POLITECNICO
MILANO 1863

SCUOLA DI INGEGNERIA INDUSTRIALE
E DELL'INFORMAZIONE

Executive Summary of the Thesis

Drone Start-Up Ecosystem and Its State of the Art Technology from 2017-2022

Laurea Magistrale in Management Engineering - Ingegneria Gestionale

Author: Balaji Venkatesh Babu

Advisor: Prof. Vincenzo Butticè

Co-advisor: Ing. Paola Olivare And ,Ing. Sveva Gallo

Academic year: 2021-2022

1. Introduction

Drones are also known as UAVs (Unmanned Aerial Vehicles) or RPAS (Remotely Piloted Aerial Systems), depending on where these technologies are used. One of the primary reasons for the widespread use of drones is their ability to traverse and maneuver through areas that would be dangerous for humans to be in. These drones were initially used for photography, military reconnaissance. In recent years, technological advancement and innovation have brought the drone to commercial applications, where significant new drones, startups, and a new industrial revolution have witnessed enormous possibilities of drone in applications that no one had ever imagined, such as agriculture, disaster management, industrial inspection, logistics and delivery, healthcare, environmental protection, and military applications, to name a few. Drone types and varieties are now being significantly redesigned and produced to be suitable for a wide range of applications, including multicopters, fixed wings, hybrid drones (multi copter + fixed wings = VTOL Drones), and single rotor drones. - The size, autonomy, payload capacities, and cutting-edge value-added features, These unique flying vehicles are capable of fragmenting hardware, sensors, or other specialized outputs in the least amount of time while maintaining data accuracy.

Drones are now an accessible resource for learning and development in a variety of space applications, ranging from a science, technology, engineering, and mathematics (STEM) Drone in a safe environment to a drone that can hover into Martian lands (like Ingenuity). In this thesis, we emphasize the overview of embryonic drone start-ups founded after January 1, 2017, their active participation in the industry, trace the number of startups evolving through these time horizons and its state-of-the-art technology in the fast-growing drone industry internationally, and how this pushes new investments and creates a leveraged drone start-up ecosystem and generate value for consumers, stakeholders, and users.

The first chapter here deals with a literature review on these drone start-ups, technology state-of-the-art among comparable drone service or product more focused on nascent drone start-up with new innovative state-of-the-art technology that functions as a catalyst to attract new investment opportunity and its competencies with these stronger drone ecosystem. The strategy

and key aims of this thesis are discussed in the second chapter. The third chapter deals with real data collection from the crunch base on these born startups that are reasonably close to drones and comparable technology, and their statistical findings with comparisons are made in the fourth chapter, followed by a discussion of the results and conclusion in the subsequent chapters that follow at the end of the thesis with a closing addition to academic literature and future forecasts.

2. Literature Review

The literature on drone startups, especially those created after 2017 and whose main technology makes them a significant competitor in the drone sector. These drone startups have been dispersed across different service or product categories, and at one point they all fell under a single drone ecosystem, which has a significant support and peer community, which gives them a significant advantage over this ecosystem and also makes them more investment attractive and competitive advantage. Despite the large number of startups founded in 2017, there has been a significant drop in the number number of new drone-related startups founded in the consecutive years, and so as to understand them with the current literature review of these number of new founded startups and its possible reasons for decline over a period of years are addressed with and following the ecosystem of startups with influence of investments with their technologies. The first section of this study focuses on drone start-ups and their state-of-the-art technology, which helps these firms to leverage swiftly in terms of financial development and market expansion, advancements with political adhering drones, and so on. Based on study by (Finnegan,P.2017) the drone industry is experiencing constant upheavals, and governing bodies like the European Aviation Safety Agency (EASA) and Federal Aviation Administration(FAA) are enacting several rules and regulations to maintain control over the drone laws and the safety of the airspace as they anticipate that the drone ecosystem will add 3 million or more users, ranging from hobbyist or recreational pilots to registered or certified drone operators / pilots.Our consideration in this research tries to explain about the drone start-up ecosystem and its state-of-the-art technology, which were established after January 2017 until 2022, to narrow down our study and how they make unique solutions to survive the nascent drone market, which is growing exponentially and becoming competitive in terms of technology state-of-the-art, and how vast this sector is growing to take the automation of drones in various sectors such Logistics ,Healthcare,Military, Industrial/ Commercial, Agricultural and many others.Acording to (Hernández et al.,2016) Second to the literature that supports startups, there is an ecosystem that supports them, Formed mainly by the community of entrepreneurs, mentors, incubators, accelerators, common service providers, long-term investors, investors in risk capital, universities and public support entities, as well as links to other ecosystems. Ecosystem is a concept that recognizes, According to (Sarafin,G.A.2020) in any closed system, the members of that system must work with and around each other to keep the system stable, ideally optimizing the collective benefit. We see plenty of evidence in the natural world of how a balanced ecosystem benefits all participants - and how destructive imbalance in an ecosystem can be.

3. Objectives and methodology

Despite the abundance of academic literature on new drones and, there is a scarcity of publications delving further into these subjects on one of the most promising developing technologies: State of the art drone technology and its drone ecosystem. Here as result of the considerations gleaned from the literature review, this thesis seeks to investigate the intriguing existence of a drone startups ecosystem, also known as a consortium, which has some added competitive advantages, and how appealing this brings product or service based on drones around these networked groups. As a result, by addressing two major research issues, this study hopes to contribute to the academic literature on the drone business and provide the groundwork for future research. RQ 1) How many new drone startups are currently operating in the drone industry at an international level specifically born after 1.1.2017 and which are their market specialization? RQ 2) What are these drone ecosystems and its categories of operations? How these

state-of-the-art drone technology industry benefits from the market and investment opportunities?

In response to the first research inquiry, A census of startups operating in the global drone industry is performed, which allows to map drone startups all over the world; data are cleaned through the databases Crunchbase, in order to integrate sources in the best possible way and to guarantee the completeness of results.The analysis is based on eight different explaining characteristics: age, geographical location of the headquarters, the number and the typology of investors engaged, the number of founders, the type of the startup's offering, the availability of any supplementary service, and the client sector. The Total fundings amount collected by each startup is set as dependent variable. Analysis of the industry's characteristics. A subset of the startups collected is then studied more in depth to better understand the characteristics of the global drone startups' industry. Specific information about these startups is organized in a database, including for example their age and geographical location, Industries, Founders, funding received, investors,Target Market,Activity typology,type of drones and contacts-Website,facebook, linkedin,twitter etc. Quantitative analysis with econometric model development. After having understood the characteristics of the industry of reference, the research proceeds according to the development of a quantitative econometric model. The econometric model aims at understanding which possible business advantages which these newest drone startups adopt, and if and how certain technology or characteristics of the company have an influence on this decision of investment and economic leverage.

