters of their craft. The main aim was to honor talented women with the same reverence that usually a diamond is honored. Of course, these two projects had a double scope: from one side, give to clients in general the possibility to personalize their jewels, obtaining an absolutely unique product and with a super high quality; from the other one, the incentive to share and honor the best crafts made by talented women, comparing them with the diamonds the firm produces.

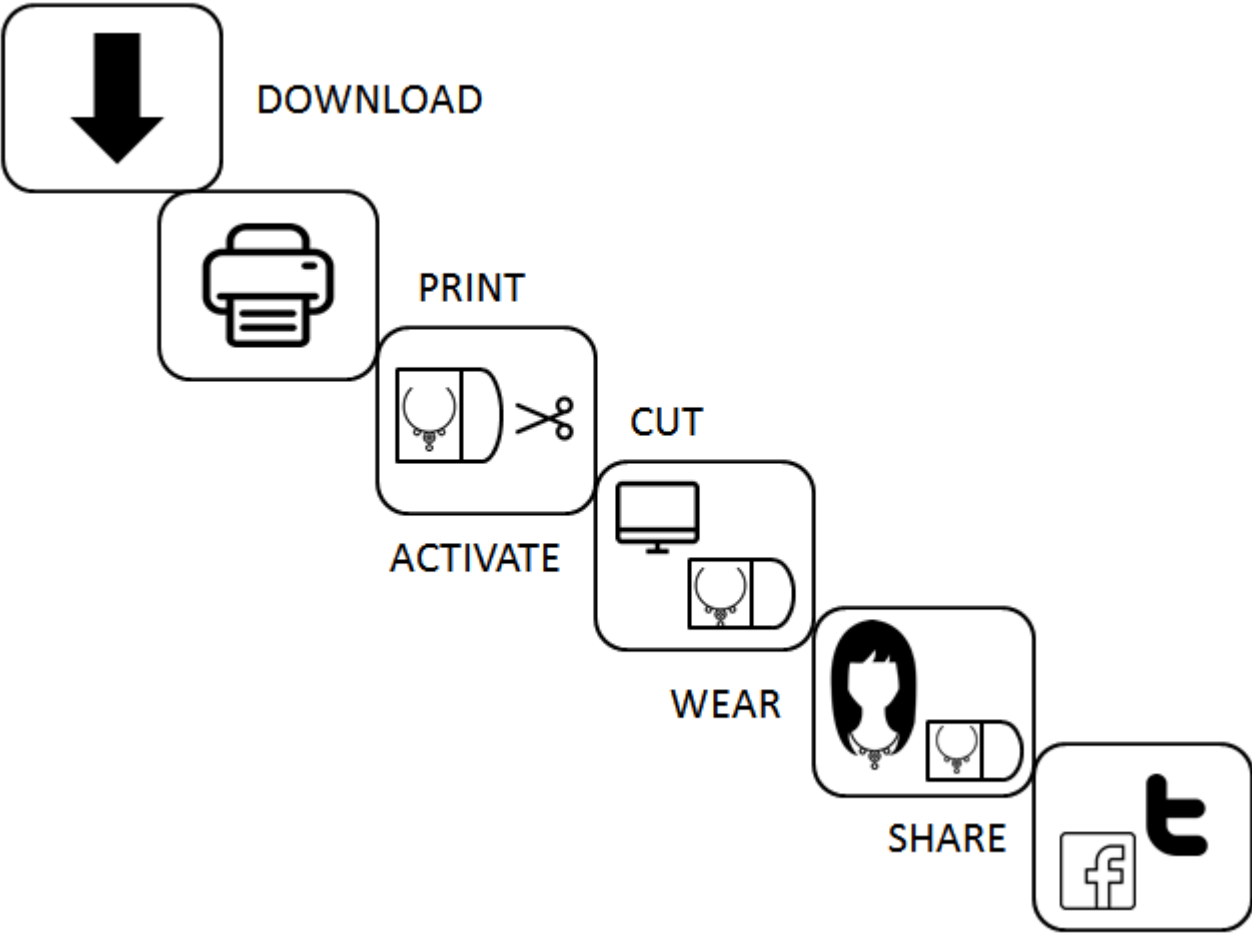
The most disruptive and totally innovative idea was introduced with the opening of the “My Forevermark Fitting” in a section of the website. Through this platform, de Beers allows people all around the world to try their Forevermark diamonds brand. How? In the simplest way. In collaboration with the creative agency AKQA and the 3D augmented reality company Holiton, they are able to create a unique user experience. Clients can comfortably try earrings, rings or pendants wherever they are and whenever they want using only their computers. The company, to make this possible, turns to augmented reality that is a live direct or indirect view of a real-world environment in which objects – jewels in this case – are augmented by computer-generated sensory inputs. People can see not only how they wear the jewels, but also how they move and sparkle in the light in an apparently live environment. Whoever would like to try this experience has just to visit the “My Forevermark Fitting” website.

Exploring more in details the process, basically people just need a computer. They have to visit the website, download a software and then print a paper with some generic images – symbols – and cut the images as indicated. After that, they have to activate their webcam, put the image near their ears or hand, depending on the type of jewel they want to try, and on the computer screen the paper is transformed into a piece of jewel. It is as the person is looking in a mirror and see his/herself wearing exactly that jewel and the image is not only static but also in movement, so that you can perceive the sparkle in the light. In my opinion,

this is an original digital tool to see in real time how you wear it, without waste time for going on the store.

It is important to underline that only 1% of the De Beers diamonds receive the Forevermark brand and each diamond receives a microscopic inscription of the Forevermark icon and an individual number. (<https://vimeo.com/>)

Fig. 15 My Forevermark Fitting process



Personal adaptation

The main aim of this project is surely the extension of the “try before you buy” concept that will become an incentive for customers to try the jewels and then going to the stores and buying them. At the same time, Forevermark offers a unique experience to its users, they can enjoy this service, share it using the social media and this will increase the brand

awareness from one side and the company's reputation from the other, showing that it is an innovative firm despite it is continuing selling traditional goods such as jewels.

.Bijouets

.Bijouets is an Italian company that produces jewels and accessories characterized by an exclusive contemporary design, modern and cosmopolitan, realized with the 3D printing technology. The brand combines the innovation and modernity of technology with the extraordinary artisanal competencies, in fact all accessories and jewels .bijouets, realized in sintered polyamide, are hand finished and colored, turning them into unique products. .bijouets utilizes a light technology that has a sustainable and airy impact. Ideas are transformed into products through a process that is almost immaterial, slight, improved over time, which is the summary of culture, passion and competencies acquired in the years, reducing the emissions and wastes and respecting the environment.

The innovative design, result of designers' creativity and international artists, and the originality and uniqueness of shapes, make .bijouets a pret-à-porter brand that revolutionize the fashion accessories and jewels world.

The company does not produce only bracelets, earrings and necklaces but also interchangeable glasses frames, putting together the aesthetic and Italian style with the digital know-how. The 3D printing, as told many times up to now, is free from any productive commitment, leaving space to creativity, personalization and beauty, creating shapes and details unexplored.

The additive manufacturing allows satisfying "economic-moral" objectives. Working *Just in Time*, this technology permits the production of small quantities of products in order to respond quickly and in an efficient way to market demand, reducing considerably the warehouse stocks and inventories. More than this, the company works to personalize the single elements and produce them with always-different styles and design.

Fig. 16 .bijouets jewels



<http://bijouets-italia.com>



<http://bijouets-italia.com>



<http://bijouets-italia.com>



<http://bijouets-italia.com>

Actually the production lines belong to eight different designers. The collection are mainly classical shapes reinvented in a modern key. They belong to natural or geometrical shapes. The designer conceptualizes the ideas, translate it in a CAD file using Rhinoceros and Grasshopper software and finally they are sent to the 3D printer and produced. Once the product has been printed, the pieces of jewelry are submitted to several processes, that comprehend both chemical and physical stages, as well as the cleaning and finishing of the goods that are hand - made. It is in this last phase that the jewels are made unique and

personalized.

Thanks to the 3D printing .bijouets is able to sell on demand giving to customers the possibility to make specific requests such as a particular coloring in addition to the elimination of wastes and stocks as I have already said above.

The clients have just to choose their jewels from the website, order them and they will receive the products directly at home. Giving that they are produced in polyamide, the company can sell them at relatively cheap prices and of course this incentives the purchasing decision: you could have a unique, changeable, personalized and cheap jewel that can be adapted to different contexts.

The recipe of .bijouets is clear: experimentation, young entrepreneurs and special jewels.

Chapter 5: The Methodology

In order to understand in depth what digital transformation means for Italian jewelry firms, I conducted a specific analysis directly addressing the actors of this scenario, rooted in the territory of the three main districts. The following chapters will describe step by step what emerged from this process, articulated in three most important phases:

- a) The distribution of an on-line questionnaire among firms;
- b) The economic analysis of the whole sector;
- c) Interviews with firms.

The first part of the analysis consists of asking to firms information that allow to define their business model: size, level of internationalization, products. Through the questionnaire data were collected for what concerns the technologies they use, if they use them and what for (prototyping, production, etc). Four main clusters were addressed: branding, internationalization, customization and innovation/technology.

The second part consists of an economic analysis of the whole sector in order to have a context in which to compare the results of the first part. In this phase, profitability, growth and level of internationalization/exports have been analyzed.

The third and last part is articulated in a series of interviews with firms of different sizes and coming from several geographical areas, in order to understand in deep if there were correlations between the results of the questionnaire and the economic analysis and the single firms that populate the jewelry industry.

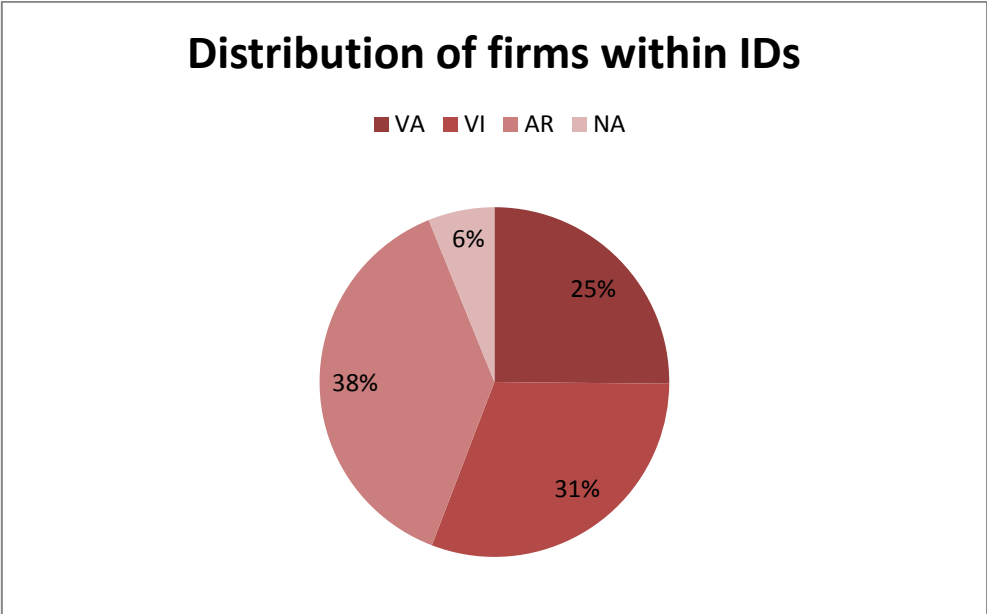
5.1. Description of the sample of firms

The analysis started from a questionnaire that “Fondazione Nord Est” submitted to several companies of the major districts in Italy. Part of the results will be reported below but with some crossing and elaboration. The sample of firms analyzed is composed by 163 companies divided in geographical areas and dimensional classes. As you can see from the graphs (table) below, the firms interviewed belong for 25% to the area 1 which corresponds

to the Valenza district, for 31% to the Vicenza one (area 2), for 38% to Arezzo (area 3) and only 6% to the area 4 which corresponds to Napoli district (area 4) (Table 14). About the dimensional classes, I decided to identify four slots which correspond to small size firms – 0-19 employees – medium-small firms – 20-49 employees – medium-large – 50-99 – and large firms – more than 100. The results show that the vast majority of companies are small size firms, 67%, a good percentage represents the medium-small, 25%, and only 8% represents the medium-large and large enterprises (Table 15).

