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The Innovation Process of companies in emerging industries: the case of Italian companies in Drone industry

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ABSTRACT

Keywords: Drones, Innovation, Ecosystem, Open Innovation.

Drones are one of the main technologies that in the last few years kept growing at a very fast pace that is widely adopted for many different reasons. The drone services market size is expected to keep increasing and reach $63.6 billion by 2025. Total sales of US customer drones to dealers surpassed $1.25 billion in 2020, according to Statista. Goldman Sachs predicts the total drone market size will be worth $100 billion—supported by an increasing demand for drones from the commercial and government sectors. This work's aim is to study the drone's market in depth, starting from gathering the general information of this sector, to the barriers for its development and in the end to understand the innovation process of Italian companies operating in this market. In order to do this, we created a database of the Italian firms in the Drone Industry and we sent them a survey regarding these topics.

ABSTRACT IN ITALIANO

Parole chiave: Droni, Innovazione, Ecosistema Imprenditoriale, Open Innovation.

I droni sono una delle principali tecnologie che negli ultimi anni ha continuato a crescere a un ritmo molto veloce che è stato largamente adottato per diverse ragioni. La dimensione del mercato dei servizi dei droni, dovrebbe continuare ad aumentare e raggiungere i 63,6 miliardi di dollari entro il 2025. Secondo Statista, le vendite totali di droni dei clienti statunitensi ai rivenditori hanno superato 1,25 miliardi di dollari nel 2020. Goldman Sachs prevede che la dimensione totale del mercato dei droni varrà $ 100 miliardi, supportata da una crescente domanda di droni dai settori commerciale e governativo. L'obiettivo di questo lavoro è quello di approfondire il mercato dei droni, partendo dalla raccolta di informazioni generali su questo settore, alle barriere, al suo sviluppo e infine a comprendere il processo di innovazione delle aziende italiane che operano in questo mercato. Per fare ciò, abbiamo creato un database delle aziende italiane del settore dei droni e abbiamo inviato loro un sondaggio su questi temi.

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EXECUTIVE SUMMARY

Drones were developed at the beginning for military applications, but later on were exploited in many other fields.

One of these is agriculture. The world's population is expected to reach 9.7 billion by 2050, causing agricultural consumption to increase 69% between 2010 and 2050. If we consider that the majority of the agriculture firms that will use drones are farms that administer thousands of acres of land, the possibility for drone's market growth in agriculture is really pivotal for this industry.

The most relevant applications for drones in agriculture include fertilisation and irrigation management. DroneFly forecast that drones can spray fertiliser 40 to 60 times faster than doing so by hand.

Another important application for drones is in the construction and mining field. This can eventually reach a $28.3 billion global market, according to PwC analysis. Businesses within these industries are leveraging drones to more easily adhere to the extensive laws and regulations surrounding worker safety.

In many countries like the US, the government laws demand construction firms to check their sites on a regular basis to ensure safety for workers. This process usually takes very long, from many hours to a few days. Through drone's application, construction inspections can be executed in less than 1 hour.

Another important application for drones is in the insurance field. It's forecasted that the average global annual cost of insurance claims from natural disasters has increased a lot in the past few years. For this reason, insurance firms will likely leverage drone technology to provide quicker and more reliable property assessments.

A pivotal application of drones is the use of these in order to get to locations immediately after a disaster hits that could be really difficult to reach. From there, they can record detailed images and videos of damage that can be sent back to mobile devices for assessment in real time. Ultimately, drones can help claims adjusters process property significantly faster than doing so manually.

Drones are also adopted by police forces for supervising expansive open areas, negotiating hostage situations, pursuing armed suspects, and investigating bomb threats.

Unmanned aerial vehicles are an innovative, affordable alternative to helicopters, which can be very costly and aren't always readily available. Most importantly, they allow police to navigate potentially dangerous situations while ensuring the safety of their officers.

A very well-done job of studying, analysing and ultimately mapping the entire drone-ecosystem has been already realised in the last years by the Drone Observatory of Politecnico di Milano. The aim of our thesis is to update the work already done and to analyse the updated data gathered from the drone's industry.

First, we realized a literature review of the existing academic articles addressing the drone's market. We concentrated our analysis on 6 main topics. Before starting to analyse the academic literature, we described in a detailed way the methodology implemented, so that we can explain how we intended to develop our research.

The first one is the history of the definition of Economic Ecosystem, from the beginning, in 1993, with the definition given by Sir Thomas R. Moore, to the most recent definitions. Then, we described what are the main elements that characterize an ecosystem, and how they can influence the success of it.

Then, we focused on a particular kind of Ecosystem, the Innovation Ecosystem. As in the previous chapter, we analysed the evolution of the definition through the years, then we offered an overview of the main elements that are in an Innovation Ecosystem, the main actors involved, and the most diffused typologies of the Innovation Ecosystem.

After that, our analysis moved to the elements and actors that can participate in an Ecosystem, and what role they can have in reaching success. A leader, for example, can act as an Aggregator, so it deals with creating the market and connecting supply and demand, allowing a frictionless exchange of value between customer and supplier. The success is set by the volume of buyers, sellers and transactions, as well as their ease of management, as an Innovator, which creates an innovative environment to allow development and access to customers to a portfolio of offers and solutions that can adapt to needs unique vertical and functional. Successful innovators are the ones who own a large number of developers. Finally, it can act as an Orchestrator: it focuses on driving the customer experience and the result of business, offering end-to-end integrated solutions and independent services. A successful orchestrator manages to define a clear framework for the governance and partnership management. The other actors can be placed at the level of Platform Ecosystem, or at the level of Offering Ecosystem.

In the fourth section of our Literature Review, we concentrated on the existing academic literature regarding Open Innovation, a particular Innovation Process that we decided to analyse in depth. We offered an overview of the definition of the concept through the years, from Rod Adner in 2006, who first mentioned it, to the most recent definitions given by Brunswicker and Chesbrough in 2018, and Chae in 2019. After that, we analysed the most relevant success factors, and the hardest challenge related to the adoption of an Open Innovation model, and finally, we offered an overview of

the main concepts related to Open Innovation: Open Innovation 2.0, the creation of Knowledge, and the concept of Openness.

In conclusion to the Literature Review, we focused on the main barriers and risks related to the adoption of Open Innovation Models, concentrating on the risks of SMEs, especially in entering into partnerships.

Subsequently, we moved from academic literature to grey literature, offering an overview of the Global Market of Drones. Despite the Covid-19 Pandemic, the sector is showing continuous increase in turnover, profits of companies, and an enlargement of the sector of appliance of Civil Drones.

In the second section of our Thesis, we explained the methodology through which we answered our first research question: What is the difference between the actual state-of-the-art of the Italian Drones Ecosystem, and the one of the previous year in terms of dimensions and actors involved?

To answer this question, we started from the Database developed the previous year by Drone Observatory of Politecnico di Milano, updating the data regarding existing companies in the database. To do this, we used Aida to get the most recent data about the firms. Then, we triangulated data from multiple sources to find new companies to add in the database. At the end, we found 724 companies, and we developed a first analysis about the companies in the database, studying the geographic distribution of firms, their foundation date, and their turnover.

In the third section of our Thesis, we explained the methodology through which we answered our second research question: In which way do firms that are into a developing industry, like drones, achieve innovation, and what kind of partnerships do they develop? Which internal or external to the sector actors are involved?

To answer this question, we developed a survey that we sent to all the companies in the database, obtaining 134 respondents. The survey was structured in 3 main sections: a section related to the company information, in order to confirm or update the data that we found in the previous research, a section related to the new Regulatory Framework of Drones, and a section related to Innovation Process: how much they spend for innovation, what are the main areas of investment, and the main goals that firms want to reach, if they collaborate with other actors, and what kind of partnerships they develop.

In the end, we have done a resume of the contributions we have given to academic literature, and the future research that can be made to improve our research, enriching it.

1. LITERATURE REVIEW

This chapter aimed to provide a detailed review of the academic literature on the topics of Industrial Ecosystems, Innovation Ecosystems, and Innovation Models, covering most of its various aspects that allow to figure out why it is critical for companies' success and how to implement it in an efficient and effective manner. Contributions from academics and practitioners will be reported, with a detailed description of the various tools used to implement it

1.1. METHODOLOGY

The analysis of Academic Literature is a critical step in defining a potential research question with the goal of filling a gap in the Literature itself. A literature review is, in fact, a search and evaluation of the available literature on a specific subject or topic area (Seuring and Gold, 2012).

The goal of any literature review is to summarise the current state of knowledge on a specific topic (Rowley and Slack, 2004), in order to:

- support the identification of a research topic, question, or hypothesis.
- identify the literature to which the research will contribute.
- contextualise the research within that literature.
- build an understanding of theoretical concepts and terminology.
- facilitate the building of a bibliography or list of the sources that have been consulted.
- suggest research methods that might be useful.
- analyse and interpret results.

We conducted a literature review to gain a clear understanding of the concept of the Innovation Ecosystem by employing a "Systematic Literature Review" approach, a scientific research tool that entails the identification and selection of various searches to answer a clearly formulated question (Dewey and Drahota, 2016).

It is a thorough and transparent search of multiple databases and grey literature. Scopus was chosen as the primary source of articles.

Scopus is a database of summaries and citations for articles in research-related publications that was created in 2004 by the Eleviser publishing house and allows for

direct viewing of abstracts. It is updated on a regular basis and contains a large number of peer-reviewed articles and journals in the scientific, technical, medical, and social fields.

For our research, we used the portal's "Search Document" modality, which allows us to search for documents using keywords and relevant criteria. We began our investigation by selecting some keywords related to the main topics of our thesis. They have been combined with logical functions such as the connector "AND", which allows to find documents that contain all of the keywords used, the connector "OR", which allows to find documents that contain at least one of the selected keywords, and the connector "*," which allows for all possible final keyword combinations. The following string was used to extract content related to our thesis: "Ecosystem*" AND ("Scalability*" OR "Innovation*").

To find articles that were more relevant to our research goal, we first looked for articles on Business Economics Management scientific research, with the constraint Subject area: business, economic, social. Furthermore, we only considered English-language articles or reviews published in a journal and at the end of the publication stage (final or article in press) within the last ten years.

We ended up with 2755 articles at the end of this process. To reduce this number, we only included documents published in prestigious and well-known journals, as determined by the SCImago Journal Rank, or SJR indicator.

The SJR indicator assesses the level of scientific influence of academic journals by examining the number of citations received by a journal as well as the importance or prestige of the journals from which those citations originate. As a result, we were able to reduce the number of articles to 413.

We began the skimming phase after the search phase was completed. We removed articles that were irrelevant to our research objectives, resulting in a final count of 156. Furthermore, we downloaded these articles (in pdf or html format) from Google Scholar and Scopus.

As a final step, we read more carefully all the downloaded papers, categorising them according to the topics covered, creating a final database which helped us to have a complete and clear view.

1.2. INTRODUCTION TO THE LITERATURE REVIEW

The term Ecosystem was defined in 1935 by the English biologist Tansley as "A biological assemblage interacting with its associated physical environment and located in a specific place" (Tansley, 1935). Then, in 1993, it abandoned the boundaries of biology, and was used in the economic field by James F. More. It explained that evolution and growth of companies is strongly influenced by how they interact with other actors like suppliers, customers, investors, and institutions. Moore defined as Ecosystem the interconnected network of all the entities (companies and stakeholders) that co-evolve their capabilities through technologies, knowledge, and skills (James F. Moore, 1993).

Then, other academics started to study Economics Ecosystems, enriching the concept with linkages to the related concept "Ecology" (Papaioannou, Wield and Chataway, 2009), defining more clearly the actors that can participate in the Ecosystem (Mason and Brown, 2014), the factors and domains that can influence the role and the actions of all the actors (Isenberg and Daniel, 2011).

We focused on academic studies about the effects that the Ecosystem can have in the development of innovation. Starting from the definitions of Innovation Ecosystems given by academics (Adner, 2006) (Jackson, 2011) (Grandstrand and Holgersson, 2020), we underlined the main characteristics of Innovation Ecosystems and the contexts in which they are developed (Oh, Phillips, Park and Lee, 2016).

Then, we focused on the barriers and risks related to the adoption of Ecosystems, especially related to the sharing of knowledge, technology, and skills, and how the adoption of Open Innovation models can solve them, partially or totally.

Finally, we offered an overview of the Drone Industry, in Italy and worldwide, given by grey literature (analysis, reports, etc.).

1.3. HISTORY AND EVOLUTIONS OF ECOSYSTEMS

The term ecosystem has been firstly used in biology to refer to an ecological unit made up of an organism's community and its environment interacting within a unit of space. It was defined by the English biologist Tansley as "A biological assemblage interacting with its associated physical environment and located in a specific place" (Tansley, 1935). Through their creations and resource sharing, these organisms and factors compete and collaborate. This interaction can frequently result in an evolutionary process. This term was later used in economic contexts as well.

The concept of ecosystem in the economic field was born with James F. Moore in 1993. In his article “Predators and Prey: A New Ecology of Competition ", published for Harvard Business Review, he explained that companies do not act and evolve in a “vacuum”, but their growth is strongly influenced by the relational nature of how they interact with stakeholders, in particular suppliers, customers, and investors. He defined an Ecosystem as an interconnected network of companies, and other entities that coevolve their capabilities through a shared set of technologies, knowledge, and skills, and work cooperatively and competitively to develop new products and services. Moore stated that, in dynamic ecosystems, new companies have more opportunities to grow and to create employment compared to firms created in areas not identifiable as dynamic ecosystems.

Moore later compared the biological and business worlds in 1996. In this study, he demonstrated how organisms within a biological ecosystem can react to other organisms and the environment, allowing them to transform and evolve in a larger context. This ecosystem is easily compared to a type of economic society, in which individuals as suppliers, manufacturers, and customers influence and evolve their own capabilities and roles, attempting to follow the paths established by the main central actors, who can represent the environment.

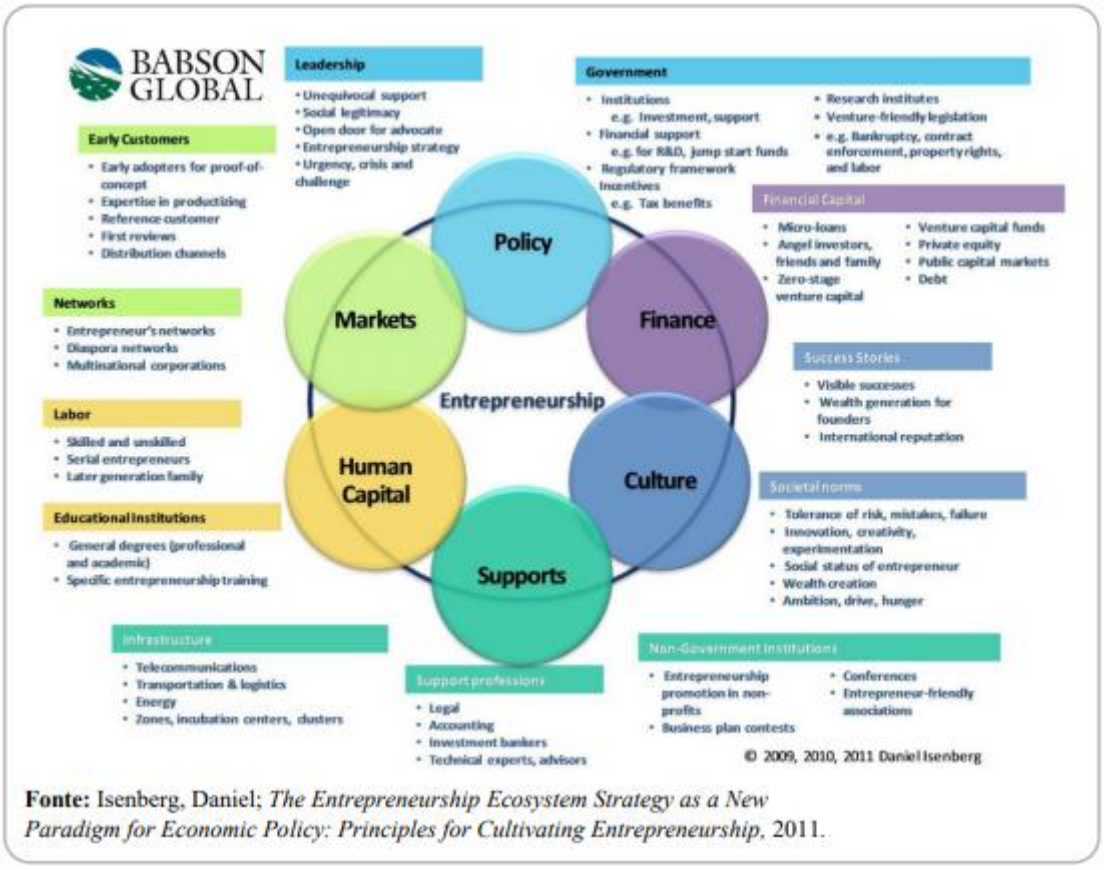
Another key concept related to ecosystems is "Ecology," which is defined in nature as "the interactions of living organisms with the environment in which they live". In 2009, Papaioannou, Wield, and Chataway, in their article “Knowledge ecologies and ecosystems? An empirically grounded reflection on recent developments in innovation systems theory”, published for Environment and Planning C: Government and Policy, developed the concept of ecology in the business world, based on analogies between natural ecosystems and business ecosystems. "Business ecology" was defined as "profit-seeking enterprises, universities, and other public and private organisations that accumulate and manage the flow of information".