Finally, a qualitative investigation is run by means of research or interviews to the founders of a restricted sample of interesting startups. The interviews are aimed at understanding the state-of-the-art technology of each drone startup, its unique value proposition and main innovation elements, its strategic partnerships and possible ecosystem of future drone industries development.

4. Analysis and discussion of results

The statistics results of a study of the 266 startups collected through the methodology outlined in the previous chapter, and they offer an overview of the features of the world drone startup industry.the bulk of companies evaluated were founded between 2017 and 2022, with newborns decreasing steadily in recent years.

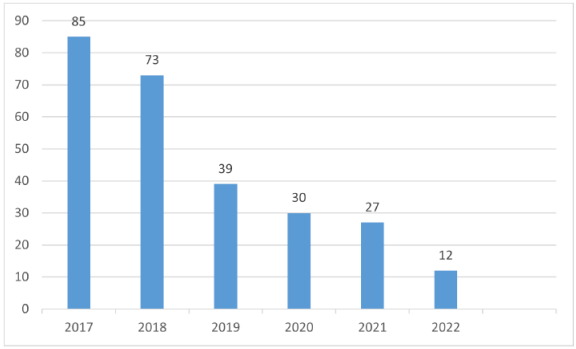


Figure 1: Distribution of drone startup founded since 2017-2022.

The great majority of drone companies created between 2017 and 2022 have their headquarters in, the United States, and Canada together referred to as North America, with 102 startups contributing approximately 38% of the total 266 startups evaluated for research. However, the European Union, which ranks second with 84 firms in the drone sector (31%), also plays an important role in the growth of the global drone industry. Aside from that, Asia has a prominent presence of 57 startups, with 21% of them being global startups. Oceania, Africa, South Central Asia, and Middle Western Asia have a little role, with 23 drone startups operating in these four areas accounting for 8% of all startups included for analysis. The startup failure rate in the drone industry has been analysed using crunchbase data by adding the filters Active and Closed Organizations, and keywords linked with startups: Drone, Drones, UAV, Unmanned aerial vehicle from 2017 to 2022. Where we can learn that in 2017, there were 928 active drone companies whereas 45 startups were closed down. With reference to 2017 statistics, there had been a significant reduction in active new companies in the following year 2018, with a 68% reduction and a 42% fall in subsequent

closed startups. 2019 had 378 active and 6 closed startups, 2020 had 211 active and 3 closed startups, 2021 had 88 active and just 1 closed company, and 2022 had 21 active and none closed startups. The graph shows that the number of new active entrants has decreased over time, resulting in a lower rate of startup departure from the market.

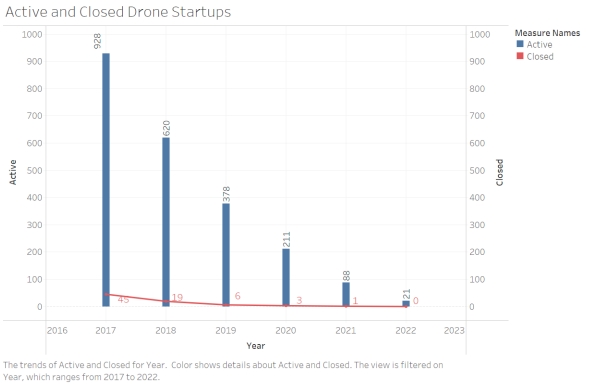


Figure 2: Active and closed startups 2017-2022.

This demonstrates that the sector and its environment are becoming more efficient and competitive, causing little harm to other peer players in the startup drone ecosystem. Looking at the financials of the startups based on their headquarters, the bulk of the fundings (almost $1.9 billion) are with the startups (68 out of 266) situated in the United States, followed by $896 million with Germany as headquarters and $219 million with Japan. These companies rank second and third in the list of top fundings with just 6 startups in both countries. Total funding for the drone startup from the 266 listed out from the crunch base from the year of startups from 2017 was the record highest in total funding of 760 Million with an average of 11 Million per startup overall out of 266 startup, where we can see decline in the overall total funding in 2018 as 315 Million with an average of 5 Million, and it gradually decreasing in the eventual years 2019 to 2022.

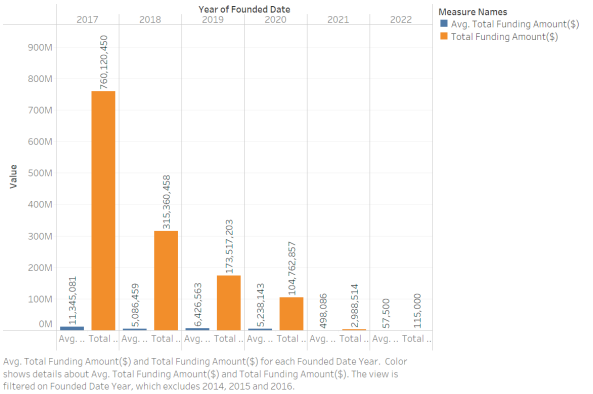


Figure 3: Funding based on sample startup from 2017-2022.

Other econometric analysis were carried out for startup distribution with target market (b2b,b2c,b2b2c,or b2g) where in this case of sample startup found to be having 63% B2B market, where as 80% of them are specialised typology of drone player and rest of them as generalised. Product and service typology analysis,followed by the details of the product typology with hardware, software and mixed model methodology in understanding these startups different category and How these companies are ideally benefiting greatly from the drone ecosystem or are known to be consortium's. The qualitative component of the mixed-method analysis is comprised of interviews with five international startups; these companies were chosen because they represent some of the most innovative realities in the drone startup industry, and they were interviewed with the goal of integrating and a survey to cross-validate results in previous analyses.