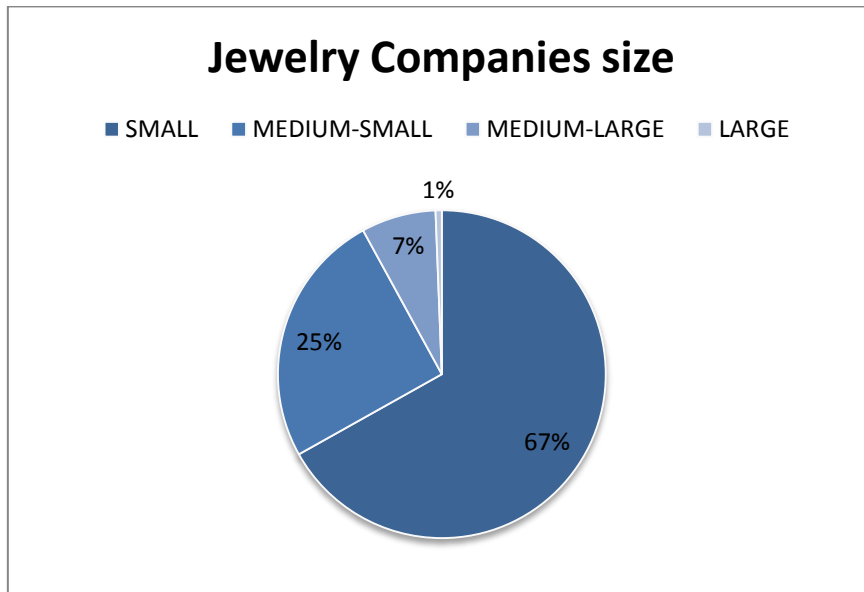
By crossing these two results it was possible for me to show how these firms are distributed within the different districts and the numbers demonstrate that in all the areas the majority of firms are of small size (Table 16). These data perfectly testify the characteristics of Italian districts which are composed by many companies distributed in a geographical area easily identifiable and composed by a low number of employees.

Table 14 - Distribution for Geographical area



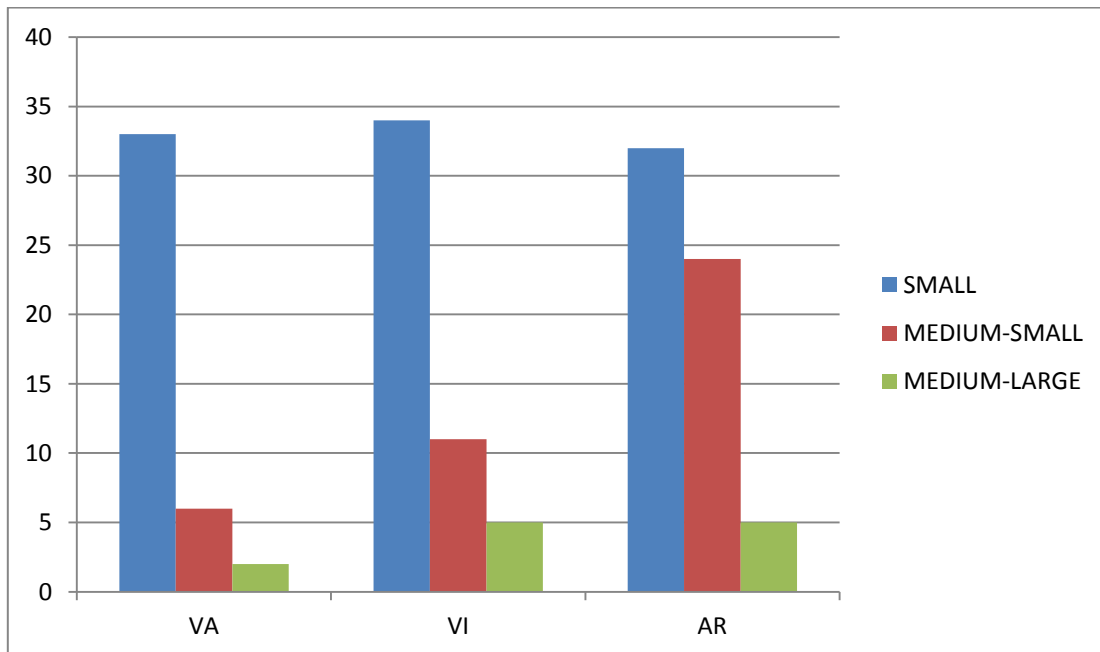
Personal elab. of Fondazione Nord Est – Banca IFIS data

Table 15 – Distribution for Dimensional Class



Personal elab. of Fondazione Nord Est – Banca IFIS data

Table 16 - Distribution for dimensional class and area



Personal elab. of Fondazione Nord Est – Banca IFIS data

5.2. Brand positioning and internationalization strategies

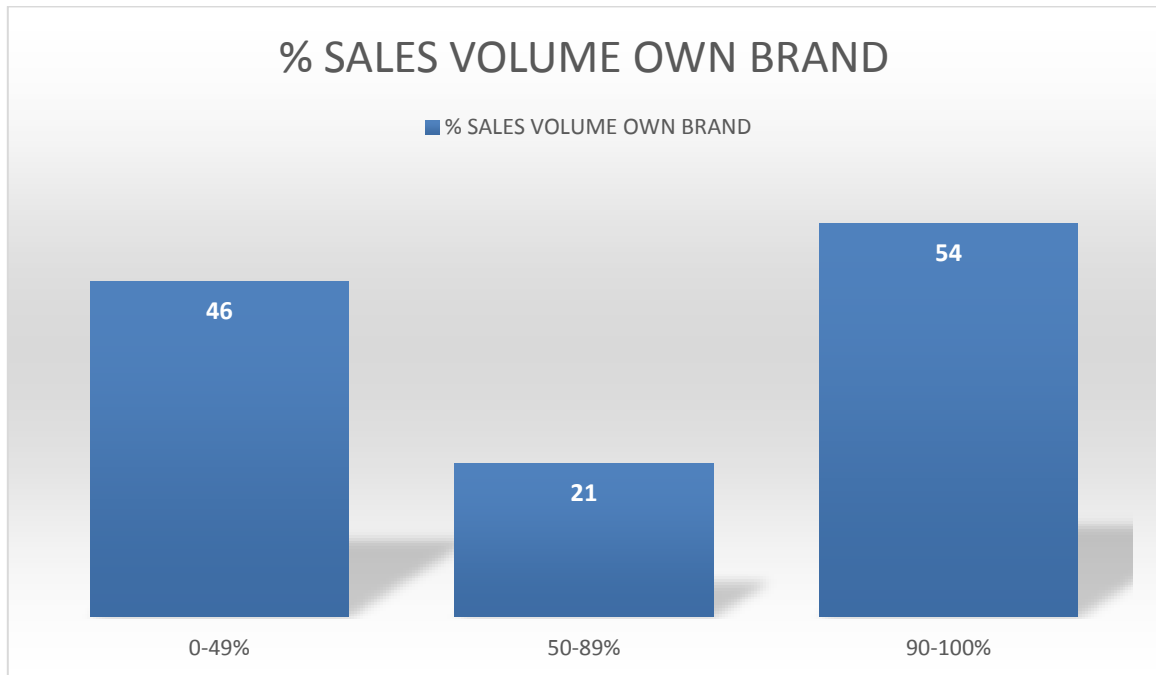
In order to understand which the business models and strategies of these firms could be, the questionnaire asked them if they sell products mainly with their own brand or for third-party brands. Moreover, I asked them how their sales are distributed within the Italian, European and extra EU markets, in order to collect information regarding the degree of internationalization of firms that are, as anticipated above, pretty small size realities. The results are quite interesting not only for what concerns the branding strategies but especially for what emerged from the internationalization questions.

The questionnaire shows that 38% of respondents firms, 121 in total, have a percentage of sales volume made with their own brand between 0-49% and so these firms produce mainly for third-party brands; for 17% of firms this percentage is between 50-89% and so they produce mainly with their own brand while the remaining 45% have a percentage of sales volume made with their own brand between 90-100% so they produce only with their own brand (Table 17). Speaking about the internationalization level of the jewelry companies, emerged that 72% of the firms are strongly internationalized, considering that 34% has a percentage of national sales between 0-20% (80% of sales in foreign markets) and for the remaining 38% this percentage is between 21-85% (medium-high level of internationalization). Only 28% answered that their national sales are the prevalent ones with a percentage between 86-100% and are characterized by a very low level of internationalization (Table 18).

I have crossed these results with the dimensional class ones in order to show which are the firms that sell mainly in foreign markets, where for foreign markets I mean both European and extra EU countries. After that, I wanted to analyze also in which district or geographical area they were more inclined to export.

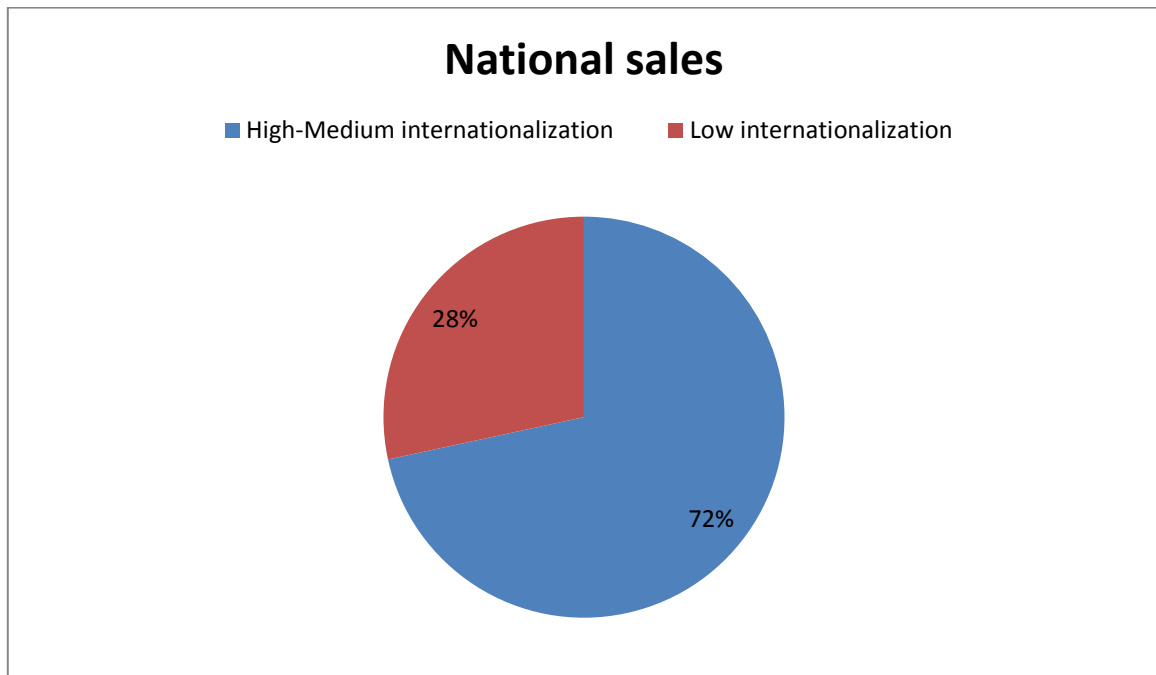
From the first crossing what came out was that the small and medium-small firms are those that have the higher level of internationalization, that at a first sight could be seen as a paradox considering their dimension (Table 19). From the internationalization for geographical areas we can see that there is a quite homogenous distribution of firms with high, medium and low level of internationalization within each district and the one with the highest percentage of firms with high internationalization is the Vicenza one (Table 20).