A more modern and effective definition of Ecosystem, based on the synthesis of previous definitions given by academic literature, has been given by Colin Mason and Ross Brown in their article Entrepreneurial Ecosystem and Growth Oriented Entrepreneurship. They defined an Ecosystem as a set of:

- **interconnected entrepreneurial actors**, both potential and existing ones.
- **organizations** like firms, business angels, venture capitalists, and banks,
- **institutions** like universities, public sector agencies, and financial bodies and
- **entrepreneurial processes** like the business birth rate, numbers of high growth firms, levels of 'blockbuster entrepreneurship', number of serial entrepreneurs, degree of sellout mentality within firms and levels of entrepreneurial ambition, which formally and informally coalesce to connect, mediate and govern the performance within the local entrepreneurial environment".

As a resume, an Ecosystem, from an economic standpoint, can be defined as a group of firms that share the same values and goals in order to create and develop value together.

Nowadays, there are several models that can represent an Entrepreneurial Ecosystem, but the one developed by D. Isenberg al Babson College (Isenberg, Daniel; 2011) can be identified as the most influential. Entrepreneurial Ecosystem is modelled as the set of 6 different domains interacting with each other (**Figure 1.1**). Domains refer to a favourable culture that allows policies aimed at growth, the availability of financing, to a quality and competent human capital, in the presence of friendly markets open to innovative products and a wide range of institutional support. These 6 domains comprise hundreds of elements which in turn interact with each other in ways random and complex, since the interactions between the variables in question do not depend on the law of cause and effect (in fact there are no arrows in the figure below). For the latter reason it can be observed that it is not possible to replicate existing ecosystem models because it turns out to be a unique combination of elements that emerges from certain conditions and territorial circumstances that are difficult to replicate.



Fonte: Isenberg, Daniel; *The Entrepreneurship Ecosystem Strategy as a New Paradigm for Economic Policy: Principles for Cultivating Entrepreneurship*, 2011.

***Figure 1.1**: Domains characterizing an entrepreneurial ecosystem, modelled by D. Isenberg*

An Entrepreneurial Ecosystem does not refer to a single specific industrial sector or to a multitude of them, it is a geographically limited, but not confined, ecosystem in a specific geographical scale: it can be representative of a region, a city or a single campus or industrial district.

It is observable that economic activity, especially entrepreneurial activity, has a natural tendency to concentrate in specific geographical locations and not to be distributed in the surroundings. Moreover, the grouping that is denoted is associated with superior economic performance of the specific geographical area. For example, the economic success of Silicon Valley, as noted by Colin Mason and Ross Brown, is attributable to the regional industrial system created, to the presence of universities oriented towards technological innovation and the type of culture based on the network, against the hierarchy of corporate functions.

The rationale for a growth-oriented business system to be limited geographically is supported by the fact that local concentration facilitates development and dissemination of knowledge on innovation. This concept refers to "Ecology of information and communication", generated by face-to-face contacts and the co-presence of people and companies in the same geographical place. People all the time

contribute and benefit from the dissemination of information and news, only by the fact of being present in that place, due to intentional or involuntary learning processes born from organized or accidental, formal, or informal meetings. Plus, the understanding of new knowledge and technologies, as well as shared cultural traditions and habits in a particular technological sector, stimulate the creation of conventions, technological standards and other institutional provisions in favour of industrial efficiency and growth.

In summary, the development of growth-oriented entrepreneurial activity is supported by the presence of an effective Entrepreneurial Ecosystem for the reasons mentioned above. An Entrepreneurial Ecosystem however tends to concentrate geographically in specific areas because resources, such as human capital, information, and funds, are led to attract each other and then to group locally in economic clusters. It can be observed then that the concept of Entrepreneurial Ecosystem refers to specific geographically limited areas, within which entrepreneurship is cultivated due to the presence of a combination of specific, unique, and not replicable assets, and due to the coexistence of competition and cooperation between the assets themselves.

Figure 1.2: *Examples of some of the most effective Entrepreneurial Ecosystems developed in the U.S.A. It is possible to observe that they refer to specific, geographically limited areas.*

The Entrepreneurial Ecosystem approach offers a new and distinct perspective on geographical concentration of economic activity. Some studies concerning geography of HGFs indicate that firms that are located in clusters show higher growth compared to other companies born in different geographical areas, which cannot be identified as

Ecosystems (Gilbert, "Clusters, knowledge spillovers and new venture performance: an empirical examination ", Journal of Business Venturing, 2008).

The specific domains on an Entrepreneurial Ecosystem, in the model of D. Isenberg, are the following:

- **Industrial Tradition:** Large, consolidated companies that locally concentrate management activities, for example the head office of the company, Research and Development (R&D), and/or production activities, are typically the heart of an Entrepreneurial Ecosystem. These companies play a key role in the local development of the ecosystem for several reasons:
    - A big company can act as an attraction for talents and can hire a great number of high-skilled workers, usually recent graduates and coming from neighbouring areas.
    - Great companies are an excellent business-trading for their workers because they allow them to increase their competences, and they offer the opportunity to grow professionally. So, workers hired in great companies may acquire managerial skills.
    - Great companies can offer business opportunities to local players, acting as customers and developing coworking areas, giving resources to small firms. Moreover, they may offer acceleration or incubation programs for young companies and start-ups, increasing the interest of companies to grow into their ecosystem.

  Isenberg underlined, in his study, that you cannot have an effective and efficient Ecosystem without the presence of big companies. To allow the advantages underlined before to become real, local players must be collaborative.

- **Success stories:** The presence of a company that is born locally, to then grow and become a global leader is a vital narrative to inspire the community. The presence of the successful enterprise shows the possibilities of success that entrepreneurship offers, and the potential benefits brought by the choice to leave a stable job to undertake business risks, starting your own business. Even just a couple of entrepreneurial successes are useful to have great advantages for the ecosystem, with both direct and indirect spillover effects. This concept is visible in the Law of Small Numbers advocated by Isenberg at Babson College. An important example turns out to be the key role played by Microsoft for the growth of a dynamic hub for software development in the city of Seattle, U.S.A. During the 90s, the workers in the "computer and processing" sector increased from 11,800 to about 60,000. The growth was driven by the birth of 148 spin-offs related to the Microsoft company in Seattle.
- **Network:** An Entrepreneurial Ecosystem is also characterized by the fact that there is a great flow of information. In this environment, people can easily

access knowledge concerning new market needs, new evolving technologies, the availability of new components and new industrial machines and the availability of new services and new marketing concepts. The presence of a multitude of organized or accidental meetings can be identified as the main channel of transmission and sharing of information in an ecosystem, even if this mode is inefficient. An interesting theory concerns the existence in the ecosystems of "bridge-activities", which have a critical role because they allow an efficient connection of people, ideas, and resources. In America, they are called "liaison-animators" and are individuals whose mission is to connect people. Most of them do not perform this role as a formal work task, they are connectors that operate accidentally and informally. These individuals are also defined as “deal-makers”, and real economic operators since they are the central actors in the process of sharing the information. These are generally identified as businessmen with experience and skills, interconnected with people and resources useful to support young companies. By sharing their know-how and providing useful contacts, deal-makers are able to help startuppers to understand the growth potential of their idea or their company. Businessmen could be both entrepreneurs and investors, or service providers. Liaison-animators usually act informally, but they can also take on some form of fiduciary role within the board of control of the undertakings they help, such as a member of the board of administration. These people can have fiduciary responsibilities for more young enterprises at the same time. Deal-makers are key to the efficient functioning of economies of successful entrepreneurs within an ecosystem. As underlined by Colin Mason and Brown Ross (2014), some of the business economies that remained anonymous show a number of deal-makers so small that they could gather in one room. This consideration suggests that the local presence of these figures may be a better way to ensure the success of entrepreneurial ecosystems, instead of just the number of entrepreneurs and investors in a region.

- **Culture:** The culture of people is another distinctive feature of entrepreneurial ecosystems. To promote the sharing and transmission of knowledge, experience and information people may necessarily have the attitude to "give-before-you-get" (Brad Feld, Startup Communities, 2012). People must have the ability to give help without considering it a direct act of pure exchange, because the dissemination of information must be informal and far from the concept of "counselling". The attitude to failure is another fundamental factor for the development of an Entrepreneurial Ecosystem, where the local community quickly absorbs people involved in other companies. Entrepreneurs should not be ashamed of business failure, they should have the opposite reaction. In an efficient ecosystem, after a failure, they are welcomed by other companies as mentors, or incubator or accelerator programs managers. As Brad Feld pointed

out, entrepreneurs after a failure should not be ashamed, but they should take a short break and then come back to business. From this last concept comes the "Philosophy of Experimentation and fast Failure", which should be used as a modus operandi by all those who aspire to undertake the business risk or who have already started their own business. Isenberg (2011) argues that when failure is fast, the entrepreneur loses little or nothing in terms of capital and time. In vibrant communities, as Feld said (2012), many people experiment with new ideas and are willing to fail quickly if initiatives undertaken attract little or no impact on the market, within a maximum waiting time of 3 years. The philosophy set out above highlights the need for the entrepreneur to have the courage to fail if the objectives imposed are not achieved, before losing excessive resources, to be able to re-invest them quickly in other ideas and in other activities, and above all to avoid getting stuck in the dimension of SME. Reasoning in this way, time becomes a precious resource, like the capital and skills, that the entrepreneur may have.

- **Financial Availability:** Preventing talent from pursuing an innovative business idea due to lack of funds leads to an inevitable market failure. In fact, in an entrepreneurial ecosystem has a lot of seed-investors who provide funds and give strategic advice to companies in the start-up phase. The business angels and business accelerators are the actors that play a critical role. The presence of venture capital funds, on the other hand, is not as necessary as it may seem, because they can be imported from outside the ecosystem, in fact the request for richer financing is required by enterprises not in the start-up phase, but in the stages of subsequent growth. However, this situation requires local investors to be connected with national or international venture capital, ready to intervene by bringing different forms of value added.
- **Education:** Universities have an important role in an entrepreneurial ecosystem, but not the role that is often attributed to them (Feld, 2012). In fact, the research-based universities are not present in every ecosystem, and it is proven that companies born from university spin-offs are typically small and the cases in which these can be considered HGFs are very rare. Feld also points out that the practices of university offices dealing with technology transfer are generally considered as barriers to the commercialization of search results, due to absurd license terms and industrial protection imposed. Currently, it is observed that businesses started by university students achieve results much more significant than companies anchored to the university system. Interpreting the criticism made by Brad Feld, it can be observed that the most important contribution that universities can give are their students, due to their entrepreneurial education programs, are its students. Students bring new ideas and increase the intellectual capacity of the community.

- **Infrastructure:** An Entrepreneurial Ecosystem is generally a desirable place where to live, because of the presence in the area of comfortable mobility such as airports, a railway network and a good public transport service, for the presence of cultural attractions, an excellent school system and for the presence of facilities and organisations that offer outdoor leisure opportunities. The right mix of these elements is indispensable because it provides the means to feed the culture and creativity of people. An Ecosystem also needs organizations that provide incubation programs and/or business acceleration. It is here that the entrepreneur acquires knowledge about the product and about the market, and develops an understanding of organizational structures, strategies, and appropriate systems to run its business. In addition, incubators motivate people to start their own businesses. It can also be pointed out that it is common use of new businesses to locate themselves next to the incubators or within the spaces made available by them, promoting the formation of clusters. The entrepreneurs must use the network available in these areas, formed by partners of commercial, connected companies and former employees, to access knowledge, human capital, and other resources needed to start and develop their own business. These social networks "bind" the entrepreneur to such locations because only in these he has access to the resources and social support required to support your business.

1.4. THE CONCEPT OF INNOVATION ECOSYSTEM

We now live in a competitive and fast-paced business environment, making it more difficult for organisations to keep up with the pace of technological change and market innovations. Under these conditions, being a part of an ecosystem, especially an innovative ecosystem, is becoming critical in order to survive and bring innovation to the world in a timely and cost-effective manner.

The concept of Innovation Ecosystem has become popular in the last 15 years, and it is now used in industrial, academical, and governmental fields. It is a composition of 4 different syntactic concepts: the concept of system, the concept of innovation, the concept of innovation system, and the concept of an ecosystem.

The use of the concept of Innovation Ecosystem with Rod Adner in 2006. He defined an Innovation Ecosystem as "the collaborative arrangements through which firms combine their individual offerings into a coherent, customer-facing solution." (Adner, 2006).

This definition is a lot linked with the definition of business ecosystem, given by James F. Moore in 1993. This is the most widely used definition of the innovation ecosystem, despite several attempts to define and describe the innovation ecosystem during these years.

Jackson, in 2011, defined an Innovation Ecosystem as "the complex relationships that are formed between actors or entities whose functional goal is to enable technology development and innovation" (Jackson, 2011). He continued saying that, as actors, must include the material resources, and the human capital, which make up institutional entities to participate in the ecosystem. This definition highlights the fact that the Innovation Ecosystem comprises two economies: the research economy, driven by fundamental research, and the commercial economy, driven by the marketplace.

Ove Grandstrand and Marcus Holgersson, in 2020, said that an Innovation Ecosystem is "the evolving set of actors, activities, and artefacts, and the institutions and relations, including complementary and substitute relations, which are important for the innovative performance of an actor or a population of actors" (Grandstrand and Holgersson, 2020). Artefact is a wide concept, which refers to products and services, tangible and intangible, technological and non-technological resources, and other kinds of inputs and outputs, one of the most important is innovation. An innovation ecosystem could include an actor system with collaborative (complementary) and competitive (substitute) relations with or without a focal firm, and an artefact system with complementary and substitute relations. This idea is in line with the concept of a natural ecosystem.

Considering all the definitions across the time, we can conclude that the three defining characteristics of an innovation ecosystem are: the dependencies established among members (members' performance and survival are inextricably linked to those of the ecosystem itself), a shared set of goals and objectives (shaped by the ecosystem-level focus on a unique customer value proposition), and a shared set of knowledge and skills.

Even the definition of types of Innovation Ecosystem changed over the years.

Nambisan and Shawhney's 2007 study classified innovation ecosystems into different types based on the nature of governance, the openness of boundaries, and the type of innovation pursued.

According to these studies, there are various types of innovation ecosystems. The most widespread is the **Hub-based Ecosystem,** in which a single company establishes and leads the ecosystem. It has also been referred to as a platform-based network, an orchestra model, and a keystone model (Nambisan and Shawhney, 2007).

The so-called "**Producer-User ecosystem**" is another example of an Innovation Ecosystem. It was studied by Christoph Hienerth, Christopher Lettl, and Peter Keinz, who highlighted the synergies that this type of ecosystem can produce. After analyzing ten cases, they discovered that it reduces the risks of individual actors triggering and facilitates entrepreneurial activities. Then, this ecosystem can have a positive impact on product offerings, because collaboration between the user community and the producer firm can help to expand product lines in order to address and reach new market segments, thus expanding the design space. Finally, the interaction of all actors can reinforce the process of innovation and raise awareness of new ideas and products, contributing to the overall success of new ventures and incumbents (Hienerth, Lettl and Kainz, 2012).