5. Conclusions and future developments

Thanks to a quantitative approach, this thesis answered the three research questions and contributed to the scientific literature about the drone industry in multiple ways. First, setting the base with an exhaustive census of the worldwide drone industry and providing active status insights from 2017. Secondly, providing statistical evidence of the factors that more than others can probably impact the decline of new drone startups , reason for geographical startup difference,offer typology od the startup across ecosystem and total fundings amount col-

lected by a drone startup, and thirdly by investigating qualitative analysis with the interview made possible with 5 different startups in drone specific industry and their connection with the drone ecosysytem and their technology advantages. Although the huge effort put into building the most comprehensive possible census, it is not excludable that some organizations are missing, mainly because of two main reasons. Firstly, due to the delay between the fast-changing nature of the drone industry and the periodical sources update. Secondly, Economical and political influences like inflation rise and war scenarios. In the beginning of 2017, the western had more investment possibilities, which was the major reason for these firms to be established, and restrictions for new tech startups were greatly simplified, which was another cause for a larger growth in their drone industry.A drone startup with a unique product and disruptive technology that has been protected and reserves a patent on the name of the founder or within the organization has the greatest number of investment opportunities, which may benefit both the investor as well as the organisation, as they would already have a clear vision with the drone product and their target customers in the market. Investors are more interested in tangible products, and then in companies that operate a dual method of product and service, which has much more benefits and is scalable in the future, and most founders believe this is the best and safe strategy to rely on, as technology innovation and the threat of obsolescence are most probable to occur if they take a long time to come to market. Extensive research on startup drones and its ecosystem was profoundly a hug branch of network associated with the drone industry ecosystem, which would be a greater view of perspective as these analyses cannot fit for our objective of time frame 2017 to 2022, as some of the external resources analysis provide all the industry which serve directly or indirectly in many forms and creating a massive ecosystem as such.There is room for further research development after the limited timeframe to investigate the whole drone industry. The first would be the drone ecosystem, where there may be one or more instances where many startups could benefit from each other's specialized technology, which today's tech startups have been making a business strategy for growth within ecosystem, which also favourably impact the financial stability of the drone startups. Secondly, this thesis may be utilized as a foundation for future comparative study on other developing technology ecosystems to get a comprehensive picture of the ecosystem startups' technical, financial, cost advantages, and ease of market penetration. At the end of the day, most Drone Startup founders consider it a great opportunity for a win-win situation to have a global corporate network and attract potential customer. Finally, research on innovative and disruptive technology within drone sectors or even other associated industries will be a never-ending chance for prospective learning and may be a complete deal for UAV and Drones companies in today's rapidly expanding industry.

6. Bibliography

Finnegan, P. (2017). World Civil Unmanned Aerial Systems: Teal Market Profile and Forecast. TEAL CROUP: Fairfax, VA, USA.

Hernández, C., & González, D. (2016). Study of the start-up ecosystem in Lima, Peru: Collective case study. Latin American Business Review, 17(2), 115-137.

Sarafin, G. A. (2020). Creating Value in Multi-Actor Environments: Understanding the value propositions of digital service ecosystems.

POLITECNICO
MILANO 1863

SCUOLA DI INGEGNERIA INDUSTRIALE
E DELL'INFORMAZIONE

Drone Start-Up Ecosystem and Its State of the Art Technology from 2017-2022

Tesi di Laurea Magistrale in
Management Engineering - Ingegneria Gestionale

Author: **Balaji Venkatesh Babu**

Student ID: 967258
Advisor: Prof. Vincenzo Butticè
Co-advisors: Ing. Paola Olivares & Ing.Sveva Gallo
Academic Year: 2021-22

Abstract

This thesis, created in partnership with Politecnico di Milano's Drones and Advanced Air Mobility Observatory, serves two objectives. The first is a map of the actual global drone startup sector, which was formed in the last 5 years. The second is an exploration of the drone ecosystem, and how these drone startups attract investment prospects with their state-of-the-art technology, as well as other important factors for the global drone sector's progress. To achieve the first objective, a database listing the worldwide startups launched in the recent five years (2017 onwards) that are active and possibly engaged in the drone industry information extracted from the Crunchbase database. So, the first phase of the census yields 523 startups; and the second approach with a more in-depth filter and keyword combination yields 667 companies, which are then shortlisted as relevant for the subsequent study. As a result, a detailed analysis is conducted to describe the essential elements of this emerging industry, with a total sample of 266 chosen drone startups for research accounting for a total of $1.356 B in fundings over the previous 5 years. The second goal of this thesis was then achieved by using two distinct econometric models. The first statistical analysis discovered that the drone startups with the highest number of new active founded startups in various geographical regions over the years, their funding strategy with different product and service categories of drone operations, typology of offer provided, typology of drone technology, and ecosystem benefits. The same is true for companies that, due to their disruptive technological capability and innovativeness, may attract Funds and many other investors. The second model focused on the startups' interviews based on the founders' individual opinions and the organizations' point of view on questions and surveys looking into the current drone startups scenario and ecosystem experience, their possible target market choice, practical application sectors, and the UAVs industry's future with growing competition and technological disruptions in the era of autonomous vehicles. The second study demonstrated how various investor typologies view distinct startup characteristics such as headquarters location, product and service application field, customer sector, startup age, and type of innovative drones.

Keywords: Drone,UAV, Drone Ecosystem, State-of-the-art Technology,

Abstract in lingua italiana

Questa tesi, realizzata in collaborazione con Drones and Advanced Air del Politecnico di Milano Osservatorio sulla mobilità, ha due obiettivi. La prima è una mappa dell'attuale drone globale settore startup, che si è formato negli ultimi 5 anni. Il secondo è un'esplorazione del ecosistema di droni e come queste startup di droni attraggono prospettive di investimento con il loro tecnologia all'avanguardia, così come altri fattori importanti per il settore globale dei droni progresso. Per raggiungere il primo obiettivo, un database che elenca le startup lanciate nel mondo negli ultimi cinque anni (dal 2017 in poi) che sono attivi e possibilmente impegnati nel drone informazioni di settore estratte dal database Crunchbase. Quindi, la prima fase del il censimento rende 523 startup; e il secondo approccio con un filtro più approfondito e key- combinazione di parole produce 667 società, che vengono quindi selezionate come rilevanti per il studio successivo. Di conseguenza, viene condotta un'analisi dettagliata per descrivere l'essenziale elementi di questo settore emergente, con un campione totale di 266 startup di droni scelte per ricerca per un totale di $ 1,356 miliardi di finanziamenti negli ultimi 5 anni. Il Il secondo obiettivo di questa tesi è stato quindi raggiunto utilizzando due distinti modelli econometrici.La prima analisi statistica ha scoperto che le startup di droni con il maggior numero di nuove startup attive fondate in diverse aree geografiche nel corso degli anni, il loro finanziamento strategia con diverse categorie di prodotti e servizi di operazioni con droni, tipologia di offerta fornita, tipologia della tecnologia dei droni e benefici ecosistemici. Lo stesso è vero per le aziende che, per la loro capacità tecnologica dirompente e innovazione,può attrarre fondi e molti altri investitori. Il secondo modello si è concentrato sulle startup interviste basate sulle opinioni individuali dei fondatori e sul punto di vista delle organizzazioni su domande e sondaggi che esaminano l'attuale scenario e l'ecosistema delle startup di droni-tem, la loro possibile scelta del mercato target, i settori di applicazione pratica e il Il futuro del settore degli UAV con la crescente concorrenza e le interruzioni tecnologiche nell'era di veicoli autonomi. Il secondo studio ha dimostrato come diverse tipologie di investitori visualizzare le caratteristiche distintive di avvio come l'ubicazione della sede centrale, il prodotto e il servizio campo di applicazione, settore di utenza, età di avvio e tipologia di droni innovativi. **Parole chiave:** drone, UAV, ecosistema di droni, tecnologia all'avanguardia