Table 17 - Branding



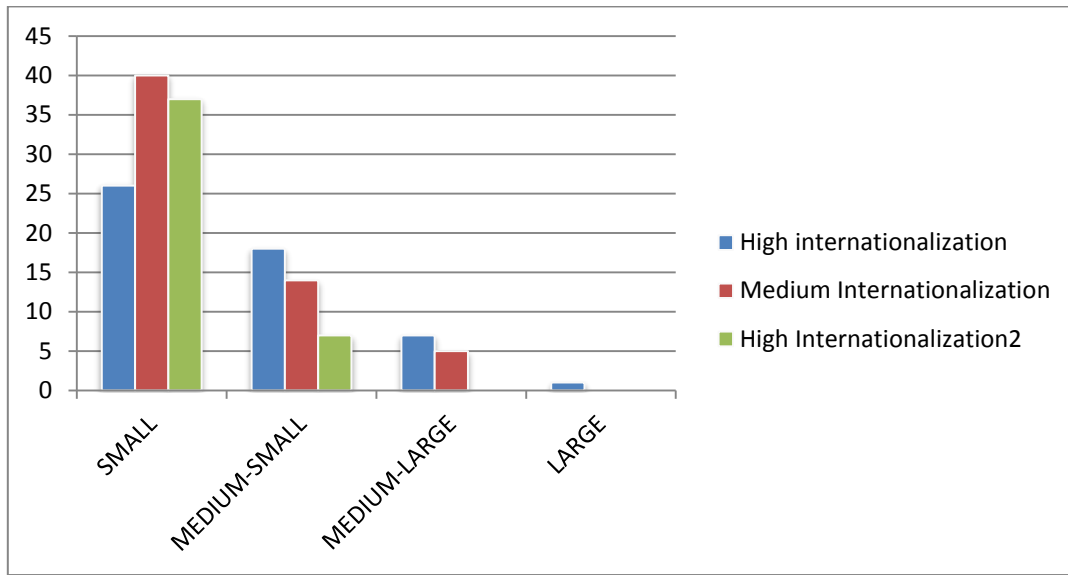
Personal elab. of Fondazione Nord Est – Banca IFIS data

Table 18 - Internationalization



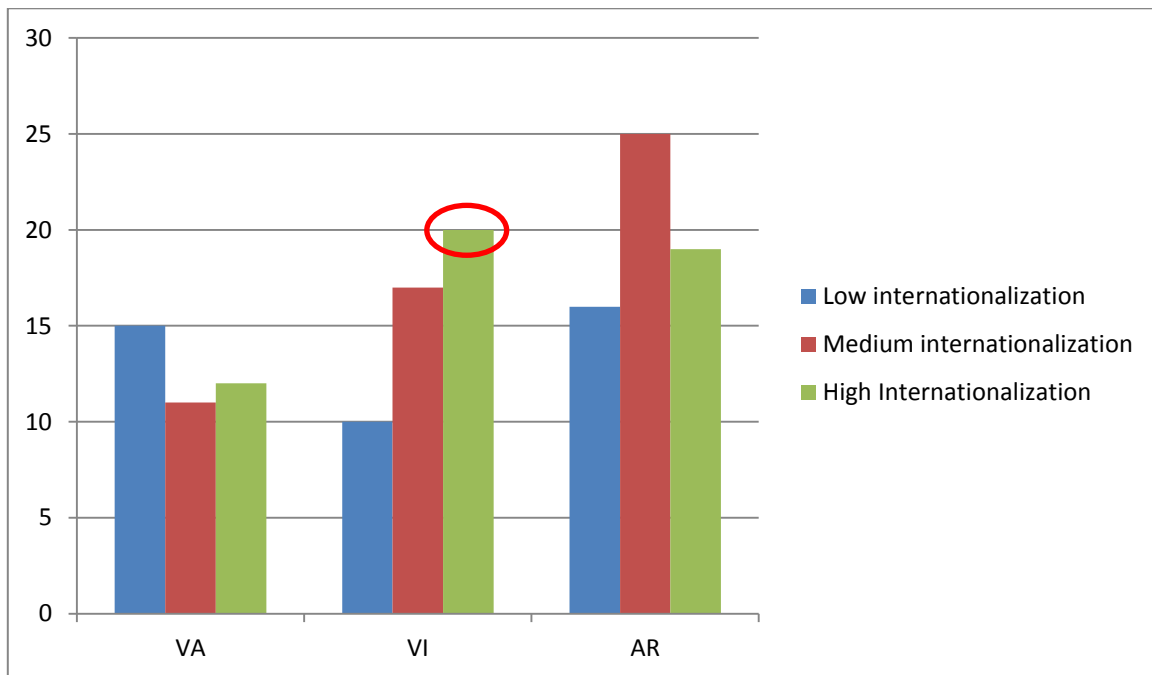
Personal elab. of Fondazione Nord Est – Banca IFIS data

Table 19 – Internationalization for Dimensional Class



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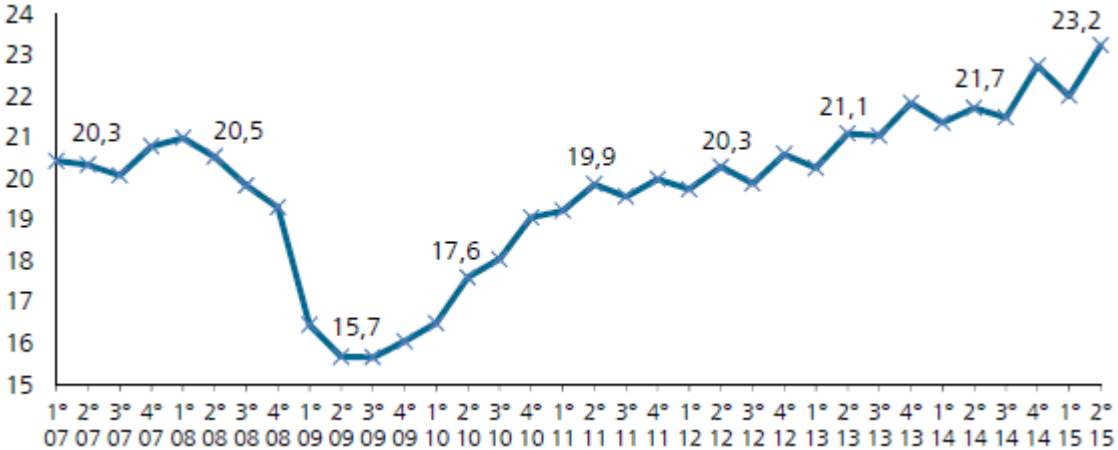
Table 20 – Internationalization for geographical Area



Personal elab. of Fondazione Nord Est – Banca IFIS data

These results have been confirmed also by the “District monitoring” made by Intesa Sanpaolo in September 2015. Generally speaking, in the second quarter of 2015, the export of the 141 Italian districts monitored by Intesa Sanpaolo reached the extraordinary result of 23,2 billion/€ (fig. 17). It is the twenty-second quarter of consecutive growth. The districts export has been subjected to a rapid acceleration, showing a growth of 7%. Industrial districts are the most dynamic areas not only in the Italian productive scenario but also in the European one.

Fig. 17 – Evolution of Districts’ exports (billion/€)



Elab.

Intesa Sanpaolo of ISTAT data

There are three main sectors in which the increase is significant: **agri-food business** (+11,3% vs -2,7% in Germany), **products and building materials** (+9,8% vs +1,4%), **fashion** (+8,8% vs +2,3%) and **furniture** (+6,4% vs +3,6%).

The most important news regards the recovery of the fashion and products and building materials districts. The first four positions for export growth volumes are covered by four districts of these industries: **the jewelry district of Valenza**, the glasses district of Belluno, the tanning district of Arzignano and the tile district of Sassuolo.

The jewelry district of Valenza has been confirmed the best Italian one for growth in foreign markets, also due to the increasing sales in Switzerland and France. The most interesting aspect is represented by the sales recovery in the European market and, particularly, of the fluxes directed to Switzerland (+14,3%), France (+6,5%), UK (+11,5%) and Spain (+13,1%).

Fig. 18 - Districts with the higher exports growth (billion/€) in the second quarter 2015

District	Billion/€			Variation %	
	2° quarter 2014	2° quarter 2015	Difference btw 2015-2014	2° quarter 2015	1° semester 2015
Oreficeria di Valenza	313	557	245	78,2	52,3
Occhialeria di Belluno	689	797	108	15,7	14,7
Concia di Arzignano	560	641	81	14,5	10,5
Piastrelle di Sassuolo	788	865	77	9,7	6,7
Ortofrutta del barese	64	137	72	112,6	78,4
Metalmeccanica di Lecco	551	622	71	12,8	8,1
Pelletteria e calzature di Firenze	773	836	63	8,1	6,4
Tessile e abbigliamento di Treviso	176	233	57	32,1	36,5
Meccanica strumentale di Varese	222	268	46	20,6	7,9
Vini del Chianti	121	166	46	37,7	31,8
Meccanica strumentale di Vicenza	335	377	42	12,5	8,4
Mobile del Livenza e Quartiere del Piave	548	588	39	7,2	8,1
Meccanica strumentale del bresciano	211	246	34	16,3	8,6
Mele dell'Alto Adige	136	170	34	25,1	8,5
Oreficeria di Arezzo	483	517	34	7	-4
Oreficeria di Vicenza	376	409	32	8,6	9,6
Cartario di Capannori	117	145	29	24,7	23,3
Rubinetti, valvole e pentolame di Lumezzane	816	844	28	3,4	3,1
Dolci e pasta veronesi	63	90	27	42,1	33
Macchine tessili e per materie plastiche di Bergamo	183	209	26	14,2	1,3
Calzature di Fermo	273	299	26	9,5	0,7
Tessile di Biella	283	308	25	9	6,8
Mozzarella di bufala campana	34	58	24	69,9	65,6
Total	21.717	23.245	1.528	7.0	5.0