Nowadays, we can also define other contexts in which Innovation Ecosystems are mentioned:

- **Corporate Innovation Ecosystems**: suppliers, users, partners, and other contributors to an Open Innovation Process.
- **Regional and National Innovation Ecosystems.**
- **Digital Innovation Ecosystems**: online platforms where customers, users, and developers can build synergies, generating network externalities that will increase the value of both hardware and software innovations. Digital ecosystems can mean the apps, the platforms, ad distributors that make technology available.
- **City-based Innovation Ecosystems and Innovation Districts:** planned by municipalities, with the help of universities. They focus on young and small

companies, giving them real estate development, rather than active business development.

- **High-Tech SMEs Centred Ecosystems:** an example of this kind of Innovation Ecosystem is Taiwan, where most of the manufacturing capability is in the hands of SMEs.
- **Incubators and Accelerators:** they combine services and facilities to create hyper-local Innovation Systems.
- **University-based Ecosystems:** Most of the university initiatives focus on the entrepreneurial subset of the innovation ecosystem and call it an entrepreneurial ecosystem.

Deog-Seong Oh et al. (2016) underlined some common features between all the kinds of Innovation Ecosystem:

- **More Explicitly Systemic:** innovation occurs through a social system Enumerating the interactions among the ecosystem's components organisations highlights the richness and diversity of actors that can give rise to emergent behaviour.
- **Digitalization:** It is recognised the central role of ICT (information and communication technologies) in new products and services, and in connecting innovation actors.
- **Open Innovation:** The borrowing, licensing, open-sourcing, crowdsourcing, and alliances that allow ideas from diverse sources to be combined into new products and services.
- The **mimetic quality** of the term "innovation ecosystem," and its appeal to the news media. This demonstrates the public relations value of the term.
- A greater emphasis on differentiated roles, or **"niches"** occupied by organisations and industries. These niches can correspond to links in industry value chains.
- Greater importance of **market forces**, relative to government- or NGO-push.

1.5. ELEMENTS AND ACTORS OF ECOSYSTEMS

Building a global network of partners or ecosystems has become critical for many companies operating in various markets in order to improve and expand their product, service, and technology offerings (Chesbrough, 2003; Nambisan & Sawhney, 2007). Startup accelerators, universities, government, corporations, venture capitalists, private investors, foundations, and entrepreneurs can all be part of an innovation ecosystem. It is the evolving set of actors, artefacts, activities, institutions, and complementary and substitute relationships that may help one or more actors in the "Environment" achieve high innovative performances (Innovation ecosystems: A conceptual review and a new definition, Ove Granstrand and Marcus Holgersson, 2020).

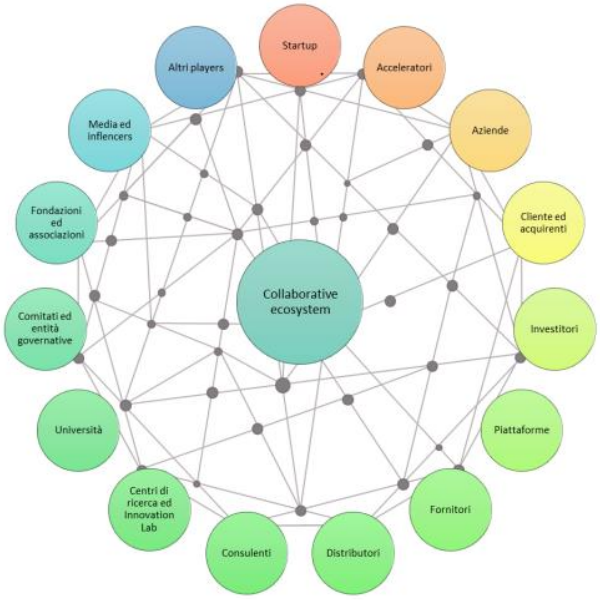


Figure 1.3: *Ecosystem Players*

Every player plays an important role in generating value in the ecosystem by transforming new ideas into reality through financial investment. Innovating ecosystems can generate an active flow of information and resources for the exchange of ideas that can be realised. In this way, we can create a process through which more innovators and entrepreneurs can transform these ideas into solutions to real-world problems. This process results in the development of expertise in new areas and can also aid in the diversification of the economy.

To define a specific ecosystem, managers need to identify the fundamental contributions that the Ecosystem will need, make a preliminary distinction on modularization and, consequently, define the contributions of the different actors (Moore, 2006).

Relations within the ecosystem can take different forms: they can be simply temporary and informal alliances or be more formal and complex relationships, with specific contracts and agreements, sometimes even with companies that could be competitors, building structures of the most varied forms, from joint ventures to mergers, exclusive and non-exclusive partnerships to agreements.

A company that is looking for certain skills or resources that it does not have but needs, begins a selection process to find the right partner, private or public, that best suits its needs, considering the markets and technologies that complement and support its strategic ambitions. The company operates in a large context and must be able to go beyond its borders.

Research made by companies cannot be restricted to organisations in a specific sector. The best approach is to systematically map the ecosystem partners among the various sectors, identify key criteria and consider trade-offs. To evaluate potential partners, the company must:

- Evaluate the market in which the potential partner operates and its level of competition.
- Consider the company's current business model and see if it fits with that proposed by the partner.
- Evaluate the management and operations team.
- Analyse the corporate culture of the partner.

For the contact with potential partners, the screening of the compatibility of the candidate and the negotiation of agreements, a specialist team, with members expertise in legal matters that can clarify the multitude of issues raised by working with third parties (IT security, intellectual property, data protection, profits sharing, privacy), must be needed.

Customising agreements and business processes can be difficult if the network starts to be denser and more intricate. So, it is necessary for teams to be able to standardise governance principles, supporting them with certain directives. Within the teams it may also be required the intervention of people with unfamiliar technical skills.

Generally, every company that becomes part of an ecosystem must determine in what position fits in, identifying what strategically controls and what to whom it has to give up control to gain an advantage.

Figure 1.4: *Partners into an Ecosystem*

At the centre of the ecosystem there is the Market Play, a term that refers to opportunities of disruptive growth with significant income potential for participants to the ecosystem. The ecosystem players present a new value proposition and offer a new customer experience by intertwining functional areas, technologies and industrial sectors. The ecosystem producer is the leader, the one responsible for managing the market play that mobilises the ecosystem during all stages of development. The Platform Ecosystem represents the set of suppliers of components, infrastructures and services and research partners. The Offering Ecosystem is made up of partners who develop, sell, supply, and assist solutions, creating customised offers and services to improve the market play and the customer experience. Finally, the customer is the entity that adopts the solutions developed by the collaboration of players.

Some companies want to implement and manage their own ecosystem, but they have to decide what kind of leader to be, differentiating in scope, complexity and potential value that they can generate. There are three main roles that a lead company an Ecosystem can choose to play:

- **Aggregator**: it deals with creating the market and connecting supply and demand, allowing a frictionless exchange of value between customer and supplier. The success is set by the volume of buyers, sellers and transactions, as well as theirs ease of management.
- **Innovator:** it creates an innovative environment to allow development and access to customers to a portfolio of offers and solutions that can adapt to needs unique vertical and functional. Successful innovators are the ones who own a large number of developers.
- **Orchestrator:** it focuses on driving the customer experience and the result of business, offering end-to-end integrated solutions and independent services. A

successful orchestrator manages to define a clear framework for the governance and partnership management.

Another fundamental framework of the interrelationships between universities, industries, and governments can be found in the article (2012) "The effect of the triple helix system and habitat on regional entrepreneurship: Empirical evidence from the U.S." written by Younghwan Kim, Wonjoon Kim, and Taeyong Yang.

They investigated the critical determinants of entrepreneurial activity in this study. The triple helix model is used to explain the determinants of entrepreneurial activity from a regional perspective in this article. Indeed, it has been identified as a source of regional innovation that drives the transformation of scientific and technological outcomes into economic outcomes. Furthermore, there was another theory, the so-called "co-evolutionary theory," which demonstrated how regional entrepreneurial activities are heavily influenced by regional characteristics and entrepreneurial environments, including habitat, as co-evolutionary studies have shown.

This study asserts that business entities and environments influence each other and reciprocally co-evolve together, which is a completely different perspective than previous studies of organisational adaptation-selection (Lewin and Volberda, 1999, Lewin et al., 1999, Porter, 2006, Tsai et al., 2009), which assumed that entities simply adapt to their environments.

Regional factors were divided into economic, demographic, geographic, industrial, and institutional environments in previous studies prior to the "The effect of the triple helix system and habitat on regional entrepreneurship: Empirical evidence from the United States," and there was recognition of reciprocal relationships. According to the researchers' research, these relationships can have a wide range of consequences:

- University-company collaboration on R&D is associated with a higher firm death rate, whereas government R&D and venture capital investments reduce the number of terminations, thereby improving firm sustainability.
- Industrial R&D, like university R&D, increases both firm birth and death rates.
- In contrast to university and government R&D, which is associated with more firm deaths, interaction between university and industrial R&D is associated with greater firm sustainability.
- Venture capital investments, combined with factors related to quality of life, are more important than R&D investments in promoting entrepreneurship.

Nowadays, the triple helix model and co-evolutionary theory are regarded as a heuristic source for comprehending the complex dynamics of institutional networks and the interactions between the three components, as well as their contribution to innovation on both a regional and national scale.

1.6. OPEN INNOVATION IN INNOVATIVE ECOSYSTEMS

Open innovation is a business model for innovating that is based on collaboration between individuals and organisations outside of the company. It was defined in 2003 by Chesbrough in his first study regarding OI as "open innovation means that valuable ideas can come from inside or outside the company and can go to market from inside or outside the company as well" Chesbrough further developed his own OI definition three years later, presenting the concept as a knowledge flow that goes from inside and outside an organisational setting with the potential to generate new information. As a result, it incorporates both external and internal information in order to forge new avenues and progress technology (Chesbrough, 2006).

They demonstrated that there appears to be a disconnect between the development of knowledge and business ecosystems by focusing on Flanders, a region in northern Belgium. Policymakers have primarily supported the development of knowledge ecosystems, with the expectation that these ecosystems will inevitably lead to the development of business ecosystems.

The value creation processes in knowledge and business ecosystems, on the other hand, are fundamentally different, implying that policies to support each type of ecosystem must be tailored specifically. Supporting large, established corporations as keystone players may be a significant step forward. We hope that this paper will spark further research and policy to help us better understand the various types of ecosystems.

As evidence of this, Brunswicker and Chesbrough conducted an executive survey titled "The Adoption of Open Innovation in Large Firms," in which they included many chief executive officers from various industrial sectors and countries. According to the findings of this study, open innovation is practised by approximately 80% of responding firms (Brunswicker and Chesbrough, 2018). Modern digital technologies and information systems, which can help companies easily activate Collaborative Innovation strategies, may be one of the reasons why companies are beginning to adopt this innovation model. These strategies, along with the many different digital communication and interaction channels available for collaboratively generating and collecting massive amounts of data (Chae,2019), can help to overcome several of today's barriers between stakeholders and companies.

In terms of the evolution of the OI concept, it should be noted that, despite a large number of studies on the subject, researchers cannot agree on a clear definition. According to one broad definition, Open Innovation is the polar opposite of previous "closed" innovation practices, in which companies relied on their own resources to conduct R&D and commercialise innovation results, and these results were vigorously

protected from third parties as intellectual property or trade secrets. This concept resulted in an enrichment that spread to several areas. The analysis of the benefits of Open Innovation in relation to innovation performance is one area that has received a lot of attention in the existing literature. Nambisan and Sawhney defined four major dimensions to study those benefits in 2007:

- Reach of companies in identifying new ideas: Open innovation has a positive effect on it.
- Cost reduction of acquisition and development of those ideas.
- Reduction of risks related to commercialization of those ideas.
- Speed increase to bring ideas into market.

After a while, the study of the benefits of Open Innovation began to be supplemented by an examination of the issues and challenges associated with its implementation. It became clear that Open Innovation frequently necessitates firms organising or actively participating in innovation ecosystems that integrate a diverse set of innovation actors at various stages of the innovation process.

Another significant challenge identified by Scholten is the management techniques associated with Open Innovation, specifically the control mechanisms to ensure focus and value capture in Open Innovation environments. Their research described how platforms were used to implement the knowledge creation and sharing process, emphasising the importance of the digital platform-based ecosystem for innovation. As a result, they prefer the term "digital platform-based ecosystem" to describe the existing Open Innovation ecosystems

As a result, the challenges represent a genuine cultural shift from the previous company's tendency to secrecy in managing R&D within the company to an innovation model based on collaboration between potential present or future competitors. Traditional approaches to Collaborative Innovation, such as Open Innovation, recognized the need to activate the process of interaction and collaboration between actors, but only if they were aware of it (Chesbrough, 2003; Dahlander & Gann, 2010; Lee et al., 2012; Randhawa et al., 2016). Companies use OI processes to obtain (informally and/or formally) knowledge and resources from external partners, primarily other companies and universities, in order to develop innovative products (Bogers & West, 2012; Chesbrough, 2003; Dahlander & Gann, 2010; Tranekjer, 2017). Co-creation is used by businesses to involve their customers in the process of product and service innovation by leveraging their experience (Galvagno & Dalli, 2014; Randhawa et al., 2016; Tekic & Willoughby, 2019). The co-innovation paradigm is centered on identifying and capitalizing on the potential for the exchange of ideas and resources that can be triggered by utilizing all possible physical and digital collaborative channels, as well as involving all potential categories of stakeholders, as

well as the firm's entire collaborative ecosystem (Chen et al., 2019; Lee et al., 2012; Lozada, et al., 2019).

1.6.1. OPEN INNOVATION 2.0

The next step in the growth of this paradigm is known as open innovation 2.0, and it is founded on concepts of integrated collaboration, co-created shared value, cultivated innovation ecosystems, unleashed exponential technologies, and incredibly rapid adoption.

The OI2 paradigm is an innovation model built on widespread networking and co-creative collaboration amongst all actors in society, spanning organisational boundaries considerably beyond standard licensing and collaboration schemes, according to the EU's Open Innovation Strategy and Policy Group (European Commission 2016). Its distinguishing feature is the employment of a "quadruple helix model," in which government, industry, academia, and civil society collaborate to co-create the future and drive structural changes well beyond what any single organisation or person could achieve on their own.

When there is a common vision and shared value is created, this quadruple helix innovation approach is most successful. The evolution of this method reflects the idea that the innovation process has transformed, shifting from vertically integrated firms to large and small companies that participate actively in a network (Langlois, 2003).

The constant advancement of the OI paradigm is linked to multiple variations affecting the surrounding environment, among which it is necessary to mention the importance of involving as many people as possible in the innovation process, as well as the importance of support from ICTs, which serve as a first-rate factor in subject cooperation (Marino and Tamburis 2005).

The concepts of value and shared vision then play a central role: corporations shift their logic from short-term financial performance optimization to a broader optimization of both internal and social conditions, that is, the creation of value for the social context in which the corporation operates. Thus, OI 2.0 refers to the search for a new organisational logic based on principles such as integrated cooperation, innovation ecosystems, which imply the involvement of multiple actors in the innovation process, and rapid adoption and use of technologies capable of generating high performing values, through which traditional "borders" between activities fade away (Song, 2009) and the creation of networking between innovators and the surrounding environment becomes a reality.

It's vital to emphasise that OI2 does not advocate for collaborating with outside parties; rather, it advocates for leveraging internal R&D. OI2 promotes businesses to diversify their resources in order to reach their growth goals. ICTs contribute to the OI2 paradigm by allowing for more flexible approaches to innovation, allowing for greater

integration of traditional and innovative services and products, and eventually shifting from innovation decided and driven by a small number of highly qualified individuals to innovation born from a diverse group of multidisciplinary skilled actors. Users are no longer viewed as passive recipients of information, but rather as active participants in the innovation process, or, to put it another way, as value co-creators. As a result, it's reasonable to deduce that as the connectivity and networking elements expand, users will be increasingly relied upon to participate as value co-creators, with high expectations (Curley and Formica, 2013).