Contents

Introduction

Drones - UAV (Unmanned Aerial Vehicle) are no longer a novel gadget, as they have become an essential element of the numerous applications used in cross-functional sectors. Where it is now a significant item or tool that has shown its capabilities internationally. Different variants and varieties of drones are currently drastically reinvented and manufactured to be suited in numerous domains of applications ranging from basic forms of drones such as multi-copters, fixed wings, hybrid drones (multi copter + fixed wings = VTOL Drones), and single rotor drones. - The size, autonomy, payload capabilities, and state-of-the-art extra value-adding features,Hardware, sensors, or other specialized outputs that conventional methods can fragment in the shortest possible time and accuracy of data are reached at the end with these innovative flying vehicles.

We may now see drones ranging from a child learning to fly as a Toy or STEM Drone in a safe setting to a drone that can hover into Martian lands (like Ingenuity) across numerous space applications. In this Thesis, we emphasize the overview of the embryonic drone start-ups that were founded after 01 Jan 2017 starting and its state-of-the-art technology in the fast-growing drone industry internationally, and how this pushes new investments and creates a leveraged drone start-up ecosystem and generate value for consumers,Stakeholders and users.

The first chapter here deals with a literature study on these drone start-ups, tech state-of-the-art among comparable drone service or product more focused on nascent drone start-up with new innovative state of the art technology which functions as a catalyst to attract new investment opportunity and its competencies with these stronger drone ecosystem. The second chapter discusses the approach and primary goals of this thesis. The third chapter deals with real data gathering from the crunch base on these born start-ups that are reasonably near to drones and comparable technology, and their statistical findings with comparisons are made in the fourth chapter, followed by a discussion of the results and conclusion in the subsequent chapters following at the end of the thesis with a closing addition to academic literature and future forecasts.

1 | Literature review

The first section of this study focuses on drone start-ups and their state-of-the-art technology, which helps these firms to leverage swiftly in terms of financial development and market expansion, advancements with political adhering drones, and so on. Our consideration in this research tries to explain about the drone start-up ecosystem and its state-of-the-art technology, which were established after January 2017 until 2022, to narrow down our study and how they make unique solutions to survive the nascent drone market, which is growing exponentially and becoming competitive in terms of technology state-of-the-art, and how vast this sector is growing to take the automation of drones in various sectors such Logistics ,Healthcare,Military, Industrial/ Commercial, Agricultural and many others.

This chapter is split into two major parts:
1. The first methodology shows collection of relevant scientific papers and articles which relates to the title and procedures which were followed to collect the papers, sort them, skimming and selecting which would be closely related to the drones and startups based on the drones with state-of-the-art technology in the same field of drones and unmanned aerial vehicles.
2. The second part summarizes the chosen papers' contents, the major patterns and discoveries that can be extracted from current state-of-the-art drone companies, kinds of innovation, with an emphasis on the drone ecosystem and industry, and their intersection point. A contextualization effort was performed to restrict the present literature on this emerging economic sector due to a shortage of publications on the Unmanned Aerial Vehicle industry.

1.1. Methodology of the literature review

The literature on young drone start-ups, notably those founded after 2017. The major reason for starting from the horizon year 2017 is that it set the record for the most startups formed in one year in history of drone based startups. As a result, Following the systematic approach of finding, categorising, and analysing all the relevant themes which relates to our objective to find the state-of-the-art drone start-ups and their technology which demands more critical task to find through as there are many technical in-depth details. Scopus[1] was the primary and mostly found platform to our necessary database which helped to perform the literature review, with the access provided by Politecnico di Milano. A series of six queries have been created, considering the combination of the keywords below:

- ("Drone*" OR "piloted aircraft system*" OR "UAV*" OR "unmanned aerial vehicle*" OR "unmanned" OR "aircraft*" OR "VTOL" OR "vertical take-off and landing" OR "unmanned aerial*" OR "Drone Startup*")
- ("start-up*" OR entrepreneur)
- ("State of the art*" OR "unmanned" OR "aircraft*" OR "VTOL" OR "vertical take-off and landing" OR "unmanned aerial*" OR "Drone Startup*")
- ("State of the art drone *")
- ("Drone technology*" OR "MULTIROTOR*" OR "BVLOS*" OR "Fixed wing drone*")

The "*" character added to the end of certain keywords is required to take into account derivative phrases. For example, searching Scopus for "Drone*" rather than "Drones" allows the researcher to include in the study all possible terms that have the same initial spelling but differ in the last word's part, such as "Drone Technology," "Drone Logistics," or "Drone Ecosystem."
The constraints considered when selecting papers are related to the typology of the document because, for the current thesis, the perimeter is primarily bound to articles and reviews produced by journals. Furthermore, the subjects that limit Scopus's literature research are "Business," "Economics," and "Social." There is also a time constraint that only considers documents published in the years, i.e. from 2017 to 2022. Furthermore, when considering the publication stage, it was decided to only evaluate final documents or articles in press (AIP). Finally, the language filter was used throughout the study on the papers' database to only consider articles authored in English. The total number of papers produced by all queries is 938. Following the formulation of the query, the