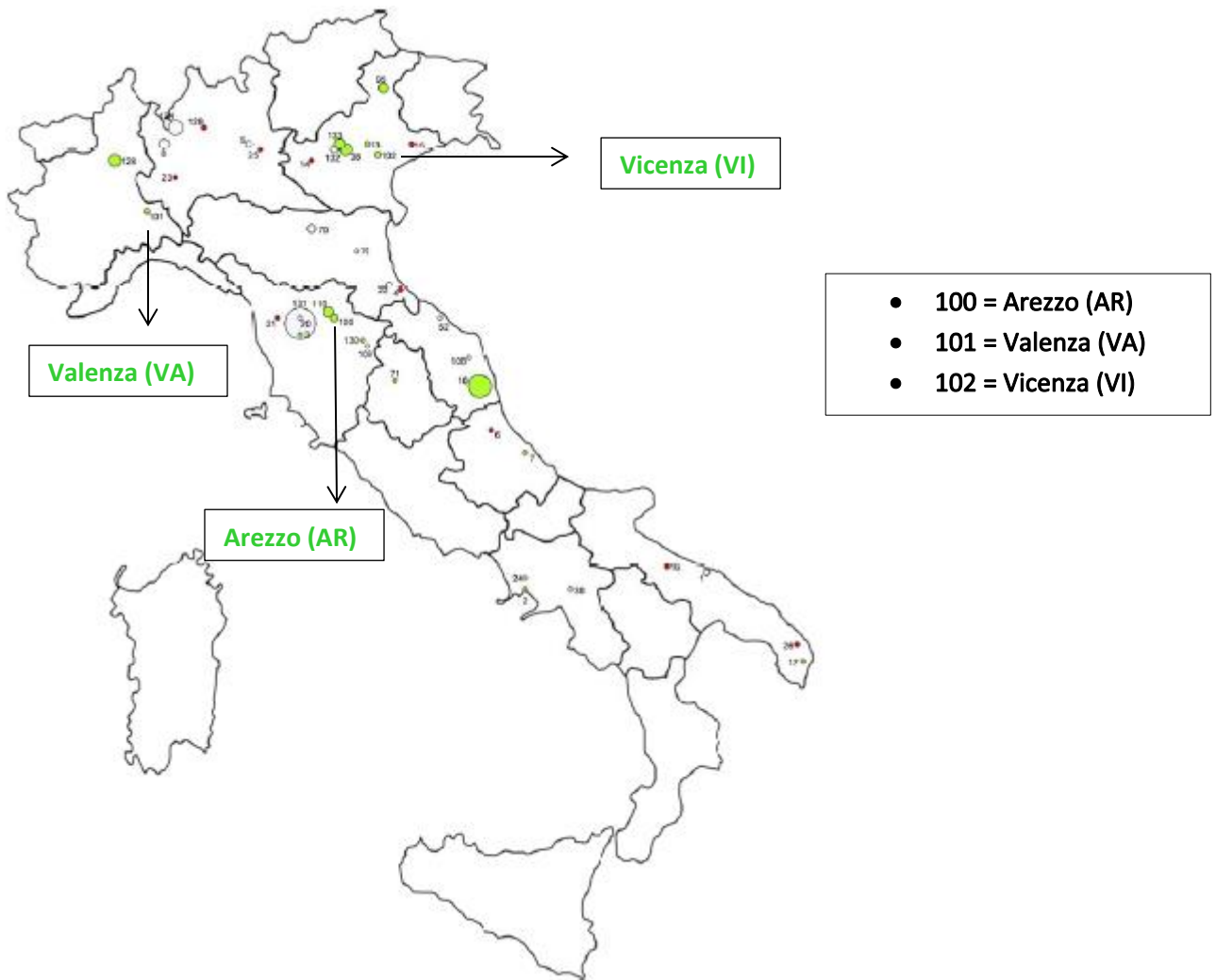
Elab. Intesa Sanpaolo of ISTAT data

In order to have a clear visualization, here attached you can find a geographical map of industrial districts, highlighting their trends on foreign markets. In the map the industrial districts analyzed by the “District monitoring” are represented with circles. The dimension of the circle represents the importance of each district in terms of sales volume and number of firms belonging to it.

The color of the circles represents the export trends in the second quarter 2015 compared with the second quarter 2014.

- In **green** the districts that have registered an exports increase higher than 5%;
- In **red** the districts that have registered an exports decrease not lower than -5%;
- In **white** the districts that have registered an exports variation between -5% and +5%.

Fig. 19 – Three jewelry industrial districts and export growth



Elab. Intesa Sanpaolo of ISTAT data

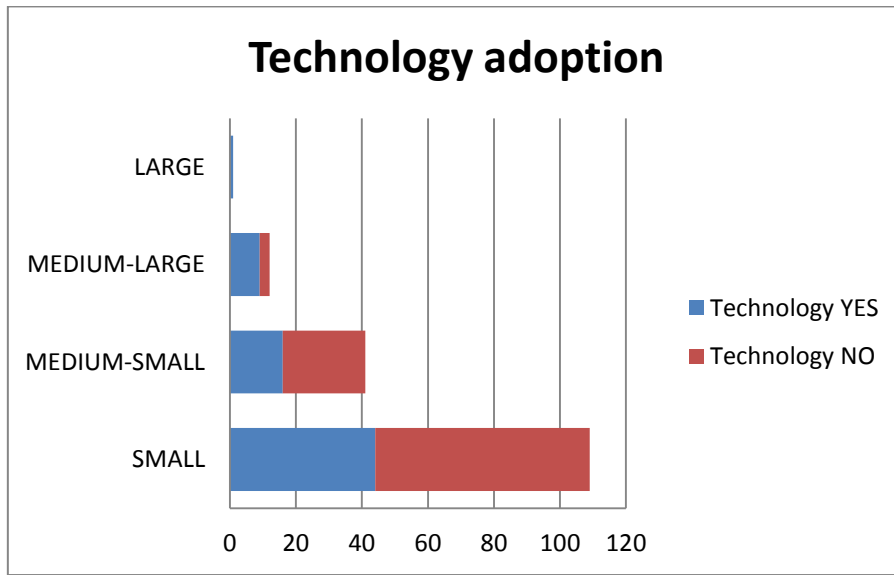
As we can see, all the three major districts – Vicenza, Valenza, Arezzo - are characterized by the green circle and this corresponds to the results of the questionnaire of “Fondazione Nord Est” submitted to the 163 firms relatively to their level of internationalization and exports.

5.2.1. Digital technologies in manufacturing

In the questionnaire we then asked to the firms if they own these disruptive technologies that characterize the digital transformation and if they use them and for what they use them. For technology I mean 3D printing and laser cutting. I have grouped the answers in “Technology YES” which include the following possibilities – I own and use technology, I own but I don’t use it, I exploit external services – and “Technology NO” which means that they don’t own and use technology neither by themselves, nor by third parties, external services. I made this grouping in order to have a more significant sample of data to analyze. In the tables below it is possible to see the number of firms that use technology (Table 21) correlated with the size and also understand how the sample of companies use it: for production, prototyping or both - mix- (Table 22). What is evident is that the small and medium-small firms tend to not use technology, even if the gap is not so relevant and this means that also many small firms are starting to adopt it, while the medium and medium-large companies have already begun to exploit it. Generally, I can say that 43% admits using technology while 57% do not use it; as anticipated above the gap is not so large. This is a positive result in my opinion because it means that the digital transformation is reaching, in this sector, the 50-50% of firms adopting technologies that allow them to innovate not only in products but especially in business models and that this is affecting also the smaller firms.

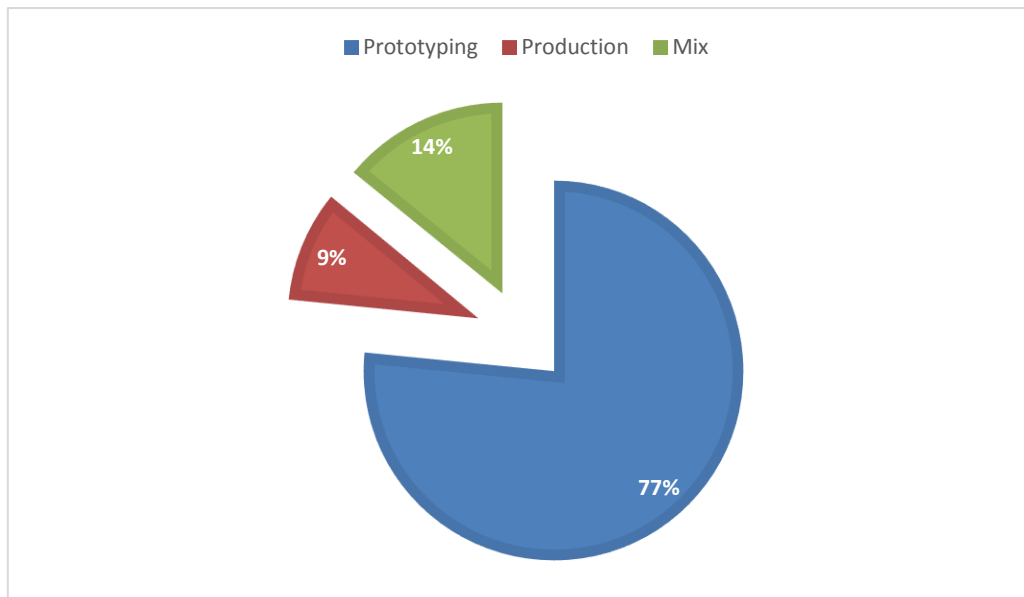
Analyzing what the main use of 3D printers and laser cutting technologies is, it arises that companies use them mainly for prototyping rather than for production and this is a potential not exploited by the industry yet.

Table 21 – Technology for dimensional class



Personal elab. of Fondazione Nord Est – Banca IFIS data

Table 22 – Technology and its use



Personal elab. of Fondazione Nord Est – Banca IFIS data

5.2.2. Are firms heading towards mass customization?

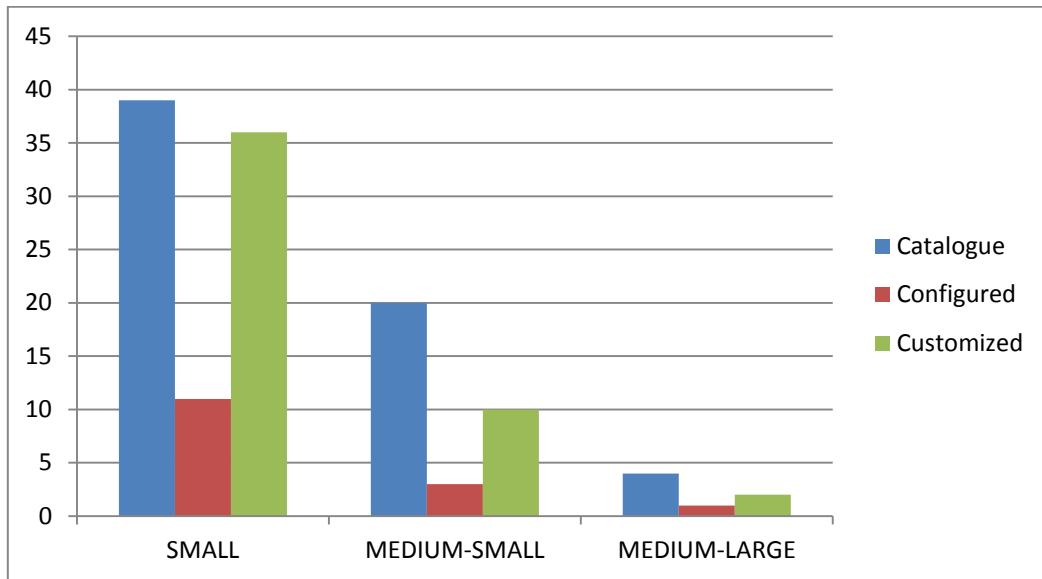
I proceeded my analysis trying to understand if jewelry firms of Italian districts are more focused on a catalogue production, a configured one or if they are exploiting also new trends such as the customization of final goods. Considering the high level of internationalization and, as a consequence, of exports and the usage of technologies, it would be interesting to see how the production is differentiated. I have analyzed firstly the customization level based on the dimensional class of the firms (Table 23), then on the geographical area (Table 24) and finally I compared the degree of internationalization and the type of production in order to understand if, as expected, to the higher level of exports there corresponds a production based on catalogue products while to the lower a more customized one (Table 25).

From the first table it is quite evident that companies declare they produce mainly on a catalogue and on a customized base; the configured production is still used at a lower level, not comparable with the other two, more consistent. Every type of firm – small size, medium and large – exploits these two types of production: on a catalogue base for 39% and on a customized one for 30%.

Crossing these results with the geographical distribution, what emerged is that the customized production is more diffused in the Valenza district, proportionally higher than the catalogue production; in the other districts the catalogue based production is still prevalent but there is not a huge gap between the two types and so the results are quite homogeneous.