1.6.2. KNOWLEDGE CREATION

Nonaka began discussing the necessity of knowledge creation as one of the primary drivers of economies in 1990. Initially, the SECI model was used to explain knowledge generation. (Nonaka and Takeuchi, 1996): socialization, externalization, combination and interiorization. This was a good depiction of how knowledge progresses from tacit to explicit, ultimately resulting in the generation of new tacit knowledge. In addition to the inclusion of intellectual capital (Ramadan 2017, Bamel 2020), Polanyi (1996) underlined the necessity for a detailed examination of tacit knowledge, which was and is still regarded as the key aspect of a competitive advantage for a company. In fact, Drucker (1993) converted the SECI model into knowledge management to better explain how knowledge creation works within a company.

The OI concept entails utilizing a variety of methods for gathering external knowledge, as well as a variety of mechanisms for integrating that knowledge with internally created ideas. The majority of academics recognize three basic forms of OI (Gassman and Enkel, 2004, Scuotto, 2017):

- The first and most popular category, "Inbound" OI, refers to the use of outside knowledge sources for in-house innovation.
- ”Outbound” innovation refers to the use of external channels for the development and commercialization of ideas.
- Instead of exchanging already developed knowledge or innovation results (new goods), the so-called coupled process combines innovation flows in both directions: organisations immediately begin partnering to build innovative solutions.

Larsen and Salter (2006) concluded, based on the results of a large-scale UK survey of 2.707 manufacturing firms, that while companies' innovation performance usually improved in the early stages of adopting "inbound" OI, after reaching a certain threshold or "tipping point," excessive openness may constrain innovative performance. Mortara and Minshall (2011) came to a similar result in their analysis of large multinational companies' OI practices. For many organizations adopting the

"inbound" OI type, finding the best feasible mix of multiple external sources of technological information became a huge challenge.

Many academics emphasise the importance of cultural characteristics as main obstacles to implementing externally acquired technologies. The so-called Not Invented Here mentality, according to several scholars, has a particularly negative impact.

The most obvious issue with the "outbound" OI type is the greater danger of valuable ideas being leaked to competitors, resulting in the loss of significant competitive advantages as a result of poorly designed collaboration with external partners (Laursen and Salter 2006)

1.6.3. KNOWLEDGE CREATION IN OI CONTEXT

Companies are more likely to communicate with the outside world and acquire knowledge (Bogers, 2016) in situations where there is a two-way interaction between people who develop knowledge and those who share it (Von Krogh 1998, Yeh 2006). As a result, knowledge is generated, shared, stored, and applied (Leo and Choi, 2003).

The OI model, which is entrenched in the knowledge creation process (Chebbi, 2013), confirms that a corporation has the creative power to turn an idea into an innovation.

Related to the Open Innovation processes, Nonaka and Konno, in 2012, started to talk about innovation management.

Passive co-innovation is another important aspect of Open Innovation. Firms can use these processes to accelerate the sharing and exchange of ideas and knowledge with their partners. They not only gain access to high-value information and knowledge resources contained in data and digital footprints generated by customers, users, and partners during their normal activities in virtual (online communities, social media, etc.) and physical (IoT sensors) environments (Erevelles, Fukawa, & Swayne, 2016; Jayashankar et al., 2019; Kunz et al., 2017; Lai, Jackson, & Jiang, 2017; Troisi et al., 2018).

The co-innovation perspective (Lee et al., 2012) sits at the crossroads of the paradigms of OI (Bogers et al., 2017; Chesbrough & Bogers, 2013; Chesbrough, 2003), CI (Chesbrough, 2003), and CI (Chesbrough, 2003). (Hartley, Srensen, & Torfing, 2013; Lee et al., 2012; Swink, 2006; Zhao, Wu, Xi, Na, & Liu, 2018). (Randhawa et al., 2016; Romero and Molina, 2011; Tekic and Willoughby, 2019) According to the CI paradigm, businesses should form collaborative networks, often through the formation of structured alliances and partnerships, with the goal of sharing knowledge, know-how, and resources in order to develop collaborative innovations (Lee et al., 2012). (Lee et al., 2012).

The philosophy of a shared place has emerged to explain the positive effects of knowledge sharing. With the spread of new advanced technologies in the digital

transformation period that we are leaving, the process of creating and sharing knowledge goes beyond organizational walls and is developed in a cross-organizational space. Chesbrough was the first to define this process as an Open Innovation model in 2003.

1.6.4. CONCEPT OF OPENNESS

Different conceptual frameworks have been proposed by academics to speculate about what it means for an external platform to be "open." As West (2003) points out, openness is more of a continuum than a binary state. According to Elsenmann (2009), a platform is more open when it has less constraints on who can participate in, use, or develop it throughout the ecosystem's many functions. Especially when the jobs in question are platform users on the supply side, such as developers (Parker & Van Alstyne, 2017).

However, openness can encompass more than just access. Devolving control (Boudreau, 2010) or decisional openness (Nambisan and Sawhney, 2011) are more ways to think about openness. This refers to how evenly the rights to make innovation decisions and, by extension, the platform's strategic direction are spread among ecosystem members. Opening up platforms gives opportunity for entities other than platform leaders within the ecosystem (Bogers 2017). The platform, in particular, can become a venue for entrepreneurial efforts as chances to build complementary products or services that become part of the platform's "orchestra" are recognised and explored (zahra & Nambisan, 2012). Complementary products are those in which the combined value of the two products exceeds the sum of their individual values (Gawer & Cusumano, 2014).

We understand that the existence and expansion of complementary goods can have a significant impact on the entire platform ecosystem's viability.

1.7. BARRIERS AND RISKS OF OPEN INNOVATION

1.7.1. BARRIERS FOR SMEs TO ENTER EXTERNAL PARTNERSHIPS

For a variety of reasons, SMEs are hesitant to enter into partnerships and accept the risks associated with joint innovative projects. Joint commitments are especially vulnerable to opportunism and may be especially problematic where synergies are not easily transparent, or firms are sceptical and inert to changing circumstances (Huggins, 2001). Furthermore, SMEs are particularly skeptical of networking and are less likely than larger firms to participate in innovation networks (Asheim et al., 2003). Xie et al. (2010) identified a 'lack of technical experts,' a 'lack of financial capital (in relation to R&D),' a 'lack of technical information regarding new technologies,' and a 'lack of suitable partners' as significant barriers to collaboration in innovation among Chinese SMEs. Yet clearly such barriers are related to SME's inherent internal resource constraints that hinder their ability to build and maintain sustainable networks beyond the Chinese context (Huizingh, 2011).

De Vrande et al. (2009) developed a classification of open innovation barriers for SMEs, highlighting a variety of structural obstacles, including: bureaucracy and administrative burdens, obtaining financial resources, a lack of technological knowledge and competent personnel, insufficient market intelligence, efficiently balancing innovation and daily tasks, cost pressure, ownership of developed innovation, poor quality of partners, customer adoption problems, customer demand being too spherical Their research concludes that lack of financial resources, limited opportunities to hire specialized workers, and small innovation portfolios make it difficult to spread the risks associated with innovation. Organizational and corporate culture-related issues that typically emerge when two or more companies are working together are clearly the most important barriers that firms face when they engage in open innovation (ibidem).

Chesbrough (2010) emphasizes the most significant structural deficiencies of SMEs as a result of open innovation. First, SMEs typically lack the ability to support dedicated resources and personnel to build structures to identify useful external knowledge. Second, even when external ideas and technologies are identified and transferred, SMEs frequently lack the ability to absorb them. Third, smaller firms are frequently unappealing as partners to others: SMEs may not be regarded as attractive partners to receive useful ideas and technologies, even if they can initially identify them. Furthermore, SMEs rarely have the resources to provide research funding to support promising academic research that could serve as the foundation for a cooperative innovation project. Fourth, deficiencies in value capture: SMEs typically do not have the market power to capture the value of their externally sourced knowledge and innovation, if not protected by intellectual property rights (IPRs). If they cannot expect

to benefit from external ideas and technologies, they cannot justify the investment in pursuing those sources (Chesbrough, 2010).
According to the Institute for Management Development (2011), open innovation is hampered primarily by a lack of trust and inconvenient regulations. Lack of trust is the result of a lack of social capital within. Awkward regulations are business regulations that discourage collaboration and partnership in the name of "free competition." Furthermore, due to widespread unethical business practices, SMEs avoid collaboration (Institute for Management Development, 2011).
Lee at al. (2010) analysed the innovation barriers for 817 Korean SMEs and found that the top 10 obstacles are: difficulties in finding suitable manpower in a labour market, short of suitable manpower within the firm, market uncertainty in innovative products, imitation possibilities of technology innovation, short of ability in R&D planning and management, lack of technological information, funding difficulties due to high risk from technological uncertainty, funding difficulties due to high innovation and commercialisation costs, lack of market information, frequent turnover of human resources. Thus, Lee et al. (2010) concluded that SMEs suffer from 'labour shortages', 'lack of information', 'lack of infrastructure' and 'lack of financial resources'. The difficulties in labour shortage, lack of information, and financial resources can be relieved by collaboration, and those with lack of information and lack of infrastructure could be alleviated to some extent by the action of an intermediary to help them complete innovation activities more effectively (Lee et. al, 2010). Subsequently, SMEs feel a profound cost pressure, resources constraints and people adversity to change, which impedes them to involve in big collaboration projects. Their size acts as a limitation and, the bigger the cost pressure the higher their dependability on internal sources of knowledge and innovation.

1.7.2. OPEN INNOVATION RISKS OF SMEs

Open innovation proponents frequently emphasise benefits, implying that we currently have a limited understanding of the costs of openness (Dahlander and Gann, 2010). The threats that exist in this open innovation context are as diverse as the field of open innovation research itself. Inter-firm collaboration may thus introduce new risks and threats, as well as increase transaction costs (Lee at al., 2010). While innovation inherently necessitates knowledge exchange, such an activity also carries significant risks, not only in terms of collaboration failure, but also of potentially losing competitive advantage if core knowledge leaks out to competing organisations (Hurmelinna-Laukkanen, 2011).
The scant literature on SMEs' participation in open innovation projects focuses on highlighting the barriers for a firm to approach open innovation rather than depicting the risks associated with such collaborative arrangements. Assuming that successfully

managing the obstacles that prevent a small firm from efficiently collaborating results in increased performance, competitiveness, and knowledge acquisition, our approach is to focus on the risks encountered during the collaboration agreement's development. Because scholars have generally focused their research on open innovation risks on large companies rather than SMEs, there is little knowledge on how the magnitude and impact of open innovation threats differ for smaller firms versus larger firms. We show in our review of literature what hinders a company's performance while involved in external collaborations, regardless of its size. Following that, in our practical research, we specifically addressed these open innovation risks from the perspective of SMEs, using a cross-sectional survey to develop a risk framework with the input of SMEs managers.

Collaboration risks pose a direct threat to strategic alliances. Strategic alliances, according to Das and Teng (2001), are characterised by relational risk and performance risk. Performance risk is essentially related to the possibility that alliance objectives will not be met despite good partner relations. The relationship risk arises because partners' individual interests may conflict with those of other partners. This can lead to opportunistic behaviour such as cheating, misinformation, and appropriation of shared resources (Das and Teng, 2001).

Collaboration can also raise costs if there is "too much" diversity among partners. Cross-collaboration between different fields of science frequently yields extremely valuable results. However, the chances of a positive outcome and, indeed, the average gain from collaborations increase if both partners' knowledge is within the scope of the same specific domain (Fleming, 2001).

Researchers argue that the following non-pecuniary disadvantages can make open innovation less attractive for innovators: secrecy concerns (Thomas and Trevino, 1993); problems in division of contributions and outcomes of cooperation (Keupp and Gassmann, 2009); outsourcing critical dimensions of business (Dahlander and Gann, 2010); developing dependence on partners, losing technological competence, slowing down self-development of innovation (Rotering, 1990 cited by Brockhoff and Brockhoff, 1992); dealing with many sources and ideas at any given moment of time (Laursen and Salter, 2006); difficulty in choosing and combining between numerous alternatives (ibidem); risk of poor governance of joint learning processes (Larsson et al., 1998); difficult to maintain large number of partnerships with different actors (Ahuja, 2000); risk of selecting wrong partners (de Vrande et al., 2009); difficulty in balancing innovation with daily tasks, communication, aligning of partners, organisation of innovation (ibidem); bureaucracy and conflicting rules (de Vrande et al., 2009); not invented here (NIH) syndrome (Katz and Allen, 1985); problem in maintaining internal commitment over period of time (Chesbrough and Crowther, 2006); and organisational resistance and fear of losing control over proprietary technologies (Keupp and Gassmann, 2009).

Opportunistic behavior by collaboration partners (Jarillo, 1993), insufficient expertise of one partner (Flowers, 2007), or precautionary measures for the possibility of information leaks concerning valuable technologies, particularly in collaborations with competitors (Oxley and Sampson, 2004), may increase costs and make external R&D less appealing. Not only does actively learning about the other's assets incur costs, but also prevents internal knowledge from spilling over to the partner (Mata and Woerter, 2012).

Knowledge sharing risks can arise from the diversity of employees involved in knowledge transfer and their competing interests, which can alter the message, defining a relational risk. According to Lichtenthaler (2011), external knowledge sharing has the potential to expose an organization's core competencies to competitors. As a result, knowledge sharing may pose a risk because the organization may lose its competitive advantage. Furthermore, this knowledge exposure may provide competitive organizations with additional advantages if the competitor adapts this knowledge and gains a significant market share (Lichtenthaler, 2011). Because of this vulnerability, knowledge sharing is a critical risk concern for open innovation (Islam, 2012).

Another major source of concern for the innovation outsourcing practice is the workforce. The main goal of open innovation projects is to find skilled and talented individuals. Furthermore, because of the "safety mentality" and competition between organizational units or individuals, employees in large organizations may be less willing to share knowledge (Brunold and Durst, 2012). Furthermore, in large corporations, a lack of trust among employees jeopardizes collaboration, a critical strategic resource. As a result, the companies must constantly develop processes to avoid risks associated with knowledge sharing, resulting in increased competitiveness.

Trust is a significant factor that influences knowledge sharing in a knowledge-intensive company. Lack of trust restricts knowledge distribution channels and jeopardizes the efficiency of organizational knowledge flow, which is influenced by people's misconceptions about the appropriateness of transparently managing knowledge. Lack of trust favors the development of deadlocks in the course of transferring knowledge with the goal of gaining a competitive advantage, whereas trust empowers knowledge sharing and acts as an integrator of knowledge processes. Trust, as a key component in the collective risk-taking structure, is even more of a knowledge-sharing incentive, while lack of trust is a knowledge risk. This risk refers to the possibility that others will exploit some people's knowledge due to ambiguity or uncertainty (Park, 2006).

There have been a few studies that specifically address open innovation risks for small businesses. According to Kutvonen (2011), recent empirical evidence on SMEs is provided by Enkel et al. (2009) in a study of 107 companies, both European SMEs and large enterprises. According to the 2008 study, risks associated with open innovation

activities include loss of knowledge (48 percent), higher coordination costs (48 percent), and loss of control and higher complexity (both 41 percent). Furthermore, significant internal barriers exist, such as difficulty in finding the right partner (43%), an imbalance between open innovation activities and daily business (36%), and insufficient time and financial resources for open innovation activities (Kutvonen, 2011).

Some authors argue that firms engaged in inbound open innovation may fail to develop strong technological competencies internally, resulting in a high reliance on third parties (Vanhaverbeke et al. 2012). Companies that are heavily involved in outbound open innovation may face increased competition in their end markets, as externalizing competitively relevant know-how may add to competitors' strength (Fosfuri, 2006). These risks may be more difficult for SMEs than for large corporations (Spithoven, Vanhaverbeke and Roijakkers, 2011).

1.8. DRONE INDUSTRY OVERVIEW

Unmanned aerial vehicles (UAV), commonly known as Drones, are vehicles characterized by the absence of human operators who carry them, but they are remotely piloted, and they can fly autonomously. Initially it was considered a military technology, used by military organizations and governments around the world for years, but it quickly started to be used by hobbyist and multimedia professionals for the realization of filming and photography. Government and companies began to find interest in drones' use in civilian and commercial application, and soon it became possible to enlarge the range of activities from firefighting and agriculture to the generation of climate data, from border surveillance to aero photogrammetry and topographic reliefs. The advent of this new technology brings firms to important economic savings in terms of costs and time, reducing risks for human operators and providing environmental benefits.