[1] https://www.scopus.com/

Year ↓	Documents ↑
2017	108
2018	119
2019	161
2022	171
2021	189
2020	190

Figure 1.1: Papers Collected over years

938 document results

TITLE-ABS-KEY ("state of the art drone *" OR "drone technology*" OR "drone*" OR "start-up*" OR "uav*" OR "multirotor*" OR "bvlos*" OR "fixed wing drone*") AND (LIMIT-TO (PUBSTAGE , "final") OR LIMIT-TO (PUBSTAGE , "aip")) AND (LIMIT-TO (OA , "all")) AND (LIMIT-TO (PUBYEAR , 2022) OR LIMIT-TO (PUBYEAR , 2021) OR LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017)) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (SUBJAREA , "BUSI")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (SRCTYPE , "j"))

Edit Save Set alert

Figure 1.2: Paper found after keyword search

identified studies' list is downloaded, exported, and grouped in an Excel sheet with all relevant information (Author, Document title, Year, Source title, Volume, issue, pages, source & documentation type, Abstract, Author keywords).
Following a one-by-one examination of the content of each paper, beginning with the abstract, the articles are chosen. Documents that pass the second screening phase are downloaded and read in their entirety using Scopus or Google Scholar. After multiple rounds of selection with a panel of experts from Politecnico di Milano's Drones and Advanced Air Mobility Observatory[1], a final collection of 65 paper is chosen. Many different sources are examined, including: Technological Forecasting and Social Change, Production Planning and Control, Internet of Things (Netherlands), IEEE Communications Standards Magazine, International Transactions in Operational Research, Technology in

[1]https://www.osservatori.net/en/research/active-observatories/droni-e-mobilita-aerea-avanzata

Society, Ecological Economics, Journal of Sustainable Tourism, Technology in Society, Journal of Open Innovation: Technology, Market, and Complexity, Journal of Open Innovation: Technology, Market, and Complexity, and Journal of Open Innovation: Technology, Market, and Complexity. Science and Engineering Ethics, Organization Science, Global Policy, International Journal of Physical Distribution and Logistics Management, Journal of Air Transport Management, International Transactions in Operational Research, Journal of Industrial and Management Optimization, Journal of Contingencies and Crisis Management, Technology in Society, Globalizations, Operations Management Drones, Biosystems Engineering, Computers and Electrical Engineering IEEE Access, IEEE Communications Surveys and Tutorials, IEEE Sensors Journal, IEEE Transactions on Broadcasting, IEEE Transactions on Control Systems Technology, IEEE Transactions on Industrial Informatics, IEEE Transactions on Instrumentation and Measurement, IEEE Transactions on Wireless Communications, IEEE Transactions on Instrumentation and Measurement, IEEE Transactions on Vehicular Technology, IEEE Wireless Communications, IEEE Transactions on Transportation Electrification, IEEE Transactions on Transportation Electrification, IEEE Transactions on Transportation Electrification, IEEE.

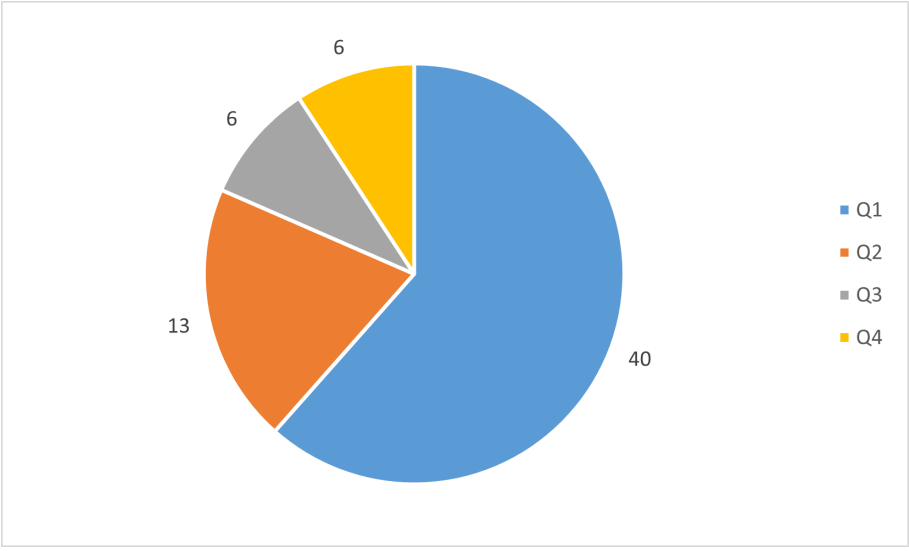


Figure 1.3: Scimago classification of papers in the literature review

The overall quality of the sources evaluated is high, according to the Scimago Journal & Country Rank. This portal classifies journals and other sources of scientific information into four categories: Q1, Q2, Q3, Q4. Q1 is assigned to the most trustworthy sources, while Q4 is assigned to the least trustworthy. The overall quality of the papers considered is excellent, as 40 percent of the articles reviewed are classified as Q1.

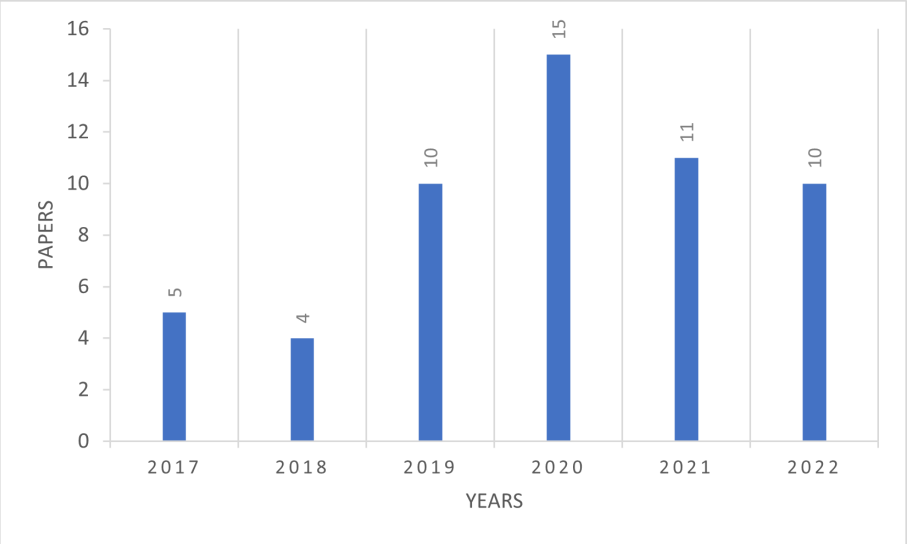


Figure 1.4: Papers collocation over time.