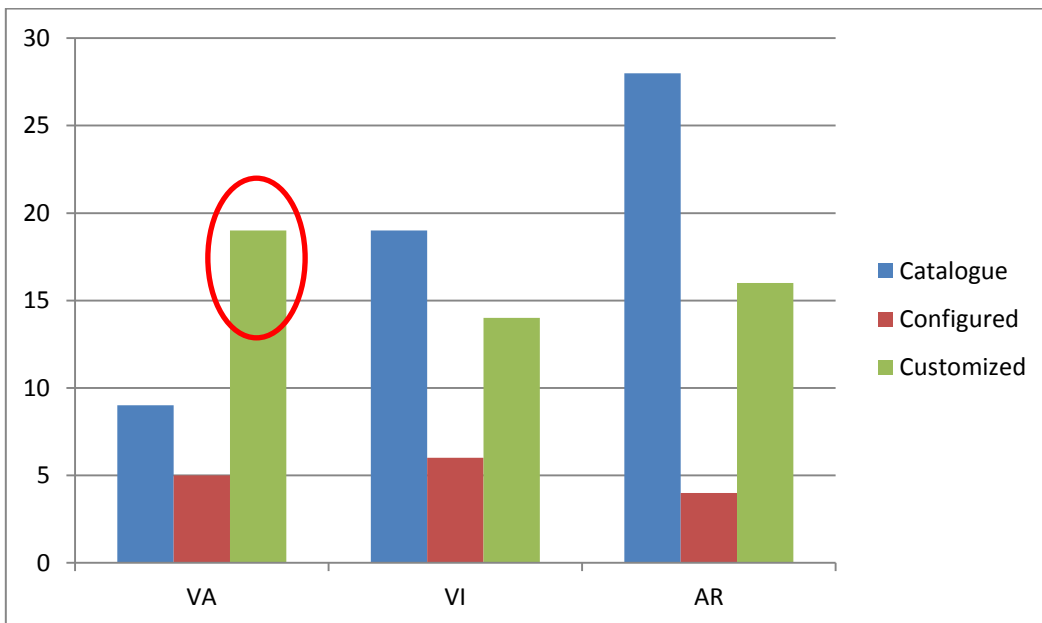
The most singular outcome derives from the crossing between internationalization and customization degrees. Indeed, companies with higher and medium levels of internationalization declared to produce mainly on a catalogue base, which was quite predictable; finally, the firms that mainly produce on a customized base are those that have a low level of internationalization and so they are able to respond both to national and foreign market's needs.

Table 23 – Customization strategies on dimensional classes base



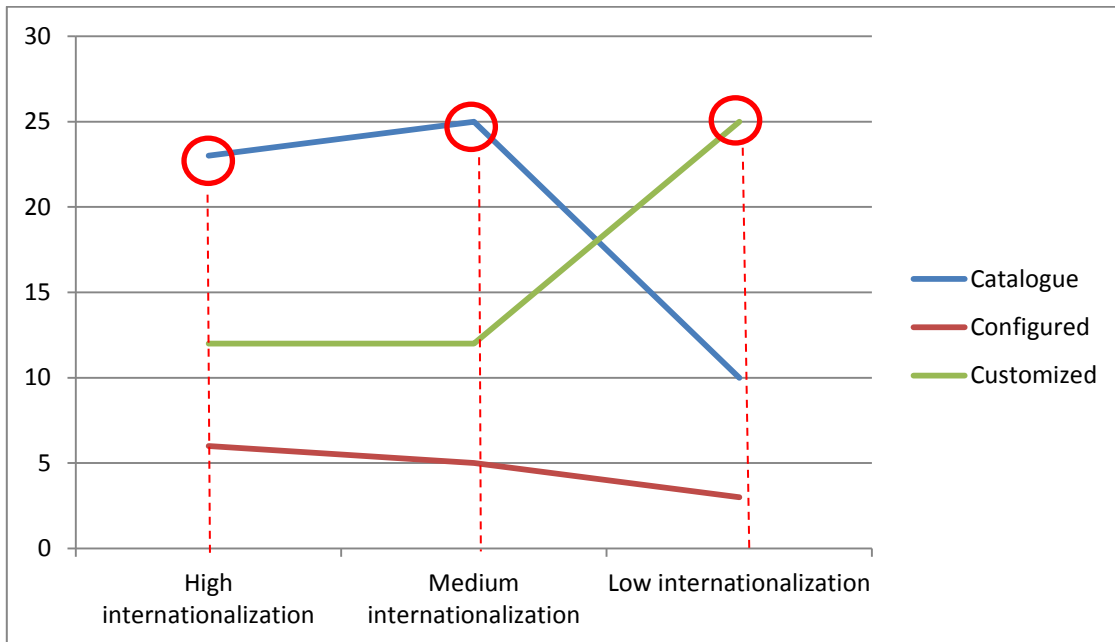
Personal elab. of Fondazione Nord Est – Banca IFIS data

Table 24 – Customization strategies on geographical areas base



Personal elab. of Fondazione Nord Est – Banca IFIS data

Table 25 – internationalization and customization strategies



Personal elab. of Fondazione Nord Est – Banca IFIS data

5.2.3. E-commerce: a channel underutilized

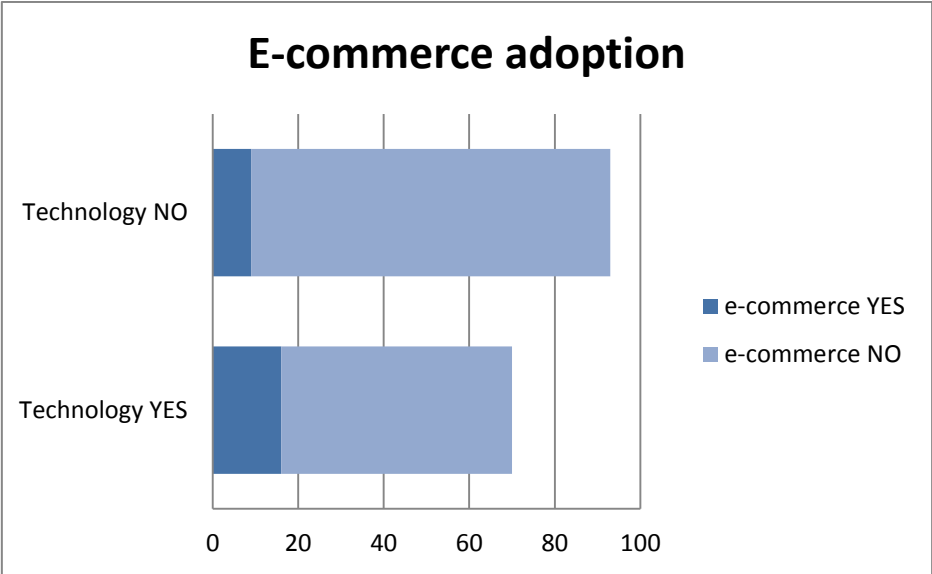
In order to understand how the strategy of the firm is developed, I analyzed the degree of adoption of the e-commerce tool within the 163 companies of the sample and I then crossed these results both with the use of technology (Table 26) and the level of customization (Table 27).

From the first one, came to light that the vast majority of firms don't use and haven't adopted the e-commerce channel yet but, the ones that own and use technologies are those that are more prepared and inclined to use these alternative distribution channels, represented by the e-commerce platforms.

Another interesting result is given by the table 27 where it is evident how the e-commerce is a tool not exploited by the jewelry industry yet: a high number of firms that affirmed to produce mainly on catalogues rather than on a customer base, have a very low percentage of utilization of e-commerce and this is a result that could be seen as a paradox. These firms are those which in a more strategical and easy way should already have adopted it as an alternative distribution channel: customers should only choose the product they want from

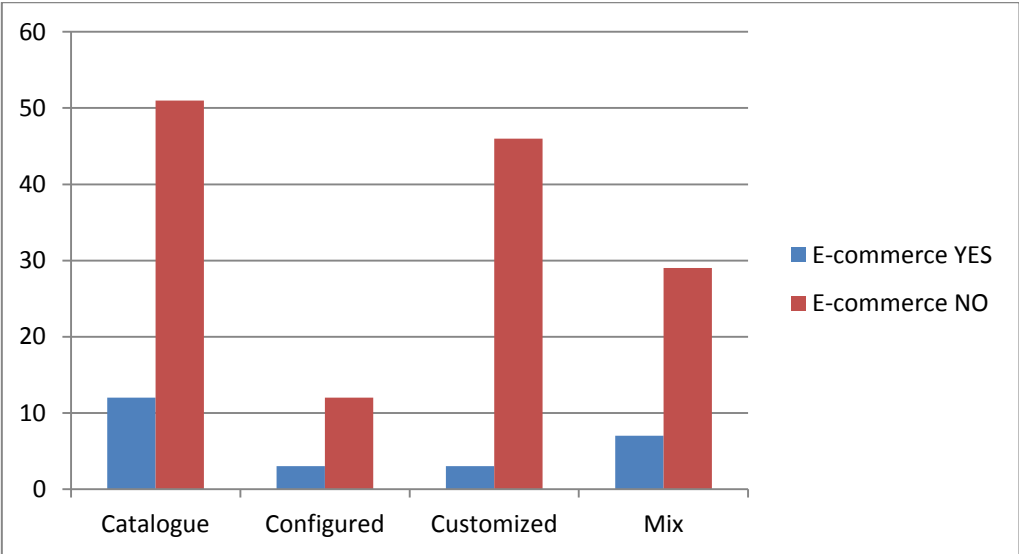
an online catalogue and buy it. This represents a highly potential tool in order to increase not only sales but especially exports and, as a consequence, the internationalization level of the companies themselves.

Table 26 – E-commerce and technology



Personal elab. of Fondazione Nord Est – Banca IFIS data

Table 27 – E-commerce and customization



Personal elab. of Fondazione Nord Est – Banca IFIS data

5.3. The Jewelry business in Italy and Europe

After having analyzed the questionnaire results submitted to 163 jewelry firms of the three major districts, I have elaborated the data collected by the “Banca dati AIDA – Bwd”. The results gathered reflect the economic scenario of a more extended sample of firms, 584 precisely, in the years 2007-2014. It is a “closed” sample: only those firms that have survived during all those years are taken into consideration and for this reason the data are elaborated on a constant base, the same firms. This means that, on the contrary, a firm that died in 2009 for instance, was eliminated from the results. In this way it is possible to make a fair consideration of what emerged.

The analysis is based on three main variables:

- Profitability;
- Growth;
- Export/internationalization.

For each class, I made different crossing of data in order to gather the highest number of information. Generally, I have compared the results of the whole sample (584 firms) respectively with the “technological” firms, those that have adopted a strategy of product customization and those that have combined the exploitation of technology with the customization strategy. Now I am going to show in depth what emerged from the analysis of each category.

5.4. The impact of innovations on firms’ profitability

In the first class of data I have analyzed the EBITDA variation of the whole sample of firms in the years 2007-2014. EBITDA – Earnings Before Interests, Taxes, Depreciation and Amortization – provides information regarding the profitability of the firms. The main aim is to show if this index grew or not during all these years in order to have a general overview of how the jewelry sector is going and to make successive comparisons possible. This will be the basis for comparison.

Jewelry profitability among 2007-2014

Fig. 20 - Jewelry, 584 firms



Banca Dati AIDA

In the graph above are represented those firms that rely between the percentile 25 and percentile 75. In correspondence of the percentile 50 is represented the median that shows the value assumed by those statistic units that are in the middle of the distribution. The average profitability is depicted by the orange line. It is evident that profitability steadily reduced over the course of 7 years from 6.7 to 5.6. This will be the comparison term for all successive analyses.

5.4.1. Does technology increase firms' profitability?

From the whole sample of companies – 584 – I have then isolated those that have adopted new technologies and I have represented their profitability variation. The number of technological firms is equal to 44, 7,53%.

The interesting result shows that these kind of organizations have an average profitability higher than the rest of the sector (from now ROS) and that is going to increase: this means that opening to new technologies reflects an effective increase of EBITDA compared to those

firms that are more “traditional”. Innovation is again synonymous of improvement, also in economic terms.

Profitability of technological firms

Fig. 21 - Jewelry, 44 firms



Banca Dati AIDA

Profitability comparison: sector and technological firms

Fig. 22 – Sector and Technology EBITDA

From the comparison between the sector results and those of the technological firms, it is evident that the second ones are superior in terms of profitability. An important aspect that has to be taken into consideration is that EBITDA in the last years is growing, not only compared with the ROS.