1.8.1. THE TECHNOLOGY

On the market diverse typology of UAVs for commercial purpose were introduced and exploited by several firms, interested in the potential of this new technology able to generate competitive advantages against competitors. UAVs, like airplanes, have evolved in different configurations and aim at developing different flight characteristics that could be exploited for various uses. In particular, the most diffused types of Drones are the Fixed-wing and the Rotating-wing ones. Fixed-wing drones are basically similar to airplanes in scale used in model aircraft, with a control station (or ground station) characterized by a control application which allows it to guide the vehicle during its flight. This type of drone always needs a large enough space for landing, but for take-off it does not always need a taxiway, given that the lightness and dynamic efficiency of some models is so great that they can be directly launched in flight to hand. In order to keep the UAVs moving forward they are equipped with electric or internal combustion engines that generate the needed thrust. Rotating-Wing drones instead use pairs of counter-rotating rotors which guarantee sustenance, advancement and stability. The most common configuration is the 4- rotor one, called quadcopter, but they could have configurations with 6, 8 or more rotors (hexacopter, octocopter, etc.). The main features of this type of drones are vertical take-off and landing and the hovering capability. In addition, the single control of each of the engines and the symmetrical shape of the aircraft allows the flight in all directions without limitations. This great control of the flight, however, is obtained at the expense of autonomy, since in this case there is no aerodynamic lift that helps sustenance. Professional multirotor drones are normally equipped with two or three axis gimbals capable of supporting an adjustable and stabilized camera for video and photographic shooting.

In addition:

- **Fixed-Wings UAVs** have greater flight range, they are able to fly for over 45 minutes. They could cover surfaces in less time, up to about 1 square km in a single flight and they can carry higher weights for longer distances using less power for the same weight. However, they are more expensive than the other typology and they are not able to hover as rotor drones do
- In the Rotating-Wings UAVs' category it is possible to identify the subcategories of micro drones, the last frontier for very specific fields of application such as robotic bees, and low-cost mini drones, with no more than 150 grams of weight and frame with a diameter of maximum 250 mm.

Figure 1.5: Fixer – Wings UAV

Figure 1.6: Rotating – Wings UAV

Ultimately, other more complex typologies of drones have been created, such as VTOLs (Vertical takeoff and Landing), or STOLs (short takeoff / Landing) which combine the flexibility of multicopters with the durability of fixed-wing drones. They are able to rotate the propellers and move from a vertical take-off to a translated flight and then return to a vertical landing.

1.8.2. DRONE GLOBAL MARKET OVERVIEW

According to Droneii.com, a leader in drone market research, the global market has reached a size in terms of revenue of 22 billion US dollar in 2020, and it expects to grow

up to 43 billion US dollar in 2025, with a 13.8% of CAGR (Compounded Annual Growth Rate). By 2021, the commercial drone industry will be selling 1,000,000 drone units per year. Unit sales will have more than doubled between 2020 and 2025. At the same time instead, private or hobbyist drone unit sales will decrease in 2020-2025.

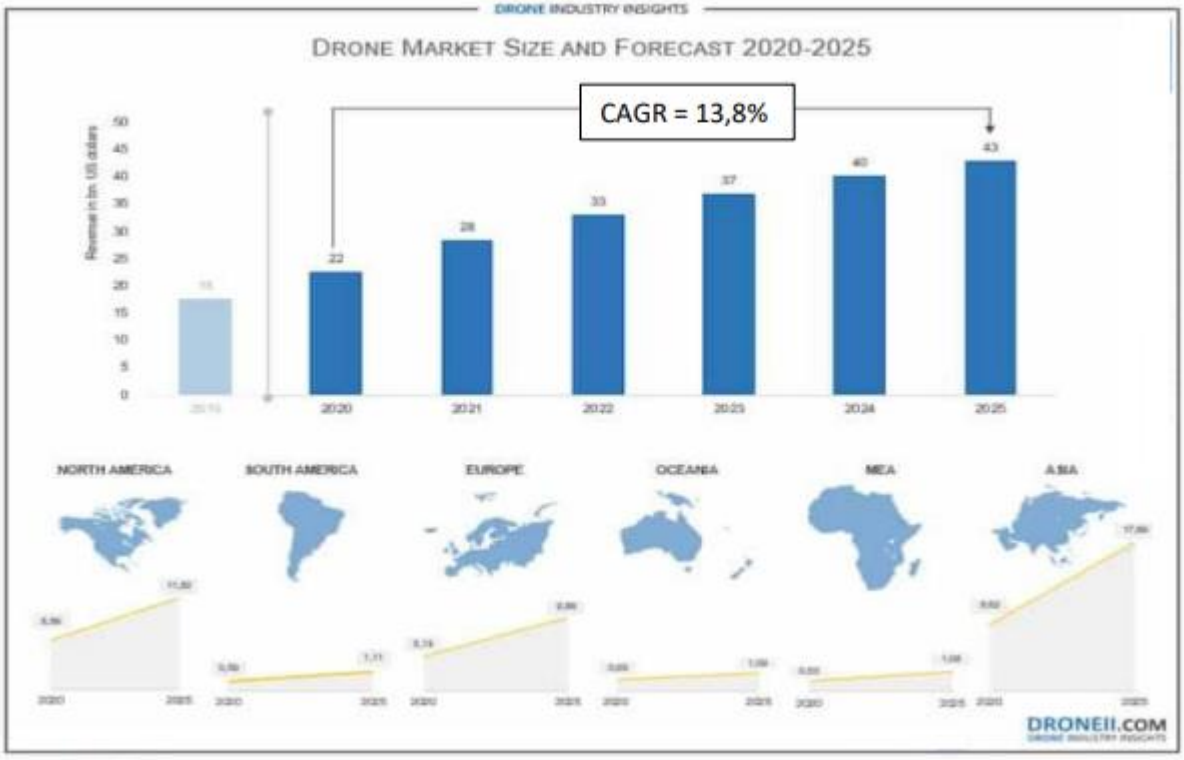


Figure 1.7: Drone Market Size 2020 – 2025 (Source: Droneii.com)

USA and China currently dominate the commercial drone market since their revenue together correspond to two thirds of the global drone market size and this does not look likely to change in the foreseeable future. In 2018 North America was generating slightly more revenue than Asia, but thanks to the growth of China, Japan and India (since the legalization of drones in December 2018), Asia pulled ahead already by the end of 2019. The region will continue to grow and reach a position of a leader in 2025. Indeed, it is expected to grow from 8.62 billion US dollar to 17.89 against a growth from 6.89 to "only" 11.82 of North America. Also in Europe, a substantial growth is expected in the period of analysis, from 5.19 to 9.86 billion US dollars. However, the United States has been a particularly strong source of commercial growth, with the value of drone activity rising from $40 million in 2012 to about $1 billion in 2017, and it is estimated that by 2026 the commercial drones will have an annual impact between 31 and 46 billion US dollar on the Country's GDP (Pamela Cohn, Alastair Green, Meredith Langstaff and Melanie Roller, McKinsey 2017), driven by regulatory clarification, continuously decreasing component costs and innovations that connect drone capabilities and big data analytics. Moreover, few emerged from the COVID-19 pandemic without suffering huge losses. The global health crisis led to a worldwide

contraction of several markets and at the same time major economies have seen rises in unemployment, slowdowns of supply chains and reduction in demand for goods. However, it is important to note that the commercial drone has also already made gains during the pandemic, thanks to medical applications of commercial drones and other automated solutions provided, such as mapping, surveying, broadcasting and so on. The rapid expansion of this industry is also fuelled by a continuous increase in the amount of investments made, which achieved another record in 2019. Indeed, the value of the total 2019 investments reached 1.2 billion US dollars, an impressive 81% result which overcame the equally excellent value of 719 million in 2018. Since 2008, 4.433 billion US dollars has been invested into the drone market, as evidence of the exponential interest in this innovative technology. Most of the investments realized in this industry were made by venture capitalists (VC), which made up a large portion of this sum. With $830 million invested, against the $679 million in 2018, they reached the highest amount invested in this market.

2. METHODOLOGY

This chapter will provide a detailed description of the objectives of this empirical research as well as the methodology used to achieve our goals. Our work is part of a larger research project on the drone industry that began two years ago at the Politecnico di Milano's Drone Observatory. This chapter is critical because it explains and validates the assumptions we made in order to fill a gap in the academic literature about how firms in emerging industries' ecosystems pursue innovation.

2.1 OBJECTIVE AND RESEARCH QUESTIONS

In the chapter of the Literature Review we have seen how many scholars have mapped the concepts of Innovation Ecosystems, and ways through which Ecosystems innovate. For this reason, we centred our study on the concept of Open Innovation, and all its typologies. However, there are few articles that underlined how companies in emerging industries can develop Innovation Models in practice. Most of the scholars focused on Open Innovation on a more theoretical level.

For this reason, we didn't have the necessary amount of data to explain how companies in an emerging industry, like Drones one, can collaborate to achieve innovation. To fill this gap, we decided to analyse the Italian Drone Industry Ecosystem, in order to highlight what are the main ways that companies use to innovate, which are the main actors through which companies sign partnerships, and what kind of partnerships they develop.

So, we focused on answering 2 main research questions:

- What is the difference between the actual state-of-the-art of the Italian Drones Ecosystem, and the one of the previous year in terms of dimensions and actors involved?
- In which way do firms that are into a developing industry, like drones, achieve innovation, and what kind of partnerships they develop? Which internal or external actors are involved?

To answer the first question, we started from the database of the Drone Observatory of Politecnico di Milano developed in the previous year, and we updated it, first modernising data of the existing companies in the database, then selecting and skimming new firms combining data coming from different sources.

To answer the second question, we created and sent a survey to all the companies into the database. The goal of the interview was to obtain detailed information regarding the companies, the effects of Covid-19 on their activity, their thoughts about the actual

state of the art of the regulatory frame on UAVs, and the collaborations that firms built, or were building, with other competitors, or other actors in the value chain.

2.2 UNIT OF ANALYSIS

- To better contextualise the methodology we will describe, it was necessary to define the starting criteria from which the entire research work evolved. These criteria, in particular, enabled us to select and analyse the companies that are part of the ecosystem under consideration.
- We only looked at the Offering side of the Italian drone industry, focusing on the B2B and B2G markets and analysing the companies that are directly involved in the provision of products and services using drone technology. In order to maintain a certain level of granularity and to ensure an appropriate level of detail, the focus was on civilian applications of UAVs, avoiding companies involved in military fields.
- To avoid dispersion in the analysis, the focus was on the innovation strategies of the six different typologies of actors that comprise this ecosystem, rather than on individual firms.
- Universities, flight schools, associations, consulting firms, and insurance companies were not included in the analysis because, while they are active participants in the ecosystem, they only contribute in a secondary way to the creation of value for the entire value chain. However, some of the companies in some of the above-mentioned categories may be included if their core business is related to one of the ecosystem's six most important categories.

2.3 DEFINITION AND UPDATING OF THE ITALIAN DRONE ECOSYSTEM

To answer our first research question, we needed to contextualise the Italian ecosystem from the first applications of UAVs in the civic field to today, when hundreds of companies have decided to become part of this industry by proposing innovative solutions through this technology. In 2019 and 2020, the Politecnico di Milano's drone observatory worked extensively and meticulously to create a database of 730 companies on the Offering side (B2B and B2G) through an iterative process of population and skimming.

The census was carried out by triangulating various data sources, most notably AIDA, and selecting a list of different ATECO codes with the goal of identifying firms that rely on drones to deliver a service or a product. Another source of data was the ENAC database, which included all of the companies that registered their drones for use in their operations. Then, in order to have better and more direct information about the characteristics of the various actors embedded in the industry, a well-structured survey was conducted. The database was obtained at the end of this work, and the Italian drone ecosystem had been thoroughly surveyed.

The first phase of our work involved re-analyzing the ecosystem a year later to see if its composition had changed or if companies' data should have been uploaded in order to get a first clear picture of the Italian Drone Ecosystem.

To update and expand the initial database, we chose various types of information, both general and specific, to identify companies in a unique way and to represent the size and manner in which they operate in the market.

As a result, we first checked for the presence of more recent financial data, such as the publication of the 2019 turnover, which was not previously available on AIDA, or research and development expenses. Simultaneously, it was necessary to confirm the presence of other general information more related to the companies' business, such as an update in the number of employees compared to the previous year, or a possible change in the company's name, or a possible change in the latter's business model.

As a result, the first step of our methodology was to verify the legal status of each company in order to determine how many were still active today and how many had gone into liquidation and subsequently failed. This was a critical step in obtaining a more precise picture of the ecosystem in general, in order to avoid considering companies that were unable to survive. To accomplish this, we first verified each company's presence on Aida using a combination of keywords (particularly the VAT number, the BVD ID number, and the company name).

Because not all of the companies were available on Aida, we used the website of the "Agenzia delle Entrate" for the missing ones, via the dedicated section "VAT number verification," which allowed us to highlight the status of these companies with a certain degree of reliability. For greater precision and confirmation, we triangulated the information obtained through a check with the company website and, in particular, with their social media, to confirm their activity and presence status on them. This final step was critical for businesses that did not have a VAT number.

Following the completion of this verification process, it was possible to obtain a more accurate picture of the current situation regarding the Offering side of the B2B Italian market of the emerging drone industry, taking into account only the companies already present in the existing database. 690 companies, in particular, were discovered to be "active." However, four of them resulted in "in liquidation," and the remaining no longer deal with or are exiting the considered side of the Drone industry.

- **VAT number (Partita IVA):** the identification code characterised by a sequence of 11 digits that uniquely identifies a firm who carries out a business' activity.
- **BvD ID number:** An extension of the VAT number in which the latter is preceded by the initials of headquarters' country. (IT for Italy).
- **CCIAA Number (Numero CCIAA):** the number of the company in the Italian "Registro delle Imprese", or the registration number attributed by the "Registro delle Imprese della Camera di Commercio". It is the ID code of the company.
- **Previous CCIAA Number**
- **Company name:** the legal company name used to identify it in the different data sources.
- **Website:** fundamental for collecting information about the business, employees, contacts of the company.
- **Telephone:** useful for carrying out the survey in case there are delays in sending it by the respondent.
- **Legal status:** important information related to the actual status of a firm, which could be still active, in liquidation or failed. This parameter will be fundamental in the updating work we performed later.
- **Legal form:** The legal form of the company is the organisational, administrative, fiscal and accounting model with which a company is conducted, according to the rules of the Civil Code. The choice of legal form is made at the time of foundation of the company.
- **Innovative startup:** startup that meets the requirements defined by Italian law in order to be considered innovative.