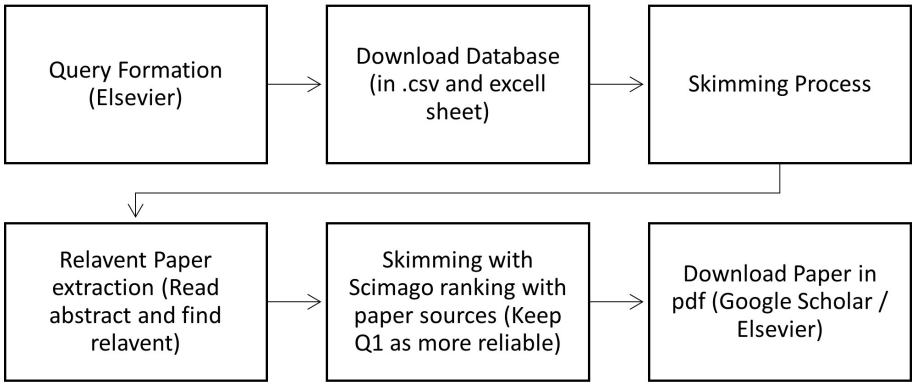


Figure 1.5: Literature review Process flow

1.2. Content of the literature review

This chapter aims to set the base of the further analysis, considering the present literature's content on the research topics to identify the knowledge gaps addressed in the following characters of this thesis. The current literature on drone start-ups and their corresponding ecosystems across the globe and fundings collection is quite wide but also very fragmented. Acording to (Hernández et al.,2016) Second to the literature that supports startups, there is an ecosystem that supports them, Formed mainly by the community of entrepreneurs, mentors, incubators, accelerators, common service providers, long-term investors, investors in risk capital, universities and public support entities, as well as links to other ecosystems.A drone ecosystem is a notion that refers to the expansion and innovation in the UAV or aviation business as a whole, connecting start-ups, research organizations, universities, consortiums, entrepreneurs, and hobbyist communities on a worldwide scale.Based on study by (Finnegan,P.2017) the drone industry is experiencing constant upheavals, and governing bodies like the EASA[2] and FAA[3] are enacting several rules and regulations to maintain control over the drone laws and the safety of the airspace as they anticipate that the drone ecosystem will add 3 million or more users, ranging from hobbyist or recreational pilots to registered or certified drone operators / pilots. The Major Ecosystem for Drones is extensive and linked, or interdependent with many stakeholders across industry, to take use of the potential best use case advantage to benefit human innovation and need for low latency of communications, to Emergency medications, Ecommerce Delivery, Military Surveillance, and so on. This ecosystem has had some significant growth in recent years with Human Urban transportation, Military Surveillance ,eVTOLS[4], Drone Food Delivery, Air Taxis with a cheaper costs, and other developments.

1.2.1. Startup definitions

In general, a startup is an entity or new firm that strives to develop a unique product or service that offers value to the end - user level. Based on the concept introduced in the first ESM[5] (Kollmann,T. et al,2015), startups are defined by three characteristics: 1. Startups are younger than 10 years 2. Startups feature (highly) innovative technologies and/or business models 3. Startups have (strive for) signifcant employee and/or sales growth.

[2]EASA:European Union Aviation Safety Agency Official link https://www.easa.europa.eu/en
[3]FAA:Federal Aviation Administration Official Link https://www.easa.europa.eu/en
[4]Electric Vertical Take off and Landing (eVTOL) Aircraft
[5]European Startup Monitor http://startupmonitor.eu/

The startup's fuel is its disruptive and inventive minded individuals who work together to make it feasible by steering towards their ultimate shared purpose and objective. Once they are ready for the market, they will be ready for their competitors and (Minimum Viable Product)MVP that stands out and disrupts the market, which may be with the quality, price, technology, or anything else that the startup's purpose can have with their distinct value proposition.

A startup is a self-contained organization that is less than five years old that aims to create, improve, and extend a scalable, innovative, technology-enabled product with high and quick growth.[6] This definition is divided into the following parts:

1. Age, self-sufficiency, and scalability

• Age: A startup is less than five years old and grows into a small to medium-sized business before becoming a company.

• Self-sufficient: Startups are enterprises that are founded and, at one time, owned and controlled by the founders.

• Scalable: A scalable product or service has a low cost of expansion in comparison to the potential income gain.

2. Organization and Invention

• Organization: Depending on the conditions, a company might be a legal organization or not at an early stage.

• Innovative: Startups take use of possibilities such as new technology to discover innovative and often more efficient solutions to issues and to develop new products that better meet the demands of both people and corporations.

3. Technology-driven and with high growth potential

• Tech-based: The majority of startups are based on information technology, such as software and/or hardware.

• High growth potential: In order to expand, companies must be able to operate in a high-growing market. This market must be large enough and/or expanding quickly enough to sustain demand for a startup's product.

[6]Citation website: https://europeanstartupnetwork.eu/

1.2.2. Ecosystem defined

Ecosystem is a concept that recognizes, According to (Sarafin,G.A.2020) in any closed system, the members of that system must work with and around each other to keep the system stable, ideally optimizing the collective benefit. We see plenty of evidence in the natural world of how a balanced ecosystem benefits all participants - and how destructive imbalance in an ecosystem can be.

1.2.3. Major category of drone ecosystem

There are various possible business cases for drones in operations in terms of their compatibility with economic and strategic concerns. Drones, for example, may eliminate labor- and risk-intensive routine labour at heights (e.g., counting inventory stored high up in warehouse racks) or in occupational hazards when combined with other technology such as cameras, sensors, and barcode scanners (e.g., an inspection of structures of great height). However, present drone capabilities, such as limited payload, degree of automation, and flying lengths, restrict the business applications. The economic case for drones, particularly for interior applications, remains uncertain when compared to typical investment choices such as forklifts, mounted cameras, and material handling systems. (Maghazei,O. et al.,2022)

Some of the recent technology applications with drones are

1. Military 2. Humanitarian and Logistics 3. Inspection 4. Agriculture 5. Internet Carrier and Communications

Military Drones

Military drones are used for surveillance, intelligence, remote situation awareness reconnaissance, aerial photography, and target tracking. Combat drones can also monitor targets and neutralize air threats. The major reason for the development of drones was originally intended for military purposes. Drones that lessen the risk of pilot or military personnel being killed while in the air.(Armour,C. et al,2017)

Humanitarian Drone

Drones may help humanitarian groups avoid blocked highways and debris obstructing road infrastructure, respond more swiftly, alter rescue operations, and trigger reaction systems (Rejeb,A. et al,2021). Drones have several benefits in this area, including timeliness, flexibility, ease, independence from the external environment, and the capacity to work

continuously. The use of unmanned aerial vehicles for humanitarian aid and surveillance is a fast expanding scientific field. This opened up a whole new platform sector by utilizing drones as the primary source of operational UAV capable of performing urban and long BVLOS missions in disaster recovery zones, as well as assisting in the in-field actual data acquisition and logistical missions by drones in humanitarian missions.