- technological firms
- - jewelry sector

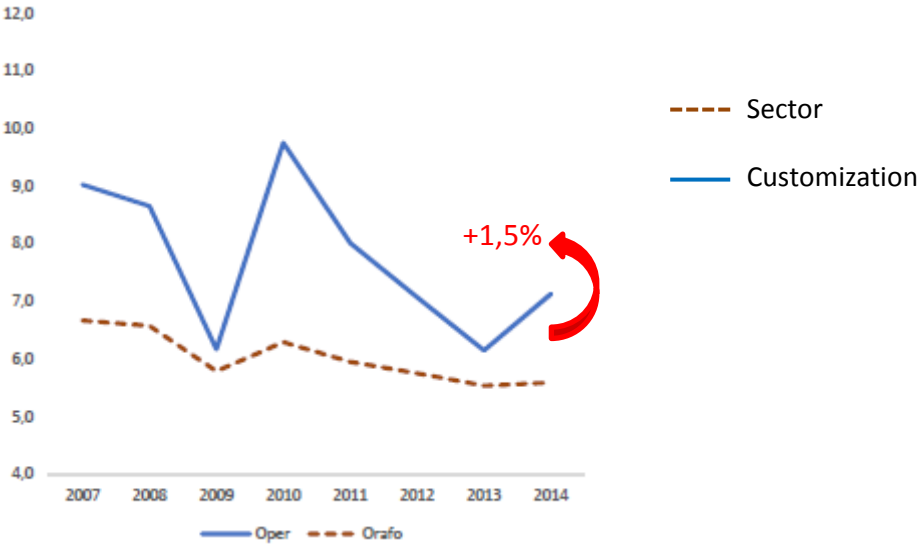
Banca Dati AIDA

5.4.2. The effects of technology and customization strategy

I then have isolated the firms that declared to have adopted a strategy of product customization – 28 companies, 4,80% – and elaborated their profitability variation compared with ROS – 584 cases. In this comparison what emerged was a strong superiority: EBITDA clearly reached very high levels during all the seven years that the sector never touched.

Profitability comparison: sector and customization strategies

Fig. 23 – Sector and customization EBITDA

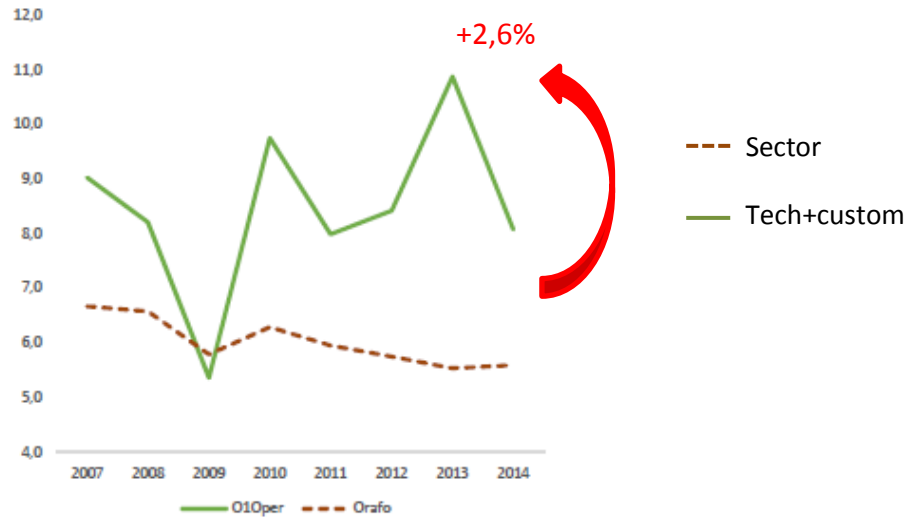


Banca Dati AIDA

After this analysis I have split up the firms that both adopted technologies in their production processes and strategies of customization in their business models – 15 firms, 2,56%. As expected, the profitability is definitely higher than the ROS, the technological firms and those that customize products.

Profitability comparison: sector and technology - customization strategies

Fig. 24 – Sector and technology/customization EBITDA

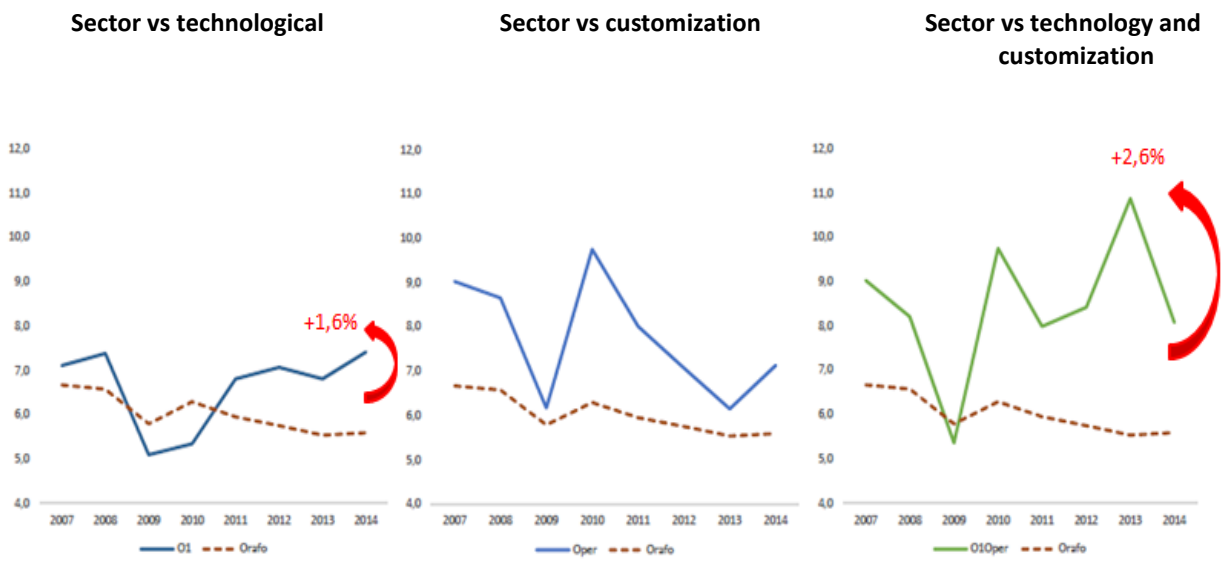


Banca Dati AIDA

Comparing linearly these graphs, the result is quite evident: opening to innovation in terms of technologies and business model strategies such as the product customization, leads companies to reach higher levels of profitability. This could be translated in new investments, innovation and growth.

Representation of profitability variation

Fig. 25 – EBITDA variation



Banca Dati AIDA

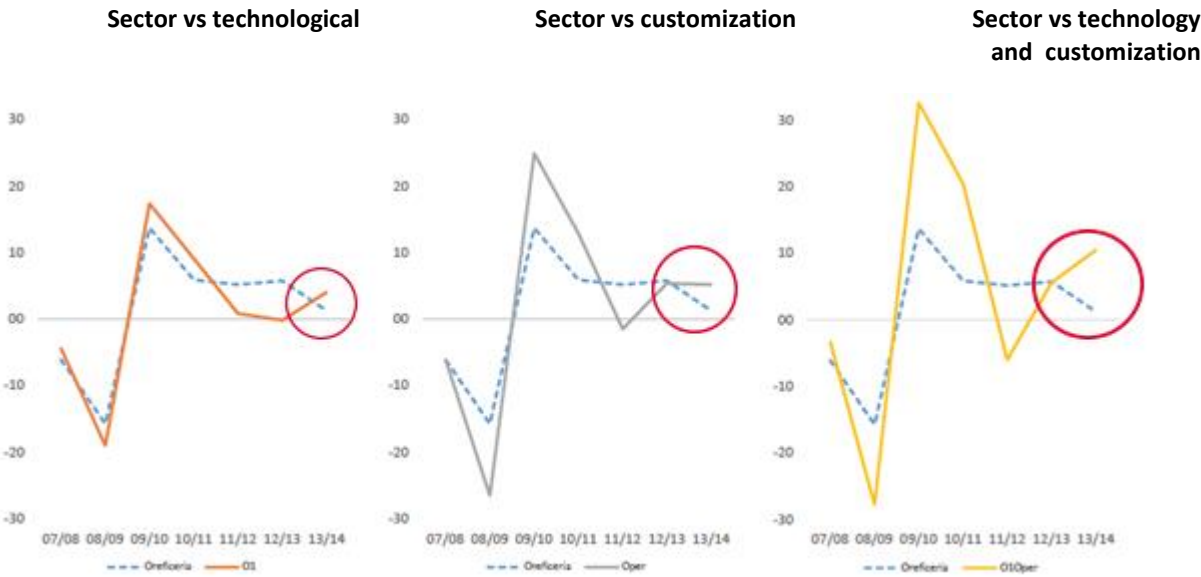
Finally I can say that the profitability is higher in those firms that have adopted new technologies or those that have opted for product customization strategies but the highest one derives from the 15 firms of the sample which declared to have chosen both technology and customization.

5.5. Does digital transformation mean higher growth?

The second category of data gathered refers to the growth in terms of revenues variation. As well as for the profitability, I have compared the results coming from the ROS, the technological firms, those companies that have adopted a product customization strategy and those that have combined technology and customization. The results are quite similar among the three graphs below but the most relevant aspect regards the exponential growth of the outcome. It is evident that in each graph respectively the technological firms, customization strategy and the combination of the two, have a higher growth compared to the sector. It is clear as well that this result is more and more significant in the combination of the firms that have adopted technologies and strategies of customization, in fact the divergence between the two lines – yellow and blue – is very meaningful.

Representation of growth variation

Fig. 26 – Growth variation

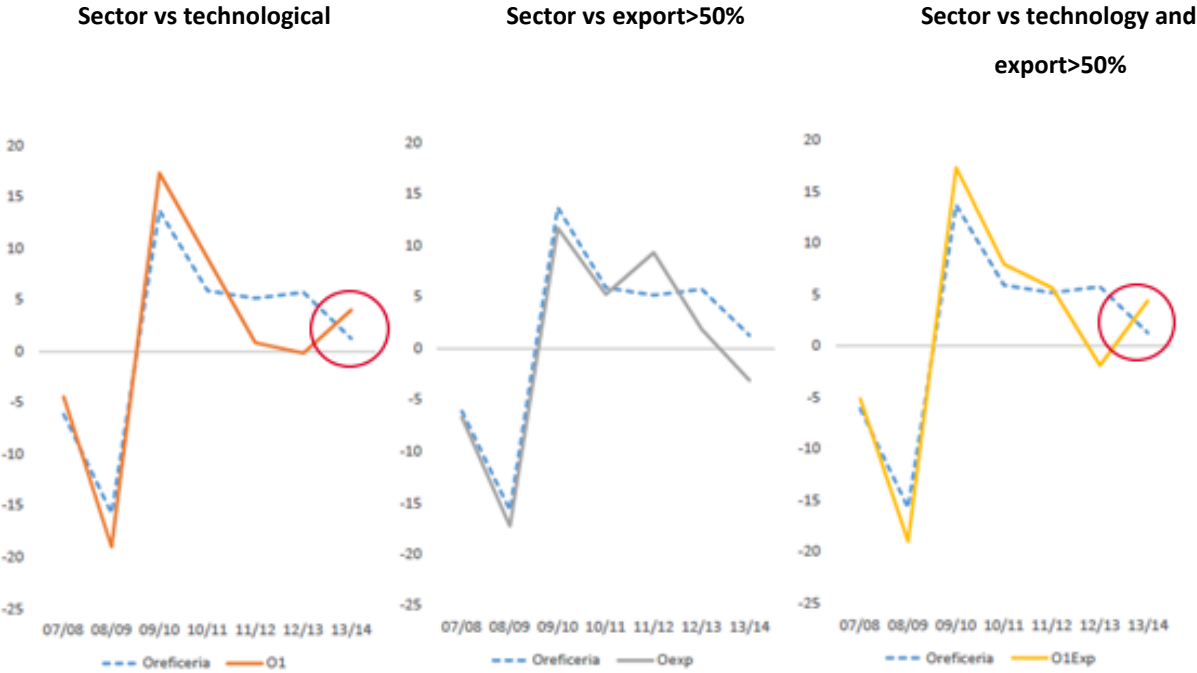


5.6. Export and technology

The third category of data collected regards the percentage of sales abroad on the total ones: the level of internationalization. In this case, I made a first comparison between the sector in general and the technological firms in order to have a general view of the trend (first graph), then I compared the sector with those firms that export more than 50% of the turnover (central graph) and finally the sector and the firms that export more than 50% and have adopted new technologies. Analyzing from the left the three pictures it is confirmed that the technological firms (44 cases) have a higher level of internationalization compared to the ROS. The second graph is the one that leads to ambiguous results that should be integrated with an analysis of the business models of these firms (61 cases). The third one finally confirmed the positive correlation between technological advancement and internationalization.