- **Foundation year:** year of establishment of the company.
- **Localization (Regione and Provincia):** The region and district of the firm's headquarters, corresponding to the registered office.
- **ATECO 2007 code:** The Ateco code is used to classify the economic activity carried out under the VAT number, to understand what is the tax and contribution regime that applies to those who carry out a certain economic activity.
- **ATECO 2007 Description:** it is the detailed description of the economic activity identified by the ATECO code.
- **Revenues from 2018 to 2021:** the sales revenues of the last four years available are reported in order to have a clear representation of the size of the company.
- **EBITDA from 2018 to 2021.**
- **EBIT from 2018 to 2021.**
- **Profit/Losses from 2018 to 2021.**
- **Employees:** a range of employees which determines the size of the company in analysis. Four ranges have been identified: micro firms (from 2 to 9 106 employees and/or founders), small firms (from 10 to 49), medium firms (from 50 to 249) and large firms (over 250).
- **DE ALIO / DE NOVO:** variable which defines if the company in analysis enters in the market of drones only after having developed its core business in another industry or if it started from the beginning of its life to provide solutions with drone technology.
- **Main Role:** the role which contributes more to the company's turnover generation. Here we find the distinction between the six categories previously described (Operators, Platform producers, Payload producers, Software producers, Distributors, Integrators).
- **Vertical Integration:** Firms can perform more than one role and we identified three levels of vertical integration, low (1-2 roles), medium (3-4 roles), high (5-6 roles).
- **Intended use (for operators):** which is the purpose of the offering provided by the firm to the customer. It is possible to identify several uses, such as Dispensing, Inventory, Inspections and Surveys, Research and Rescue, Security and Surveillance, Entertainment, Transport of goods, Transport of people, Material handling, Surveys, Precision Agriculture, Maintenance and Rent

2.3.1 ITALIAN DRONE ECOSYSTEM UPDATE

Once the process of checking and updating the existing database was completed, it was necessary to proceed with a further step of populating the ecosystem by adding those companies that were recently born, entered the market during the last year or that were not present in the data sources used for the initial triangulation of the first census of the industry conducted by the Drone Observatory of Politecnico di Milano in 2020. This process has been important in order to obtain a more updated and complete picture of the companies that were part of our ecosystem. To do this, it was necessary to repeat similar operations carried out for the first filling of the database, following a step system characterised by an initial phase of research and skimming, a subsequent analysis and verification of the consistency of the results obtained with our search parameters and finally, the insertion of the key information described above. As regards to the research process, we carried out a first investigation by filtering on AIDA all those companies that belonged to the ATECO code categories that were used for the initial database population. In this way it was possible to obtain a sample of companies belonging to the aforementioned categories as a starting point for the selection of those really involved in the drone industry and in particular that were part of the Offering side of the B2B market. In this phase, the screening was carried out by analysing, company by company, their website, general information related to the business on AIDA and social media, always checking the legal status also on the portal of the "Agenzia delle Entrate". After a further check on the websites to verify that these companies were actually part of the offering side, thus distinguishing them from those belonging to the demand side, they were inserted into the updated database with all the key information necessary for their identification and description. To obtain more information and more precise and coherent data, the search for new companies belonging to this industry was done by triangulating AIDA data with other data sources, in order to obtain a larger sample of information to be analysed. In particular, this triangulation has been made through the research and selection of companies registered on the D-Flight portal, where from March 2020 it is possible to see all the authorizations required for operations with UAVs. In this way it has been possible to immediately identify the presence of companies in the industry, also providing a first description of their role. However, for the companies listed in the database provided by D-Flight, we needed to perform a deeper analysis to understand if they met our requirements. Indeed, those companies certainly belonged to the Drone market, but we had to check if they were a B2B or a B2C company and if they were part of the Offering or Demand side. Finally, a further step of research and screening was conducted on the databases of provided by sales navigator and Registro delle Imprese Innovative italiane, where it was possible to carry out the selection process respectively of those companies that had a presence on LinkedIn, with sales navigator, and those startups present on the Registro, where it was also possible to verify whether

these companies had been categorised as innovative startup (also in this case we performed a check of the state of innovative startup on AIDA). At the end of this research phase, a further skimming process was necessary in order to identify and classify those companies on the borders of the definition of "companies of demand side" and "company of the Offering side", such as those film production companies who use drones for their jobs. In this case, it was necessary to analyse the “border line” firm on a case-by-case basis, to figure out if the services offered were carried out entirely with drones or if this technology was used only as a support for other more important operations, and therefore to be considered as a demand side company. Once the process was completed it became possible to identify that 34 new companies entered the market. In addition, during our research and selection work, we have identified one other company, not embedded in the existing database, but which was "in liquidation", and therefore to be excluded for future analysis. In conclusion, after the first two steps of our methodology we obtained a final census composed of 724 companies considered "on target", which means that for these it would be possible to carry out a more in-depth analysis linked to our research purposes.

2.3.2 SOURCES OF DATA

As already described, to update the existing database of the Italian Drone ecosystem we relied on several data sources, triangulating the information gathered from them to have data which were as complete as possible. Therefore, a clear and concise explanation of the different data sources previously mentioned must be provided, in order to clarify which were the references from which we obtained the information.

- **Aida:** Aida is a platform developed by Bureau Van Dijk Electronic Edition Spa (acquired in 2017 by Moody’s), a leading publisher of business information specialised in private company data combined with software for business research and analysis). The platform collects up to ten years of historical financial and legal data of Italian companies. Its database is periodically updated based on the new information available and can be useful for searching an individual company, companies with specific profiles and also for analysis. In particular, for each firm it is possible to find a multitude of different data, from basic financial statements (Balance Sheet, Income Statement, Cash Flow Statement) to more specific modules which allow to perform deeper analysis: the “financial strength” module includes rating and credit risk analysis, the probability of being sold, financial indicators and environmental risk rates; the “probability of default” module provides credit scores, rating classes and the probability of default of companies. In addition, it helps to identify potential customers and prospects; the “BYO Value” module is a decision-making tool integrated in Aida useful to analyse the performance of small and micro-Italian enterprises thanks to the studies on the whole industries in which they operate;

the "SPL" module allows the user to assess the enterprises owned by public authorities. Furthermore, for each firm Aida provides non-financial information related to the company headquarter, business sector, number of employees, shareholders and holdings, managers, ATECO code and description, website and phone numbers. Through a very flexible software it is possible to search companies with a variety of parameters and criteria (for instance company name, VAT number, BvD ID number, geographic area, sectors), even considering trends over several years. These criteria can be combined together thanks to the Boolean logic at the software's basis. Moreover, it allows to execute market research and benchmarking analysis, by creating and customising indicators and data layouts, calculating sector's averages and modifying report layouts, useful for a multitude of activities, from financial and statistical analysis to credit risk assessment, corporate finance and M&A research. Considering all these features, thanks to the different functionalities and it's easy accessibility, Aida represents our reference framework to collect information about the Drone industry firms.

- **Sales navigator:** Sales navigator is a platform developed by LinkedIn (a free social networking web service, founded in 2003 by Microsoft, mainly used in the development of professional contacts and in the dissemination of specific content related to the labour market). This instrument allows the user to intercept new leads with specific characteristics, in line with the final target. The LinkedIn database, which is at the basis of Sales Navigator, enables the search of new "Leads" (people profiles) or new "Account" (companies' profiles). The algorithm of the platform is able to process the information that the user gives to it, and in this way, it starts to match the Accounts and Leads in the database with the elaborated information. Furthermore, Sales Navigator gives the possibility to use a multitude of filters (for instance the industry, sector, dimension, geography, postal code and company name) with a maximum of 21 combinations at time, in order to search the target profiles. Each research is stored and analysed by the algorithm, which in this way can improve the initial proposal of new contacts. Moreover, the platform also gives the instruments to get in touch with the final users. In particular, it is possible to distinguish between two different ways to do this: a direct instrument, in which is possible to send InMail message (message with a maximum of 300 characters) and to obtain complete and detailed information about the new contacts, and an indirect one, which collects all the updates of the monitored contacts and indicates topics of common interest and point of contact between the user and them. For these reasons, this platform is very suitable for us in order to try to find new companies, which are part of the Drone Ecosystem, and consequently to improve and expand the ecosystem itself.

- **D-Flight:** A database realised by D-Flight in which there is information (like code, operator name, company's vat number, Drone's type, drone's constructor, classification and weight) about all Italian UAV operators. D-Flight S.p.A. is a company of ENAV Group, which is responsible for the management and control of civil air traffic in Italy. D-Flight pursues the development and provision of services for the management of low-altitude air traffic for remotely piloted aircraft (APR) and all other types of aircraft falling within the category of unmanned aerial vehicles (UAV) and any activity connected to them. D-Flight in collaboration with ENAC (Italian national body for Civil Aviation), which is the only Authority for technical regulation, certification, supervision and control in the civil aviation sector in Italy, has developed a specific portal for the management of drones and starting from the first of March 2020, all the declarations and authorizations must be registered in this new portal. In particular, this portal offers to each operator a service that allows them to register the drone and to obtain a unique identification code of the drone itself which must be communicated before each flight to obtain the authorization. Furthermore, within the portal is possible to find all the rules that must be followed in order to carry out the missions in total safety and in compliance with the regulation, and all the news regarding the drones' world. The analysis of this database is fundamental to depict the Italian Drones ecosystem in a complete and accurate way because it is immediate to find all the actors involved in it.
- **Registro delle Imprese Innovative Italiane:** the Register of Italian Innovative Companies is a particular section of the Italian Business Register, which can be defined as the register of companies that contains the data (constitution, modification, termination) of all companies with any legal form and sector of economic activity, with headquarters or local units (offices, factories, warehouses) on the national territory, as well as other subjects provided for by law. The Business Register is a fundamental archive for the development of economic and entrepreneurial development indicators in each area of belonging. The Business Register contains all the main information relating to the companies (name, statute, directors, ...) and all subsequent events that affected them after registration (e.g. changes to the statute and corporate offices, transfer of headquarters, liquidation, bankruptcy proceedings, etc.). The register of innovative companies, in particular, focuses on the so-called "innovative start-ups", which according to the Ministry of Economic Development are newly or recently established companies that deal with bringing innovative and high-value products or services to the market technologically. To be considered innovative, a start-up must comply with the following requirements: the main legal requirement for any innovative start-up is that the main or exclusive activity is the development, production and

marketing of an innovative product or service and is highly technological. Furthermore, the company cannot carry out activities parallel to that typical of startups. In particular, the company must deal with all three phases that bring the idea to the market (development, realisation and sale), and cannot carry out activities parallel to that of a startup. Any other activities must be secondary. The law also provides that companies must have been established for no more than 5 years, and cannot distribute profits to shareholders, but must rather invest any revenues in the business. Finally, innovative start-ups must comply with the following additional requirements: to bear research and development expenses for at least 15% of annual costs (or revenues); have highly qualified personnel, at least 1/3 of the collaborators for doctoral students, research doctors or researchers or at least 2/3 of the collaborators with a master's degree; be the owner, custodian or licensee of a registered patent or software.

At the end of each research, the user will be able to visualise all the information through intuitive graphs, dynamic company's structures, pivots, maps and other visualisation and analysis tools to immediately interpret the results. Given the complementarity of this instrument with Aida, we also use it in our Master Thesis to triangulate the information to be sure not to lose some companies which are part of the Drone market.

2.3.3 SURVEY

So far, we have been able to obtain information by triangulating different data sources, thus creating a complete database that fully defines the B2B drone offer market in Italy. We were also able to provide, for each company in the ecosystem, both specific information on the state of the business and more general ones depicting in detail their characteristics. This information, however, was obtained indirectly through the different sources described above, and therefore there may be biases caused by a lack of some of them or by our interpretations. For this reason, we have carried out a survey in order to obtain a sample of information directly from companies themselves, comparing them with those obtained from our data sources and eliminating or correcting any misalignments. Before doing this, however, it was necessary to create an excel file on the census database of our ecosystem where the contacts (in particular the E-mail) of all the companies just identified were collected. To create this new file, we followed a logical procedure: first of all, we searched each company's websites for the contact person in the field of drones. If the personal Email was available, we selected both the contact's and the company email. If the contact's personal email was not available, we tried to find it through an email domain verification site (Mio-Ip.it), taking the company's domain as a basis. As a last resort, in case of absence of personal Email, failure to find it with Mio-Ip.it or no particular contact indicated, we opted to use the company email to avoid not sending the survey.

Moreover, the database contained all the contacts we have registered with the name of the company, the name and surname of the respondent, the job title, the website of the company and the telephone number for any future needs. The survey specifically consisted of four sections concerning issues related to the drone industry, regulation, the impact of COVID-19 on this market, and the innovation process of the companies (in the Annex The detailed structure of the survey is presented):

- Section 1: The Italian drone market; This section analysed the industry in terms of the roles covered by companies in the market, the intended use of UAVs within them, the size of companies operating in the market in terms of employees, turnover achieved and estimated, limitations on technology development and investments made for the growth of companies.
- Section 2: The second part was linked to the impact of EASA regulation on the Italian drone market, analysing which are the regulatory aspects most blocking the diffusion and use of drones in the B2B field in Italy.
- Section 2: This section was more focused on the impact of Covid-19 on the companies' activities and on the drone market. In particular, here we analysed whether or not companies have suffered from the advent of the pandemic, if they had recovered after the openings, and if the state has guaranteed subsidies for these companies, also trying to understand if it was possible to intervene to ensure greater use of drones in emergency situations.
- Section 3: This section was focused on how Italian companies in the drone industry achieves innovation. In particular, we analysed how much companies spend for R&D, what are the main areas in which they invest, what goals they reach when they perceive innovation, if they collaborate with external actors in the search for innovation, and what are these actors.

Once the survey was carried out, we launched it using the Qualtrics software, a platform capable of making surveys and collecting the information sought, sending the survey to our previously created contact list composed of 724 firms. The survey was active for about three months and to get as many answers as possible we conducted two rounds of calls to kindly ask them to answer the survey, so that we had more data available in order to compare the information received with the one obtained through data sources. We obtained 134 answers which allowed us to analyse a sample of companies and to figure out if the two typologies of data were coherent. However, there is a problem when relying on a survey, which is related to the possibility of bias that respondents can create when they fill the questions, as they may not fully understand what is being asked or they may overestimate the potential of their companies. For this reason, these data must be considered as useful but, in any case, compared with other sources of information, in order to be as consistent as possible.

3. MAIN RESULTS

This chapter shows all the results obtained once all the steps of the methodology described above have been implemented, divided for each of the two research questions to which we have tried to provide an answer as detailed as possible.

3.1 RESULTS FROM THE DATABASE

We began our work of studying the drones' market through the building of a database containing the main traits that characterise a business. We started from a database created by other students of the Politecnico di Milano in 2020 that highlighted the presence of 730 firms in the Italian drones industry. Firstly, we decided to map again the number of companies working in this industry, in order to be aware of the changes occurring in this context. We discovered that 34 new enterprises joined this ecosystem in 2021, and for this reason, these weren't present in the 2020 database. We also found out that 38 firms, who were included in the 2020 database, recently left the drones industry. For this reason, in our database there are 726 companies. Starting from these ones, we conducted a few analyses.

Companies data	
Companies present in the DB 2020	730
New companies	34
Companies no longer present on the market	38
Companies present in DB 2021	726

Table 1: *Comparison between companies in 2020 Database and in 2021 Database*

Then, we mapped the drones market from a geographical point of view, dividing the firms in 4 main clusters: north-west, north-east, centre of Italy and South and islands. The aim of this analysis was to understand the correlation between the possibility of creating a company who developed an innovative product and the surrounding geographical ecosystem. We tried to understand the so-called "geography of innovation" that summarises the advantages of innovation associated with the location. Innovating companies gain when located in places with abundant resources and well-developed social networks. All factors that increase the probability of

recognizing a problem and consequently an opportunity for providing a solution to these problems.

geographical area	# firms	%
North-west	212	29%
North-east	162	22%
Centre of Italy	191	26%
South and islands	159	22%
	724	**100%**

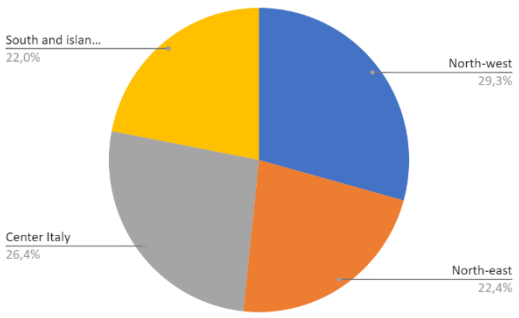


Table 2: *Geographical distribution of companies in 2021 Database per geographic area*

Through this analysis we discovered that the majority of the firms operating in the drone business: 51%, are based in the North of Italy, respectively 29% in the North-West and 22% in the North-East. So, Northern Italy is the main developing area for this kind of business. Instead the smallest segment where drones companies are established is the South Italy and Islands.

Furthermore, after this first classification based on the geographical area, we decided to classify and study the firms more in detail, dividing these in the regions where these ones are present.

In this way, we discovered that Lombardia is the most relevant region in terms of drone's enterprises. In fact, there are 132 firms operating in this market out of 724 firms operating in the whole of Italy. Looking more in detail into each area, we discovered that:

- Regarding **North-West**, as explained before, Lombardia is the region with the highest number of companies, 132. In the second position in this geographic area is Piemonte with 55 drone firms. These 2 together represent 88% of the North-West area. The smallest region in terms of drones' enterprise in this geographical area is the Valle D'Aosta with only 4 companies operating in this market, representing only 2%.

- Regarding **North-East,** the region with the highest number of drone enterprises founded is Emilia Romagna, with 59 companies. It's immediately followed by Veneto with 55 firms. These 2 together represent 70% of this geographical area. After them, there are Trentino with 28 companies working in the drone's sector and Friuli Venezia Giulia with 20 firms operating in this industry.