Inspection Drones

Drone inspections are being carried out in almost every sector that needs visual inspections as part of its maintenance operations. Drone inspections save inspectors from putting themselves in risky circumstances by collecting visual data on the status of an asset.(Chehri,A. et al,2021) Inspection drones are revolutionizing manual inspection operations, enabling inspectors to acquire inspection data faster while eliminating slower manual stages that put them in risk.

Manually examining a cell tower, for example, may need climbing many floors in the air on a tower to get a close look at a guy-wire. In addition, physically checking an industrial boiler may need going fifty feet or more into the air on scaffolding. However, inspection drones are altering efforts of inspection service provider,as they may fly an inspection ready drone up the cell tower, over the hot chamber boiler ,Chimneys and other high elevations by recording all of the visual data required by the inspector to conduct their assessment.

Agriculture Drones

Drones have several agricultural applications, and they are one of the technologies driving precision agriculture. Precision agriculture is the science of using technology to improve efficiency, productivity, crop output, and profitability. Analysts predict that agricultural drones will be worth $5 billion by the end of 2025(Mammarella,M. et al,2021). Drones are an effective tool for farmers and agronomists in assessing crop health. They can obtain a better perspective of their fields and gather data more quicker and more effectively using drones than with previous techniques. Farmers will be able to use drones to monitor how healthy their plants are, where they may need water or nutrients, and if there is any insect activity before it becomes out of hand. Drones help farmers save money by allowing them to swiftly discover issues that might otherwise go unnoticed. The improper technique might result in hundreds or even thousands of dollars in crop losses owing to problems that were not detected early enough on the ground

Internet Of Things Drones and Communication

Drones may be utilized as flying base stations in wireless networks to offer dependable and cost-effective wireless connection. (Amponis et al,2022) Drones, with their flexibility, agility, and mobility, can provide ground users with dependable, cost-effective, and high-data-rate wireless communications. There is a specific need to augment the limited capacity and coverage capabilities of current cellular networking infrastructure during important public events such as Olympic games, which create a significant demand for communication. Drone-based wireless communication is a perfect alternative in such cases. AT&T and Verizon, for example, want to utilize flying drones to improve Internet service for the college football national championship and the Super Bowl. Drones may also help provide wireless communication in other critical circumstances such as public safety and Internet of Things (IoT).

Drone Startup Scenario before and after Pandemic Scenarios

The epidemic does not seem to have had a big financial impact on the drone business. It may have even aided it, since industry officials approached 2020 worried about the consumer, fly-a-drone-for-fun market's stagnant growth. That may not be the case any more. According to NPD[7] market analysts in a January 2021 study(Greenwood, F,2021), sales of consumer drones—most likely to locked-down individuals looking for socially-distanced activities—"soared" during the pandemic, with sales more than tripling from March to November of 2020 compared to 2019. According to an April 2021 study on the drone hardware market, sales of agricultural spraying drones increased by 135%, with Asia accounting for the majority of the gain. DroneDeploy, a major drone mapping software startup, informed Fast Company that its sales increased 130% in April 2020 compared to April 2019. A number of drone delivery firms, such as Zipline, seem to have profited handsomely from the surge of interest in their services. According to NPD experts, the worldwide drone industry will be worth $6.15 billion by 2023, up from $2.80 billion in 2017. COVID-19, on the other hand, has hindered the drone industry's attempts to have the technology it sells viewed as "normal" and unstigmatized by affiliation with authoritarian authority. Camera-equipped drones have proved to be an important tool for civilian interests ranging from ecological study to transit planning, disaster response, winemaking, and more during the past decade, yet many people still dislike drones and those who utilize them. While the technology has received a lot of positive press for somewhat overblown efforts to "help" fight the pandemic by delivering medical supplies and spraying down stadium seats, those reports have been overshadowed in many places

[7] American market research company https://www.npd.com/

by darker images of drones being used to enforce lockdowns and intimidate protesters as the pandemic has progressed.(Maximilian Kunovjanek et al,2021) While tiny drones are not intrinsically more militaristic than an iPhone, a basic digital camera, or an SUV (all of which are routinely employed by police), that is not how the general public perceives them. Rather than making drones seem friendly, the government's adoption of drone technology for public control during the COVID-era may, sadly, have contributed to drones' image as an oppressive instrument. It would be unfortunate if the epidemic made it even more difficult to achieve drones' promise as a tool for benign causes.

2 | Objectives and Methodology

The following chapter presents the paper's main objectives and research questions. It also describes in detail the approach followed for the analysis, which is made of:

- A census of startups in the national international ecosystem of drone industry and deep analysis on recent born drone startups after 1st January 2017.
- An econometric model to finally discover the primary elements influencing the entire investment amount gathered by a startup drone business, as well as the disruptive and innovation driving aspects to compete in the market.
- Analysis of the Drone industry's State of the art Technology characteristics . A subset of the startups collected is then studied more in depth to better understand the characteristics of the global drone startups ecosystem.

  Example their age and geographical location, target market, funding received, value proposition, application fields and client sectors covered

2.1. Objectives, research questions and methodology

As indicated in the literature study, the Drone Ecosystem and its cutting-edge technology are useful to current entrepreneurs in connecting and growing their company and technology. Furthermore, many scientific papers of research highlight how these innovative technologies play a primary role in the success of startups by providing investment attractiveness with financials and market penetration in various different domains and segments with more possibility of using these tech drone startups indefinite solutions.