Representation of export variation

Fig. 27 – Export variation



Banca Dati AIDA


Chapter 6: Case Study Analysis

The last part of my analysis has been conducted interviewing a champion of firms with different business models and strategies: someone has adopted technologies, someone customization strategies, someone is pretty internationalized while other could not have adopted none of the mentioned above. I made these interviews in order to understand if the results of the questionnaire in the first part, and of the Banca Dati AIDA in the second one, effectively reflect the scenario that characterizes our firms.

After this last analysis, it will be possible to identify the existing correlations between growth, internationalization, and profitability and in particular it will be possible to address which kind of firms are characterized by the highest combination of the three variables above.

6.1 Discussions and implications of this study

In order to offer a clear visualization of what emerged from the literature researches, the questionnaire and the interviews, I would like to highlight the four main topics that came out and emphasize the existing correlations among them, whenever they are, and the potentials unexploited. The themes I believe fundamental to discuss of comprehend: technology, internationalization, customization and e-commerce.



TECHNOLOGY

What emerged from the interviews made is that, all firms have already adopted technologies since 5-10 years. The companies are of small and medium size and the fact that they are exploiting 3D printers and laser cutters since so far, allows having a bunch of data with a high level of reliability. Going in depth trying to understand which are the main uses of the technologies, came out that they use them especially for prototyping rather than producing . This result is absolutely in line with what the questionnaire highlighted. The fact that production is actually using only partially the technologies, means that there is a potential not developed yet that could lead to new disruptive products and, as a consequence, new business models and market niches.

Another interesting aspect that some firms underlined regards how technology is perceived as a tool that helps artisans in doing better their work. CNC machines, for instance, ensure a precision measurement that humans hardly can reach: this reflects a significant save of time for artisans that can, in this way, focusing more on what they do better, develop their creativity. In this perspective technology is seen as an aid to human resources that, especially in this industry, could never be completely replaced by machines. Technologies allow firms to:

+ SAVE OF TIME + EFFICIENCY +RESPONSIVENESS - COST REDUCTION

3D printers and laser cutters are not a source of reduction of costs because the wax used by the machines is almost 10 times more costly than the traditional one, but the high level of efficiency, flexibility and responsiveness with clients represents an advantage that would not be reach traditionally. The prototype that in the past was prepared in one week, actually is ready in one day; of course this will represent an increase in the production stage.




All the companies surveyed declared to have a very high percentage of sales abroad. The small and medium firms are highly internationalized, data confirmed both by the questionnaire where emerged that the 72% of the whole champion had a high level of exports and the vast majority were small-medium enterprises and by the “District Monitoring” made by Intesa Sanpaolo. Another time Italian jewelry districts

increase of 7% in exports and, the first place in the most growing Italian districts, is occupied by Valenza jewelry. Also Vicenza and Arezzo highlighted an increase of +5% in exports in the second quarter 2015 compared to 2014. Internationalization is strictly linked with technology: as anticipated above, machines allow companies to reach a competitive advantage in terms of high quality and precision, flexibility and responsiveness, all characteristics fundamental to survive in international markets. Firms demonstrated to adapt rapidly their products, responding to each market needs and trends, and this would not be achievable following the traditional methodology.



CUSTOMIZATION

Despite the high and unexpected level of openness to technologies, new strategies and markets, companies are still focusing on the catalogue based production. They put all their efforts in order to offer to their customers innovative collections, both in design, looking at the trends of the moment, and in technologies, developing new semi-finished goods. From the interviews emerged that the personalization of the product is not diffused yet among companies. Some of them are starting moving in this direction, but considering the whole context, the customization strategy is not so consolidated and taken into consideration as technologies have been. In some cases the reason is a positioning strategy: the company ensures to propose innovative and high quality goods for which customers should not ask for edits. In other cases, personalization is not seen as a way in order to differentiate themselves among the others but it is perceived as something that facilitates the product to be copied. As emerged from the questionnaire, customization strategies cover a lower percentage than the catalogue ones, but they are starting to be adopted by some firms. Considering also the high level of internationalization of the companies interviewed, it is quite normal that they favor the catalogue production, in order to be more responsive with customers, analyzing in advance trends and tastes of each specific market and also this aspect was confirmed by the questionnaire. It is possible to say that firms are mainly focused on a variety production rather than a quantity one.



E-COMMERCE

An interesting aspect emerged from the analysis of distribution channels. The vast majority of firms confirmed to exploit direct existing relationships with clients, someone uses agents or developed a subsidiary to cover and control also the foreign markets. It is quite uncommon especially if we refer to the same companies that declared to use new technologies from 10 years. Digitalization in distribution channels is not following the lead of technology adoption. The result that emerged in the questionnaire of Fondazione Nord Est – 85% of firms do not have an e-commerce channel – was confirmed by the interviews. The

companies have only recently opened the e-commerce both in their websites and/or their clients' one, but sales deriving from this channel are still irrelevant. Especially for those firms highly internationalized that produce on a catalogue base, this instrument should be fundamental and easy to exploit. The digital maturity under this point of view is not so developed yet but, as confirmed by the vast majority of enterprises, they are moving towards the opening of this distribution channel. This is a result that testifies how, despite the high majority of firms have not adopted e-commerce yet, those that are using technologies from many years and realized the advantages deriving from them, are the most inclined in adopting it.

Here below I have reported some interesting case studies I met during my interviews. I had the possibility to speak with a B2B reality, a B2C one and a contractor firm that works only for third parties as external service.

6.2 Case Study α

The first firm interviewed is a company that in 2016 had a turnover of approximately 23.000.000 € and employs about 39 persons, so it represents a typical small-medium enterprise. In the last November 2016 became/went quoted on the Milan Stock exchange. The firm α affirmed to having adopted new technologies in two directions: in order to ensure either product and process innovation. Product innovation means development of new products through the advantage given by new technologies. In 2007, the firm patented a technology that allows to make the bracelets “flexible”: it was possible to produce the semi- finished products that put together not only bracelets but also necklaces in an innovative way. It invested a significant amount in R&D and expanded the technology horizontally to all the products. This investment needed about 18 months in order to become effective and represented a cost both internally and for external services. For what concerns the process innovation, the firm heads towards efficiency. The main objective is producing **high quality** semi-finished goods, reaching **efficiency** in terms of reduction of the lean time: the strategy is about satisfying rapidly the orders, in this way the firm is able to reduce the warehousing stock and increase the speed about the order’s escape, and cut industrial costs making **flexibility** easier to be achieved.

What kind of technology does it use? The company uses robots in some stations of the production line, it is important to remember that even now some phases have to be accomplished by humans; laser cutters and 3D printers. This is a first result that reflects what the questionnaire already showed. The firm adopted the technology more or less 10 years ago and nowadays it uses the 3D printer in particular for both prototyping and producing. They are internal processes and the firm exploits the 3D printer especially in prototyping: considering that it produces only with its own brand, the prototyping phase becomes fundamental in order to experiment from one side, and being responsive to its customers – that in this case are jewelry stores - from the other. The company produces its own collection, that is innovative in design and technology used, and this is the reason why it sells only on a catalogue base. The decision of not producing on a customized base has been a

positioning strategy: its jewels address a medium-high bracket and the company puts the efforts in order to offer a continually new collection, based on market trends and with innovative aspects. “If you want a Rolex, you just buy it, you don’t ask for edits” Cit. For what concerns the internationalization level, this firm exports the 80% of the final turnover. Even in the markets abroad the company is able to manage its clients directly: it uses some agents and, with the exception of the USA market where it established a subsidiary, it collaborates with its final clients not only regarding the orders but also in the development of the marketing and communication strategy. This allows a constant swing between producer-consumer.

The company α , despite the high attention given to innovation, technology and the high level of internationalization, adopted the “alternative” distribution channel of e-commerce only in 2016. This was justified by the fact that it is mainly a B2B scenario given that the firm sells to the stores that will sell to the final consumer. Anyway, the instrument is already utilized by final consumers even if actually it still represents a marginal part of sales. The company has its own e-commerce on the website but it is present also in the e-commerce of its clients, whenever they use it. The perspective for the future is moving into the incremental development of digital channels for the distribution, maintaining the focus on high quality products and processes’ efficiency.

6.3 Case Study 6

The second company interviewed is a medium-large firm based in Vicenza's district that had a turnover of about € 48 million in 2015 and employs more or less 50 persons. This is a typical example of high-internationalized organization considering that sales abroad cover the 98% of the total sales. This has confirmed by the presence in more than 63 countries in foreign markets through both clients' stores and flagship boutique. The company has invested in both techniques that have a strong correlation with the production process and in technologies that have a more significant impact on prototyping process. The main aim is to reach efficiency exploiting computers that are fundamental for the production phase and investing in the most sophisticated techniques for finite element modeling and melting processes.

The main advantages that the company can measure regard the possibility to have a more variable production, more sophisticated and at the same time light but complex, always in line with the most ancient gold traditions.

The firm, even though was very careful about innovation, aims firstly at the high craftsmanship and Italianism of the brand. The marriage between innovation and tradition led the firm to produce handmade jewels but at the same time goods realized through 3D printing. The last ones, even if produced technologically, are sophisticated and complicated to produce. In fact, the company is open to innovative models and strategies and would like to reach also those brands not so popular.

The organization is extremely interesting because it has its own business characterized by a dozen of collections and so it produces on a catalogue base, and simultaneously some of its clients buy a wide range of high jewelry products and exclusive or limited pieces. This means that the company is quite flexible and oriented at satisfying clients' needs, putting its efforts in both innovating in products and processes and presenting a new collection and trying to respond to personalization needs.

Surely the new technologies represent a fundamental tool in order to increase responsiveness, flexibility and efficiency that added to the high quality of craftsmanship, allows the firm to reach high levels of quantities produced.

The firm sells to a cross variety of customers in over 62 countries and for this reason it pays attention to different styles and trends. It tries to respond in the better way to each market's need both in terms of goods produced and of communication and marketing strategies.

It relies a high attention especially to those markets where sales are growing up such as Usa, Canada and Mexico. How does it reach its customers? The firm demonstrates itself a step ahead also under this point of view because it adopted the e-commerce tool more than the most traditional distribution channels. In this way, it is able to reach a wider audience: it is in possess of the e-commerce both in its own website and in those of its clients. Furthermore, the firm has a direct relationship with the end consumer thanks to the net of stores, or better boutique, that it spreads around. In this way, it has a constant comparison with consumers' preferences and this allows to catch up information and translate them, thanks to technologies, in a short time in catalogue's products.

The company defines the relationship between technology and customization a real contrast that, if it would be possible to make it "concrete", everything would be easier. Contrary to what have been said until now, the company offered me a different perspective. We have always thought that technologies were the key tools to allow product's customization for those people that want to differentiate themselves from the mass, that want to have a unique jewel. In the firm's perspective, technology does not facilitate the customization of the product because it is easier to copy it.