- Regarding the **Centre of Italy,** the region with the highest number of firms founded is Lazio, with 95 companies. At the second position is Toscana with 58 drone enterprises operating in the drone's industry. These 2 together represent 80% of the Centre-Italy area.

- Regarding **South and Islands,** the region with the highest number of firms founded is Campania, with 36 companies. In the second position in this geographic area are Puglia and Sardegna with 30 drone enterprises. They are immediately followed by Sicilia with 25 firms. These 4 regions represent 76% of the whole South and Islands geographical area.

Region	Number	geographical area
Abruzzo	10	South and islands
Basilicata	6	South and islands
Calabria	18	South and islands
Campania	36	South and islands
Emilia-Romagna	59	North-east
Friuli Venezia Giulia	20	North-east
Lazio	95	Centre of Italy
Liguria	21	North-west
Lombardia	132	North-west
Marche	18	Centre of Italy
Molise	4	South and islands
Piemonte	55	North-west
Puglia	30	South and islands
Sardegna	30	South and islands
Sicilia	25	South and islands
Toscana	58	Centre of Italy
Trentino Alto Adige	28	North-east
Umbria	20	Centre of Italy
Valle D'Aosta	4	North-west
Veneto	55	North-east
	724	

Table 3: *Geographical distribution of companies in 2021 Database per region*

Subsequently, we analysed these companies from a temporal point of view, in order to understand how this industry evolved in the last few years and what is the potential future for this sector. For this reason, we classified the firms for which we were able to gather the founding date into 3 main clusters:

- the ones born before 2007.
- the ones born between 2007 and 2016.
- the ones born after 2017.

The results obtained from this analysis are: almost 49% of the companies working in the drone industry were born in the decade that goes from 2007 to 2016. The 27% of the firms were born before 2007 and the remaining 24% of the businesses were born after 2017.

Period	**# firms**	**Total %**
Before 2007	185	27,01%
Between 2007 and 2016	335	48,91%
From 2017 until now	165	24,09%
Total	685	100%

Table 4: *Founding date of companies*

Later on, we divided the companies for their typology of business between the ones who are De Novo and the ones that are De Alio.

- **De Novo** firms are new firms created in the focal industry.
- **De Alio** companies are pre-existing firms in other industries that entered this business.

Business' typology	**# firms**	**%**
DE NOVO	353	48,76%
DE ALIO	356	49,17%
N.D.	15	2,07%
	724	100%

Table 5: *De Novo / De Alio firms*

The results we achieved are that approximately half of the companies operating in the drones market can be classified as "De Novo" and the other half as "De Alio". So half of the companies operating in this market were already existing before entering this business and they were doing something else and then they transformed in order to order to operate in the drones industry.

Finally, we divided the companies into the main role that they have in the drone's industry. We discovered, thanks to the previous research of Drone Observatory, that Italian companies in drone industry can act as 6 main roles:

- **Platform Producer:** company that manufactures the hardware of the machine; this activity may also include the assembly of some components produced by third parties.
- **Payload Producer:** company that produces the components that are integrated with the machine and allow the collection of data and information useful for the work that this will have to carry out, for example, the camera.
- **Software Producer:** company that develops software programs through which control the machine, allow it to perform specific operations, or analyse the data collected during flights.
- **Integrator:** company that integrates the payload with hardware and software.
- **Operator:** company that offers services to third parties using its own or hired drones.
- **Distributor:** company that sells or leases finished machines to other companies.

Main role in the market	#	%
OPERATOR	615	84,94%
PLATFORM PRODUCER	50	6,91%
SOFTWARE PRODUCER	24	3,31%
DISTRIBUTOR	22	3,04%
INTEGRATOR	8	1,10%
PAYLOAD PRODUCER	5	0,69%
Total	**724**	**100%**

Table 6: *Main Role in the market of firms in 2021 Database*

Through this analysis we discovered that the main job that is done in the drone's market is the Operator, as shown in the previous table, it represents almost 85% of the total industry. Companies who offer services to third parties using their own or hired drones are the most present in this sector. After them the most developed job is the platform producer, almost 7% of the drones companies do this in this market.

Subsequently, there are the software producer and distributor as main roles who represent on average 3% of the whole market. In the end there are the integrator and the payload producer who represent approximately 1% of the total industry.

3.2 RESULTS OF THE SURVEY

To carry out a more detailed and coherent analysis, we compared the data obtained from our research with those obtained through the survey. In particular, the data acquired through the survey allowed us both to consolidate the results described above and to figure out other interesting characteristics of this emerging industry.

The percentage of respondents to the survey was large enough to make meaningful analysis. Indeed, starting from the sample of 724 companies to which we sent the survey, 134 completed it, thus obtaining 18,51% of respondents.

Considering the respondents, 82 of them completed, the 61,19%, completed the Survey. The others 52 answered partially to the questions, as shown in the following table:

%Survey Completed	Nr. of Respondents	Percentage
0	2	1,49%
2	6	4,48%
4	18	13,43%
13	1	0,75%
28	2	1,49%
33	1	0,75%
37	1	0,75%
39	15	11,19%
46	1	0,75%
52	2	1,49%
65	1	0,75%
72	1	0,75%
83	1	0,75%
100	82	61,19%
Totale	**134**	**1**

Table 7: *Percentage of completion of the survey by respondent companies*

3.2.1 GENERAL MARKET INFORMATION

First of all, the results obtained by the survey helped us to better analyse the composition of the ecosystem in terms of roles covered. The Operator confirmed to be the main role covered, even if the percentage was lower compared to the database.

Comparing the percentage of roles covered by companies in Database, and on the survey, we found some misalignments. These "misalignments" are due to the size of the two samples, since being the survey's sample lower, each answer had a higher impact on the total.

Role covered by each company (More than one choice possible)	**Nr. of Respondents**	**Percentage of Respondents**
Produttore di Piattaforma	17	12,69%
Produttore di Payload	7	5,22%
Produttore di Software	9	6,72%
Integratore	15	11,19%
Operatore	70	52,24%
Distributore	10	7,46%
Altro	13	9,70%

Table 8: *Role covered by each company*

Furthermore, another important aspect emerged from the survey was the heterogeneity of the sector in which the client companies operate. In fact, each operator can offer drone services to a wide range of customers, belonging to different market sectors. In particular, Infrastructure and Engineer is the leader, with 56 respondents, 41,79% of them, followed by Agriculture (26,87%), Utility and Oil&Gas (23,88%), Environmental Safeguard (23,13%), and Public Administration (21,64%). Compared to the previous year, there are elements of the most diffused sectors of the clients, but Infrastructure and Engineer is confirmed as the leader.

Final Clients' sector	Nr. of Respondents	Percentage
Agricoltura	36	26,87%
Arte e Cultura	20	14,93%
Assicurazioni	4	2,99%
Automotive	9	6,72%
Infrastrutture e Grandi Opere	56	41,79%
Intrattenimento e Media	15	11,19%
Largo Consumo	2	1,49%
Logistica	7	5,22%
Mobilità	6	4,48%
Pubblica Amministrazione	29	21,64%
Salvaguardia Ambientale	31	23,13%
Sanità e farmaceutico	5	3,73%
Telecomunicazioni	14	10,45%
Utility e Oil&Gas	32	23,88%
Altro	23	17,16%

Table 9: *Final Client's sector of the companies in Italian Drone Industry.*

Regarding the typology of clients, we found that the main market for Italian companies is the Drone Industry. Considering the percentage of turnover per typology, the main market for Italian Companies is B2B (47,92% average percentage of turnover) followed by B2C (26,69%), Public Administration (20,84%) and Other (Projects financed by the EU, internal projects) (4,56%).

Typology of Clients for Italian companies in drone industry	Average percentage of Turnover
B2C	26,69%
B2B	47,92%
Public Administration	20,84%
Other	4,56%

Table 10: *Typolgy of Clients of the companies in the Italian Drone Industry.*

3.2.2 MAIN BARRIERS TO INDUSTRY DEVELOPMENT

Another crucial aspect that emerged from the survey was the presence of some hurdles that could delay the growth of this emerging industry. Indeed, respondents had underlined some criticalities in operating in the market.

The 36,57% of them, in reduction compared to previous year, considered the legislation as the main issue preventing the development of Drone Industry, especially the lack of stability of the regulative framework, lack of legislation in specific areas, the difficulty to obtain certifications and authorizations owning certifications defined by ENAC and insurance policies. Problems related to legislation have also been indicated regarding the European Regulatory Framework. According to the companies, the new European Regulatory Framework increased the threat of entrance of foreign companies into Italian market (59,02% of Respondents consider it a threat), while it didn't bring great opportunities to Italian companies to expand their business outside Italy (47,54% said that it brought great opportunities, 32,79% of Respondents did not agree with the statement, 19,67% don't know). Despite these indications, companies also underlined that the new European Framerwork is giving a positive impulse to the Drone Market (57,38% of Respondents).

The 24,63% indicated an abusive phenomenon (people who buy drones for personal purposes, but at the same time offer services to third parties,) as the main problem in Italy for companies in the sector, while 15,67% defined lack of knowledge by the decision makers as the main issue to growth.

At the same time, also customers could also represent a possible barrier both regarding the relationship (7,46% of respondents indicated that as an issue) with firms and for their lack of attractiveness in this emerging technology (7,46% of respondents, like the previous issue), due to a difficulty in the communication of benefits of the usage of drones. In both cases, the most relevant problems could be the lack of knowledge of the possible application of the technology and of the legislation, the lack of specific

solutions that can solve clients' needs, and the requirement of projects not included in the normative framework.

Despite the presence of the barriers described above, the same actors involved in the value chain (83,87% of respondents) sustained that this emerging industry would be promising and would develop in the future years, supported by the entrance into the market of new structured players coming from other market sectors

Problems related to the development of Drone Market in Italy	**Percentage of Respondents**
Abusiviness Phenomenon	24,63%
Legislation	36,57%
Technological Delay	3,73%
Relationships with clients	7,46%
Lack of a supportive infrastrucutre	8,96%
Lack ofattractiveness in the technology	7,46%
Lack of knowledge by Decision-Makers	15,67%
Reduction of demand due to Covid-19	11,19%
Other	4,48%

Table 11: *Main barriers to the Drone Industry Development.*

3.2.3 THE INNOVATION PROCESS OF ITALIAN COMPANIES IN THE DRONE SECTOR

Once the Italian Drone Ecosystem has been defined, the following step of our thesis was to analyse the Innovation Processes implemented by firms.

So, we dedicated a specific sector into our survey to Innovation, considering first the average amount of investments in Innovation on total expenditures, then highlighting the main areas where companies are investing more on Innovation, and what are the main goals that companies want to reach with investments on Innovation. Finally, we analysed if firms collaborate with other entities to reach innovation, and what kind of actors are involved in partnerships.

Regarding the investments on Innovation, we found that expenditures in Innovation are on average 31,38% over total expenditures. Going more in detail, only 20,75% of respondents indicated to spend 50% or over of its expenditures in Innovation.

Percentage of investments in innovation compared to total expenditures	Nr. of Respondents	Percentage
0	6	11,32%
1	1	1,89%
3	1	1,89%
4	1	1,89%
5	6	11,32%
10	6	11,32%
15	1	1,89%
20	6	11,32%
25	1	1,89%
30	8	15,09%
35	1	1,89%
40	3	5,66%
50	1	1,89%
60	3	5,66%
90	2	3,77%
100	6	11,32%

Table 12: *Percentage of investments in Innovation compared to total expenditures.*

Considering the area of Innovation, 33,70% of companies declared to invest in innovation to develop a better organization, and to increase efficiency of processes. These investments may be done to improve the activity, reducing costs, both operational and organizational, so increasing profit margins.

Another important area of investment is Marketing & Sales (26,09% of Respondents). Investments in these areas are fundamental to build a company reputation and increase sales.

The investments in development of products, both from the hardware and software side, are less diffused (15,22% of Respondents for software, 19,57% of Respondents for

hardware), probably because companies in Italian Drone Industry are mainly Operators, which use drones to offer services, so they do not need to invest on products' research.

Other minor areas in which companies concentrate on Innovation are service development, RAA services, and civil Engineering.

Main Areas of Innovation	Nr. of Respondents	Percentage
Product Development on Software	14	15,22%
Product Development on Hardware	18	19,57%
Organization and efficiency of processes	31	33,70%
Marketing & Sales	24	26,09%
Other	5	5,43%

Table 13: *Main Areas of Innovation*

Focusing on the actors involved in the Innovation Process, most of the respondents to the survey said that they do not involve other actors in collaborations to innovate (27,17% of respondents). This underlines a situation in Italy, where companies still look at collaborations in investments, especially in innovation, still with distrust, probably because of all the risks related to intellectual property, flows of data and knowledge sharing. Looking at existing partnerships, the most diffused actors are Universities and Research Centres (22,83%), that can offer knowledge and high skilled workers and researchers. Then, companies collaborate with other firms in the sectors (21,74%), with which they can develop cooperation models. With companies in the same sector, the sharing of knowledge and data is easier, thanks to a similar infrastructure, but the risks related to data protection, violation of intellectual property, and free riding are higher. Other actors are less diffused and vary from Vendors and Sourcer ICT (8,70%), to start-ups (5,43%), to Public Administration (5,43%).

External Actors Involved in Innovation Process	Nr. of Respondents	Percentage
No Other Actors	25	27,17%
Startup	5	5,43%
Other firms in the sector	20	21,74%
Vendor and Sourcer ICT	8	8,70%
Universities and Research Centres	21	22,83%
Consulting companies	5	5,43%
Institutions and Public Administration	5	5,43%
Trade Associations	2	2,17%
Other	1	1,09%

Table 14: *Actors Involved in the Innovation Process.*

At the end of the study of the results of our study, we had an overview of the main ways through which companies involve other actors in Innovation. The vast majority of the respondents (53,66%) indicated that they rely on collaboration with Universities and Research centres to involve actors in innovation. Another diffused way is Partner Scouting (17,07%), that can offer a deep analysis of all the benefits and risks related to the selection of a specific partner.

Ways through which companies involve external actors in Innovation	Nr. of Respondents	Percentage
Call4Ideas, Call4startup, Contest	2	4,88%
Crowdsourcing	2	4,88%
Corporate Venture Capital	1	2,44%
Incubator e Accelerator	2	4,88%
Merger & Acquisition	2	4,88%
Partner Scouting	7	17,07%
Startup Intelligence	2	4,88%
Collaborazione con Università e Centri di Ricerca	22	53,66%
Licensing	1	2,44%

Table 15: *Ways through which companies involve external actors in Innovation.*

4. CONCLUSIONS

In this last chapter it is outlined the contribution of this master thesis to the academic literature on the Innovation Process in emerging industries. Then will be presented the main limitations and the possible future research.

4.1 CONTRIBUTIONS TO ACADEMIC LITERATURE

The work of our Thesis aimed at developing a detailed analysis of the Offer side of the Italian Drone ecosystem, focusing in particular on the B2B market. This was done more precisely for identifying the possible Innovation Process developed in this ecosystem, in order to evaluate their characteristics and at the same time which ones of them were able to bring more value to the companies which adopt them. The process was carried out in order to fill the existing gap between the extant literature about the topic of Innovation Processes in emerging industries and the different ways of the design and the adoption of these processes in emerging industries like that of the case under analysis. Moreover, we were able to pursue our goal by continuing the work done last year by the Drone Observatory of the Politecnico di Milano, which aimed at mapping the Drone industry managing to identify a heterogeneous ecosystem characterized by the presence of different actors involved and several firms with different business purposes. We tried to continue this work by first updating the existing ecosystem of the Offer side of the B2B Italian Drone market, and then developing a process of analysis through a Survey, which led us to identify, by collecting the answers, the average amount of Investments in Innovation made by companies, the main areas in which they reach innovation, and the possible success factors that can bring to companies. Then, we were also able to identify the main goals that companies want to reach when they invest on Innovation and what are the main actors with which they sign partnerships in order to develop Innovation. In this way, it was possible to shed some light on the existing gap in the development and adoption of Innovation Processes in emerging industries like that one of Drones.