The company interviewed is a high-internationalized firm, the 98% of total sales is made in foreign markets; only the remaining 2% is made in the Italian market. In order to be more responsive with its clients, it differentiates each brand with its own style based on the category and trends of clients around the world. This means that in some countries is possible to find some brands and not others, because they do not reflect the market's requests. The style is constantly adapted to different markets and local trends.

The company sustains that, despite this characteristic, it is difficult to identify which products are more requested in each market and in its opinion, this depends on what the company produces.

Considered the high level of internationalization, it is quite obvious that the company have adopted the e-commerce also in the foreign markets, even if the sales coming from this channel are almost irrelevant.

In conclusion, what I can say is that technology of course helps firms being more responsive with their customers and clients, but it makes harder the planning process. Nowadays, it is difficult to program the production because through channels, such as the e-commerce is,

you are not able to make previsions; there is not a logic behind these tools.

6.4 Case study γ

The third case interviewed is a young and dynamic firm that works as external service for the most prestigious and renowned jewelry companies and brands. This is extremely interesting because in this way I can offer also the perspective and vision of a contractor.

The company is located in the Arezzo's district and it is a small-medium firm with a turnover of about 2 million. The production process of an external service is characterized by the possibility to receive the drawing directly from its clients or they can just share the idea of how they want the jewel and then the firm has to develop from the sketch to the final product. In both these cases, then the drawings and of course jewels will be of the client's property.

Therefore, high responsiveness and flexibility are of fundamental importance for this kind of business. What allows the company to be one of the top performer among great brands is also technology.

The company only five years ago adopted digital technologies such as 3D printers and laser cutters and nowadays it is using them both for producing and prototyping. It owns seven machines.

While the production process is only partially impacted by technologies, the prototyping phase has experienced a radical change. The 80-90% of prototypes are made through the production of 3D printers. This change has allowed a reduction of time but not of costs: this process gives to companies a higher level of flexibility and a higher production of prototypes but not of final goods. If we have to look at costs, traditional waxes are less expensive than the wax with which the 3D printer works but it allows an extremely high level of responsiveness to clients. The wax is quite similar to the traditional one but it costs ten times more.

Using the traditional method, an entire week was necessary in order to develop a prototype; now, thanks to 3D printers, the client can receive the prototype the day after; the prototyping phase is almost a real time process: higher level of responsiveness are achieved. 3D printing in the production process is effective when a single piece cannot be crafted with the traditional method or when the production batch is not so large.

Of course, the firm produces only for third parties and so does not have its own collections. In the 90% of the cases the firm has to design the drawing, the CAD file and moves forward

with the entire production process. For the remaining 10% it receives the sketch from its client and then produces the goods requested. After the production, the client will sell directly to the final consumers that, most of the time, are international.

The organization regulates the link with its clients through the direct relationship because there is a constant exchange and comparison.

6.5 Case Study δ

The last interview made could be apparently forced but in my opinion is an interesting case to take into consideration. The company that I am going to describe produces a particular kind of jewels: home jewels. It has always sold home furniture since its born in 1867; this art has been transmitted through generations and nowadays it is affirming in the market place as a super innovative reality.

The aim of the company is maintaining the art as heritage, tradition and passion, is blending together the ancient techniques with new original innovations.

I wanted to interview it because it is actually exploiting all those technologies that jewelry firms are adopting but in a larger scale: it mixes together craftsmanship and tradition. It has introduced technologies in the production process more or less 7 years ago, with the acquisition of 3D printers and CNCs (computer numerical control). Today it is evolving in a technological path that is leading the firm at the top of the sector.

The company does not have a classic idea of home furniture because of the belonging to the art tradition: every single piece, is an art work. The period in which the firm born of course had an important impact on the mindset of the new generations that have been able to commit to the ancient tradition with a new opening to innovations.

The firm produces for a niche market: an extremely high luxury business. Its products are for people that have no limits, those that have a high possibility of spending.

Its success in fact is ensured by the two main channels through which it works: from one side the direct retail, with flagship stores, and from the other the network created and continually growing with designers and architects. It owns more than 15 stores, spread around the world, in which it can directly addresses single customers interested in the products. At the same time this allows the company to show which are the goods it produces, considering the style of its boutiques. The second consistent channel is represented by the network that the firm has built through years: it offers an internal design service or it collaborates with designers. For this reason the organization affirmed to produce both its own collection and customized products. Also the catalogue goods could be partially edited by consumers that are free of choosing specific colors and details. Differently from the most traditional jewelry firms, this company has already adopted a customization strategy.

Also in this case the 3D printer is used only for the prototyping phase with the support of a CNC machine: it scans all the components of the different furniture and integrates them with the CAD drawings. This allows the company to develop a product responding to the clients' preferences, because they have just to select the kind of material they want, but the printer has already saved the drawings for each model. A meaningful advantage is given by the CNC machine: it guarantees the extremely high measurement precision that the hands of artisans were not able to achieve. And this is a plus for these artists. Industry 4.0 and digital transformation is seen in the company as a supportive tool: it allows save of time to artisans that have more time to do what machines cannot replace: develop creativity. Another important result is given by the elimination of errors before the production process started and, if any criticality has identified, trying to resolve and avoid it the successive times. This reflects a reduction of developing times.

All these results foster the dedication to more complex projects.

As anticipated above, the firm has a high level of internationalization or better, markets abroad are the main sources of revenues. Despite the strong presence abroad, the company has not adopted the e-commerce, that actually is a work in progress and is seen as a future integration of its technological path.

As well as e-commerce channel, the firm is going to move to the virtual reality world with the construction of a *virtual room* through which clients could be directly immersed in a specific location and see the furniture installed. This is one the main projects it is going to develop and will be possible to experience it at the "Salone del Mobile" fair in Milan in 2018.

Remarkable Findings

“Industry 4.0” represents an industrial automation tendency that integrates some new productive technologies to improve working conditions and increase productivity, as well as the quality of plants. I analyzed the so call digital enablers of digital transformation, focusing on those that had a major impact on the jewelry industry: 3D printers, laser cutters and CNC machines, taking into consideration the effects that these could create within a smart factory. Different theories have been developed regarding the possible substitution of humans with machines, the alienation from work and the fact that a lot of jobs could be lost. From this research, it emerged that the introduction of machines has not been perceived in a negative manner: technologies are seen as tools that facilitate humans’ jobs, allowing them to focus on what they perform better. Machines have a higher precision than individuals, but especially in this industry, difficultly people could be replaced by technologies because there is a high craftsmanship aspect that is what makes the difference. Of course digital transformation means change, and as all changes, it might not be easy to accept. It may be easier to take on this challenge if we understood the benefits it produces. I proceed my analysis providing an overview of the sector of my interest: the jewelry one. As typical example of Made in Italy, it is structured in districts, three of which are the most important ones: Vicenza, Valenza and Arezzo. After having analyzed in detail the characteristics of each one, I reported the evolution of the three districts during the globalization and the recent recession crisis of 2008-2009 through the theoretical lenses of the global value chain. What emerged was the different internationalization strategies as well as organizational and structural ones that the companies of different Italian jewelry districts followed, understanding the different ways of innovation they developed.

After this deep dive in IDs main features, I explained the jewelry production process, comparing the digital manufacturing procedure with the most traditional one. It was evident that some phases of the whole process that once were handcrafted, now are replaced by machines and this is translated in time saving and major flexibility for the firms. When the context in all its complexity and magnificence has been depicted, I started the research elaborating the data of the questionnaire of Fondazione Nord Est. In this first part of the analysis, after having categorized the kind of firms based on the dimensional class in number of employees and the district of provenience, four main categories were considered:

internationalization, technology exploitation, customization strategies and e-commerce adoption. The number of respondent firms were 163, equally distributed among the three districts, mainly of small or medium-small size. The majority of companies, 45%, declared to produce with its own brand while 38% produces mainly for third -party brands. Speaking about the internationalization level, it came out that 72% has a meaningful level of sales abroad and only 28% of companies interviewed declared to have national sales between 86-100%, demonstrating a very low level of internationalization. There is a quite homogenous distribution of companies with high, medium and low level of exports among the three districts even if, those with the highest percentage are the small and medium-small enterprises. Of course these results have been compared with data collected by the “District Monitoring” by Intesa Sanpaolo that confirmed the internationalization growth of our districts of +5% in the second quarter 2015 compared to 2014.

For what concerns technology, it came to light that the small and medium-small firms are adopting technology slowly compared to the medium-large, even if the gap is not so significant. Another important result regarded the use of these technologies within our firms and, as confirmed later by interviews made with entrepreneurs, they are used mainly for prototyping rather than producing.

The Italian companies are still rooted in the traditional catalogue based production, are just starting to develop a customization product approach. This happened because of positioning strategies in some cases, due to the fact that firms put all their efforts in innovating the products, not only in design but also in technology of semi-finished goods. It was quite predictable that the catalogue production is the one preferred by firms that reach high or medium level of internationalization and so those that have to consider in advance which are the tastes and trends of each market. While the customized based production is actually more diffused among the firms with a low level of exports, that can focus more on national customer needs. Despite the high level of internationalization, it seems that firms have just recently started adopting the e-commerce, even if sales belonging to this channel are irrelevant so far. 85% of companies have not adopted it yet, but those firms that declared to use technology are equally more inclined to exploit this distribution channel soon.

The second part of the research took into consideration the whole jewelry sector between 2007 and 2014, comprehending only those firms that existed during all these years, in order to have a stable basis of data. In this second stage three main variables were considered: profitability, growth and exports.

I have analyzed the EBITDA variation of 584 firms of the sector and compared at a later time respectively with firms that have adopted technologies, customization strategies and both. It was evident that profitability was growing more in technological firms rather than the ROS, but the most significant variation derived from those firms that adopted both technologies and customization strategies. For what concerns growth, the comparison terms were maintained and the final result confirmed the higher growth of technological companies or of those which adopted personalization strategies compared to the ROS. Finally, within the exports cluster, I made a comparison between the sector, the technological firms, those that registered an export share higher than 50% of the total turnover and finally those that are technological and have exports higher than 50%. Also in this case, the positive correlation between technology and internationalization was confirmed.

The last and maybe most interesting part was articulated in a series of interviews made to national firms of the three major districts. The results were absolutely in line with what the questionnaire in the first part, and the economic analysis in the second one, highlighted. The introduction of new disruptive technologies allowed Italian jewelry companies to innovate both products and processes, improving the quality of the final goods and reaching high levels of efficiency. Using technology does not mean, as underlined by firms, a meaningful source of cost reduction, but, it allows to reach high levels of responsiveness with clients, fundamental in the fast changing environment in which we are living. It allows to cut production time, responding to orders in a faster way, and improving flexibility.

APPENDIX:

Questionnaire of Fondazione Nord-Est

Section 1 – General outline

1.1 Does the company sell with its own brand or third party brand? (% on the total turnover)

Own brand	%
Third party brand	%
Total	100%

1.2 In the last 12 months, which was the percentage of sales on national market and on markets abroad?

Italy	%
Europe	%
Extra EU	%
Total	100%

1.3 Which products does your company produces?

Catalogue products	%
Configured products	%
Customized products	%
Total	100%

Section 2 – Hardware equipment

2.1 Which of the following technologies does the firm exploit?

	Technology YES			If yes, how long are you using them?	Technology NO I don't own and use technologies
	I own and use technology	I own but don't exploit technologies	I entrust in external services		
CNC (computer numerical control)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>
Laser cutting	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>
3D printing and scanning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>
Robots	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>

Section 3 – Software equipment

3.1 If the company uses the e-commerce tool, can you indicate which is the percentage of sales on the total turnover realized through this channel?

_____ %

Section 4 – 3D printing and 3D scanning

4.1 In which production phase does the use of 3D printing more utilize?

Ideation and prototyping of new products	%
Production	%
Total	100%

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