4.2 LIMITATIONS AND FUTURE RESEARCH

The study conducted in this thesis has some limitations that could be overcome with future research. The entire work carried out has been realized by providing a static picture of the Drone ecosystem. Indeed, to validate our assumptions we carried out a survey which allowed us to verify the consistency of data collected in order to gather as much information as possible for the firms embedded in the industry. If this survey were applied from year to year, we would not only be able to see which innovation processes will be adopted in emerging industries, but also how these innovation processes can evolve over time or evolve as a function of contingent factors or strategic choices of the enterprises. In this way it is possible to analyse the industry not only in respect with the year of the study, but also considering the future years compared to the one in analysis. Furthermore, in the study there were some aspects which have not been analysed, such as the entrepreneurs' preferences, the strategic decision taken by managers, and how these firms were organized. All of these aspects could be linked in different ways into the development of an innovation process. For this reason, it could be interesting to analyse how these factors could affect each other and this could be a possible path for future research.

Moreover, it is possible to underline how this study is a research focused only on the Italian market, aimed at identifying the most important features of this emerging industry in the Italian landscape. This work could be extended to other countries in order to figure out if the innovation process adopted by firms could change as a function of the institutional context or the country system. At the same time it may be interesting to analyse the industrial evolution of drone technology in order to evaluate it as a function of the incumbents' entrance or the roles assumed by governments in the development of both the technology and the industry in general.

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- Appendix A: Actors In The Industry

In order to be as complete as possible it should be important to underline how in the Italian landscape there are not only the actors described in detail in the analysis of the Italian Drone industry, but there are also other figures which play a secondary role but at the same time they contribute to the value creation within the value chain. In particular, it is possible to identify:

- **Flight school:** They are authorized bodies that provide a training and preparation service for those who intend to obtain the patent by granting the authorization to operate in accordance with the regulations in force. The mission is to make them professional UAV and SAPR drone pilots thanks to complete training courses and teams of highly experienced and highly qualified instructors.
- **Associations:** They are groups of different actors involved in the development of the Italian Drone market, which identify solutions that allow to boost the industry favouring its growth.
- **Institutions:** Here universities and research centres allow the development of the industry by analysing which would be the possible innovative solutions which bring the market to future evolutions. They provide to the industry the needed know-how in order to allow companies to continuously innovate, but at the same time they are able to raise capital which helps the market grow from a financial standpoint.
- **Consulting firms:** They are able to support drone companies to elaborate their business models and to develop some solutions which brings them to achieve a competitive advantage against competitors. They help firms thanks to their knowledge obtained by deep research on the market and on its possible future development.
- **Airports:** It is necessary for some categories of UAVs some places where they can safely take-off and landing, and at the same time there is the need to regulate the air traffic in order to avoid accidents.
- **Insurance firms:** They provide services which assure coverage for the pilots in all its operations.

- Appendix B: Survey

Section 0: Registry

The company's name is: _____ (Mandatory)

Name and Surname of the Respondent: _____ (Mandatory)

Job title of the relevant employee in the company: _____ (Mandatory)

E-mail of the respondent: _____ (Mandatory)

Section 1: The Italian drone market

1.1 What part of the drone market does your company play? (There may be more than one answer)

- Manufacturer of platforms (company that manufactures the hardware of the machine; this activity may also include the assembly of some components produced by third parties)
- Producer of payloads (company that produces the components that integrate with the machine and allow the collection of data and information useful for the work that this will have to carry out, for example, the camera)
- Producer of software (company that develops software programs through which to control the machine, allow it to perform specific operations or analyse the data collected during flights)
- Architect/Integrator (company that integrates the payload with hardware and software)
- Operator (company that offers services to third parties using its own or hired drones)
- Distributor (company that sells or rents the finished machines to other companies)
- Alternatively (specify the role in the comment)

***Comment*: _____**

1.2 Which of the roles listed above contributes the most to your company's turnover generation?
(only one answer possible)

- Platform manufacturer
- Payload producer
- Software manufacturer
- Supplement
- Operator
- Distributor

Comment: _____

1.3. What kinds of drones does your firm now manufacture? (There may be more than one answer)

- Rotating wing
- Rotary wing (multirotor)
- Fixed wing
- VTOL
- Dirigible
- Balloon
- Other (specify in the comment)

Comment: _____

1.4 What type of payload does your company currently produce? (more than one answer possible)

- RGB cameras
- Multispectral chambers
- Hyperspectral chambers
- Thermal imaging cameras
- Laser Scanner (LiDAR)

- Radar, meters, spectrometers
- Dispensers of liquids, granulates and powders
- Dispensers and other material transport devices (i.e. capsules, tubes, packs)
- Other (specify in the comment)

Comment: _____

1.5 What type of software does your company currently develop? (more than one answer possible)

- Flight planning, fleet management and operations
- Navigation
- Unmanned Traffic Management (UTM)
- Data analysis
- Other (specify in the comment)

Comment: _____

1.6. Does your company develop software that incorporates artificial intelligence (AI) algorithms? (only one possible response)

- Yes, we have developed software based on IA
- No, but we intend to develop it within the next three years
- No, and we do not intend to include it in our commercial offering

Comment: _____

1.7. Which IA algorithms does your company develop? (More than one response is possible)

- Machine Learning (the ability to complete tasks without specific instructions and make decisions based on patterns)
- Advanced Learning (un sottoinsieme del Machine Learning basato su reti neurali artificiali)
- Other (specify in the comment)

Comment: _____

1.8. What are the goals of the IA algorithms developed by the company? (More than one response is possible)

- Flight planning, flight operations, and fleet management
- Navigation
- Unmanned Traffic Management Navigation (UTM)
- Other data analysis
- Other answer (specify in the comment)

Comment: _____

1.9. The AI solutions made available by your company act: (more than one response possible)

- On board the drone in real-time
- Post data collection through processing, i.e. in the cloud
- Other (specify in the comment)

Comment: _____

1.10. What are the intended uses of the drone services offered by your company to customers? (more than one answer possible)

- Dispensing of substances (e.g. spreading fertilizers in agricultural fields)
- Warehouse inventory (e.g. barcode scanning)
- Inspections and inspections (e.g. of production plants)
- Search and rescue (e.g. of a missing person)
- Security and surveillance (e.g. of public events)
- Show (e.g. light show in the sky)
- Transportation of goods (e.g. home delivery of parcels)
- Transport of people (e.g. air taxi)
- Maintenance (e.g. of power lines)
- Other (specify in the comment)

Comment: _____

1.11. Does your company use Artificial Intelligence (AI) -based solutions in carrying out drone operations? (possible more than one answer among yes)

- Yes, the flight planning, fleet management and operations software includes AI
- Yes, the navigation software includes AI
- Yes, the data analysis software includes AI
- No, but we plan to implement them within the next 3 years
- No and we have no plans to implement any at the moment

Comment: _____

1.12. Does your company offer counter-dron solutions?

- Yes
- No

1.13. Does your company offer Umanned Traffic Management (UTM) solutions?

- Yup
- No

1.14. In which sectors do your client companies operate? (more than one answer possible)

- Agriculture
- Art and culture
- Insurance
- Automotive
- Infrastructures and major works
- Entertainment and media
- Wide consumption
- Logistics
- Mobility

- Public administration
- Environmental protection
- Healthcare and pharmaceutical
- Telecommunications
- Utility and Oil & Gas
- Other (specify in the comment)

Comment: _____

1.15. How many employees (including the entrepreneur (s) working in the company) does your company have in 2021? (only one possible answer)

- Exact number: _____
- 1
- 2 to 9
- 10 to 49
- 50 to 249
- Over 250

1.16. What was the turnover achieved by your company at the end of September 2021 and what is the estimate of the total turnover for 2021? What% of this turnover is generated exclusively through drone activities?

Year	company's revenue [€]	% of turnover generated through drone activities
2021 (until the end of September 2021)	**_____€**	**_____%**

Estimated total turnover in 2021	**_____€**	**_____%**

***Comment*: _____**

1.17. How do you divide the% of turnover generated by your company through drone activities among the following types of customers?

Type of customer	% of turnover generated through drone activities
Final consumers (B2c)	**%**
Other companies (B2b)	**%**
Public Administration (B2g, eg. Police, Defense, Regions, Municipalities, etc.)	**%**
Other (specify in the comment)	**%**
TOTAL	**100 %**

Comment:

1.18. What are the main problems related to the development of the UAS drone market in Italy today? (more than one answer possible)

- Unauthorized
- Regulations
- Technological delay
- Relationship with customers
- Lack of an appropriate support infrastructure in urban and extra-urban environments
- Lack of attractiveness of this technology to customers
- Lack of knowledge among decision makers
- Strong compression of demand following the Covid-19 pandemic
- Other (specify in the comment)

Comment: _____

1.19. What regulatory aspects prevent a greater diffusion and use of drones in the B2b sector in Italy? (more than one answer possible)

- The regulatory aspects are not blocking to date
- Lack of regulation in specific areas
- Lack of regulatory stability
- Difficulty in obtaining the necessary authorizations to carry out experiments
- Need to operate beyond the limits set by current legislation
- Authorization times not suitable for providing the service
- Other (specify in the comment)

Comment: _____

1.20. Focusing on the relationship with your customers, what are the problems facing your company? (more than one answer possible)

- No problem in particular
- Poor knowledge of technology
- Little knowledge of the possible applications of the technology
- Lack of knowledge of the legislation
- Request for projects not currently regulated by legislation
- Excessive payment terms
- Difficulty in communicating the benefits of using drones
- Lack of specific solutions aimed at solving the customer's need
- Split payment regime
- Other (specify in the comment)

Comment: _____

1.21. Indicate from a scale of 1 to 7 (with 1 = completely disagree and 7 = completely agree) how much you agree with the following statements:

The commercial and industrial drone market has developed strongly over the past 12 months	c 1 c 2 c 3 c 4 c 5 c 6 c 7 c I don't know

The commercial and industrial drone market will have strong growth over the next 3 years	c 1 c 2 c 3 c 4 c 5 c 6 c 7 c I don't know
The pandemic has highlighted the potential of using drone technology for professional purposes	c 1 c 2 c 3 c 4 c 5 c 6 c 7 c I don't know
The funds available with the PNRR will be able to support the investments of companies in the sector	c 1 c 2 c 3 c 4 c 5 c 6 c 7 c I don't know
The drone sector will remain a niche market	c 1 c 2 c 3 c 4 c 5 c 6 c 7 c I don't know
Advanced Air Mobility (transport of goods and people with drones) will have a disruptive development in the next 5 years	c 1 c 2 c 3 c 4 c 5 c 6 c 7 c I don't know
The drone market will see a greater concentration of business towards larger and more structured companies	c 1 c 2 c 3 c 4 c 5 c 6 c 7 c I don't know
The drone market will see the entry of new structured players from adjacent technological sectors	c 1 c 2 c 3 c 4 c 5 c 6 c 7 c I don't know
More and more customer companies from different sectors (i.e. Utilities,	c 1 c 2 c 3 c 4 c 5 c 6 c 7

Logistics, etc.) will decide to start projects with drones using internal staff and skills	c I don't know
More and more client companies from different sectors (i.e. Utilities, Logistics, etc.) will decide to start projects aimed at introducing collaborations with external companies specialized in offering services with drones	c 1 c 2 c 3 c 4 c 5 c 6 c 7 c I don't know
The job market will change with the introduction of new professionals related to the drone sector	c 1 c 2 c 3 c 4 c 5 c 6 c 7 c I don't know

Comment: _____

1.22. Has your business made investments in the advancement of advanced air mobility (the use of drones to move people and products) or does it plan to? (Only one viable response)

- No, we don't deal with that sector. o Yes, we will deal with it within the next three years.

- Yes, we have previously considered changes to the offer in this regard.

- Yes, we have already invested in this area.

Comment: _____

Only those who responded "Yes" to question 1.22 will see question 1.23.

1.23. What kinds of advanced air mobility solutions has your organization already invested in or plans to do so? (There may be more than one response)

- Delivery of products to homes
- transporting large objects
- transporting medical supplies
- the movement of people

Comment: _____

1.24 Which technologies does your organization consider to be priorities in the medium to long term? (There may be more than one response)

- Automation
- Autonomy
- Communication and Navigation
- Integration of airspace
- Other (specify in the comment)

Comment: _____

Section 2: The impact of the EASA regulation on the Italian drone market

2.1. Indicate on a scale from 1 to 7 (with 1 = completely disagree and 7 = completely agree) how much you agree with the following statements:

The new European Drone Regulation is giving an important impetus to the commercial and industrial drone market	**c 1 c 2 c 3 c 4 c 5 c 6 c 7 c I don't know**
The new European Drones Regulation has increased the threat of foreign companies entering the Italian market	**c 1 c 2 c 3 c 4 c 5 c 6 c 7c c I don't know**
The new European Drones Regulation has brought great opportunities for Italian companies to expand their business by carrying out operations in extra-national contexts	**c 1 c 2 c 3 c 4 c 5 c 6 c 7 c I don't know**
The delay in the complete applicability of the European Drones Regulation is currently holding back various activities of companies in the sector	**c 1 c 2 c 3 c 4 c 5 c 6 c 7 c I don't know**

Comment: _____

2.2. Has your company conducted operations trials in BVLOS? (only one answer possible)

- Yes, in Italy
- Yes, abroad (specify the country in the comment)
- No, but I would be very interested
- No and I don't see its usefulness for my activities
- I don't understand what is meant by BVLOS
- Other (specify)

Comment: _____

2.3. Has your company carried out experiments with automatic flight (presence of a subject that monitors the route and who can intervene at any time) or autonomous (the aircraft operates without the remote pilot being able to intervene)? (only one possible answer apart from the two yeses which are not mutually exclusive)

- Yes, automatic flight
- Yes, autonomous flight
- No, we have not yet equipped ourselves with technologies with these characteristics
- No, I didn't know it was possible to do this
- Other (specify in the comment)

Comment: _____

2.4. On a scale from 1 (completely useless) to 7 (indispensable), the publication of all the experimental activities conducted with drones approved by regulatory bodies is useful for the development of the entire sector

c 1 c 2 c 3 c 4 c 5 c 6 c 7 c I don't know

Section 3: The innovation process of Italian companies in the drone sector

3.1. What percentage of innovation spending will your company dedicate to the drone business in 2021? _____%

Indicate a value between 0% and 100%. If you are unable to indicate the exact percentage, please provide a reasonable approximation.

Comment: _____

3.2. What are the areas in which your company is focusing its innovative efforts the most? (more than one answer possible)

- Product development on the software side
- Hardware product development
- Process efficiency and business organization
- Marketing & Sales
- Other (specify in the comment)

Comment: _____

3.3. What is the main objective of your innovation activities? (more than one answer possible)

- Respond to the current needs of the market

- Anticipate future trends
- Other (specify in the comment)

Comment: _____

3.4. In the innovation process, does your company make use of collaboration with external actors? If so, select the types of external actors involved (more than one answer possible)

No, at the moment we do not involve external actors in the corporate innovation process

- Startup
- Other companies in the sector
- ICT Vendor and Sourcer
- Universities and Research Centers
- Consulting company
- Institutions and Public Administration
- Trade associations
- Other (specify in the comment)

Comment: _____

The next question (3.5) appears only for those who answered "Yes" in question (3.4)

3.5. How does your company engage / involve previous external actors to develop innovations? (more than one answer possible)

- Hackathon, Datathon, Appathon

- Call4Ideas, Call4startup, Contest
- Crowdsourcing
- Corporate Venture Capital
- Incubator and Accelerator
- Merger & Acquisition
- Scouting partner
- Startup Intelligence
- Collaboration with Universities and Research Centers
- Licensing
- Joint-Venture
- Other (specify in the comment)

Comment: _____

The next question (3.6) appears only for those who answered "Yes" in the question (3.4)

3.6. Does your company have active collaborations / partnerships with foreign players to develop innovation? (more than one answer possible)

- Yes, with European actors
- Yes, with non-European actors
- No, we don't have any active, but we plan to launch them within the next 3 years
- No, we do not have any active and we are not interested in activating them outside national borders

Comment: _____

Section 4: Knowledge and use of 5G technology

4.0. "Would you be able to answer 3 questions on the knowledge and use of 5G?" (only one answer possible)

- Yes
- No

For those who answered “Yes” in the previous question (4.0) the following 3 questions are activated (see screenshot).

For those who answered “No”, go to the final conclusion page of the survey.

5.List of Figures

6.List of Tables