The rapidly evolving economic circumstances of the global economy are providing chances for these creative drone entrepreneurs. Startups exist in an ecosystem that is characterised by the continuous development of new disruptive technologies that drastically change industries. Competencies of teams and the availability of financial resources are required to survive in adverse conditions and establish the basis for future success. The recent COVID-19 epidemic has accelerated the pace of invention and development, accelerating the digitalization trend across all industries. Only adaptable businesses can thrive in this volatile environment, and startups have enormous potential to grow and bring their innovations to market, primarily by displacing incumbents, creating new market segments, or gaining access to businesses that previously appeared to have insurmountable barriers to entry. In this environment, new technologies that have not yet been completely researched and utilized have the highest development potential. Thus, the link between startups and its partner industries ecosystem, with the goal of generating a market-demanding product or service, is a particularly critical topic that is only going to increase in importance.

We never imagined that one day we would be able to fly inside cities using urban air transport using drones, which is now becoming a reality thanks to technology given by investigating drones as air taxis to enable rapid mobility in the age of traffic-clogged urban transportation and roadways.

Drones fall into this category because of their high degree of innovation, relative newness, and growth possibilities. However, scientific research on the impact of ecosystem for startups and organizations whose value proposition depends upon drones is severely lacking. There is practically no qualitative or quantitative data on this issue at the moment. As a consequence, it is difficult to find fresh insights and fully leverage the potential of this exciting technology. Since 2017, the drone sector has been dropping its active drone companies, and its success factor and financial support is dependent on product and service innovation with the kind of drone and specialty they serve, such as humanitarian, military, and commercial deliveries. (Gilardi,S. et al.,2019)
To understand the unmet knowledge gaps, we begin by identifying active new drone star-

tups formed between 2017 and 2022, How many of them are operational, and which sectors of the industry are most concerned with earning the most benefits.
However, papers on the specific case of the drone startup ecosystem, whose value proposition revolves around the innovate technology of drone startups and other industry players supporting directly or indirectly by creating a startups unique innovative drone technology, have not yet been written, and research on the topic is lacking both qualitatively and quantitatively. As a result of the considerations gleaned from the literature review, this thesis seeks to investigate the intriguing existence of a drone startups ecosystem, also known as a consortium, which has some added competitive advantages and how appealing this brings product or service based on drones around these networked groups. It specifically seeks to solve the following research questions:
RQ 1) How many new drone startups are currently operating in the drone industry at an international level specifically born after 1.1.2017 and which are their market specialization?

RQ 2) What are these drone ecosystems and its categories of operations? How these state-of-the-art drone technology industry benefits from the market and investment opportunities?

In order to address these questions, a structured mixed-method process is followed, that is composed of different steps.

- Step 1: Census. A census of startups operating in the global drone industry is performed, which allows to map drone startups all over the world; data are gleaned through the databases Crunc Q hbase, in order to integrate sources in the best possible way and to guarantee the completeness of results.
- Step 2: Analysis of the industry's characteristics. A subset of the startups collected is then studied more in depth to better understand the characteristics of the global drone startups' industry. Specific information about these startups is organized in a database, including for example their age and geographical location, Industries, Founders, funding received, investors,Target Market,Activity typology,type of drones and contacts-Website,facebook, linkedin,twitter.
- Step 3: Quantitative analysis with econometric model development. After having understood the characteristics of the industry of reference, the research proceeds according to the development of a quantitative econometric model. The econometric model aims at understanding which possible business advantages which these newest drone startups adopt, and if and how certain technology or characteristics of the company have an influence on this decision of investment and economic leverage.

- Step 4: Qualitative analysis with interviews. Finally, a qualitative investigation is run by means of research or interviews to the founders of a restricted sample of interesting startups. The interviews are aimed at understanding the state-of-the-art technology of each drone startup, its unique value proposition and main innovation elements, its strategic partnerships and possible ecosystem of future drone industries development. These insights integrate and cross-validate results of the previous steps.

Overall, Step 1 and Step 2 provide an answer to the first research questions, while Step 3 and Step 4 allow to answer to the second research question. Thanks to a mixed-method research process, this thesis develops the specific case of startups operating in the innovative industry of drones with a worldwide perspective, it tries to understand the business model they adopt in relation to their characteristics and it verifies if and how certain variables can explain this choice. Indeed, several papers have been written about Drone and its Technology, but none of them has yet properly deepened from a qualitative nor quantitative viewpoint how the concept applies to startups in the industry of drones and its ecosystems; This study, in this respect, fills a gap in the current literature and eventually gives useful insights for future research.

2.1.1. Data extraction sources

It is fundamental to find, collect and exploit data from multiple yet complementary sources of information considering the variety of data typology this thesis requires. So, the extraction process consists of the use of only one main sources of information: Crunchbase

Figure 2.1: Crunchbase Logo

(CB) is an online platform founded in 2007 with the initial objective of aggregating all startup-related information. It is now one of the most trustworthy databases for public and private enterprises, provides essential information on firms' milestones such as founding date, investments, teams, and mergers and acquisitions. The massive data is gathered via three major channels: the Crunchbase community & venture programme, a machine learning algorithm, and a specialized data team. Crunchbase is utilized in its "pro" edition for this research, ensuring access to all accessible information on the selected firms. The main focus of this information source is US-based companies. The most precise way to research data in this platform is to use the query builder. This tool contains three main components: the field, which refers to a company's specific detail, the desired value related to the field and the operator, which connects the two previous elements defining their relation.

2.2. Data collection strategy and gathering process

The study base lies on quantitative data on startups in the drone sector to collect information on them and the industry these organizations operate in. The first data source to be analyzed is Crunchbase through three steps to create the most complete and accurate database possible. In practice, the extractions are made by applying specific filters with the query builder into each Crunchbase research, picking only the relevant information above all the firms available. Finally, the results are exported into an Excel sheet and analyzed.

2.2.1. Data collection from Crunchbase: Part I

The first extraction is the result of the application of the following filters:

1 "Operating status" equals "active".

2 "Founded date" after the 1st of January 2017;

3 "Industry" (which defines the possible industries in which the company operates) includes the words "drones" and/or "drone management".

It is reasonable to limit the research to companies that respect the above characteristics according to the scope of this research. However, restricting the real data to these findings could be not exhausting. The main reason this occurs is related to the imprecision that could derive from the third filter. While "Founded date" and "Operating status" are usually accurate, the "Industry" tag could present some issues mainly derived from the flexible nature of startups that may have undergone a pivot after the last Crunchbase update and may have led to an entry or exit from the drone industry. This lack of precision could also result from a human error, namely a misunderstanding during the classification of Crunchbase's data team. The data generated from this extraction consists of 523 startups.

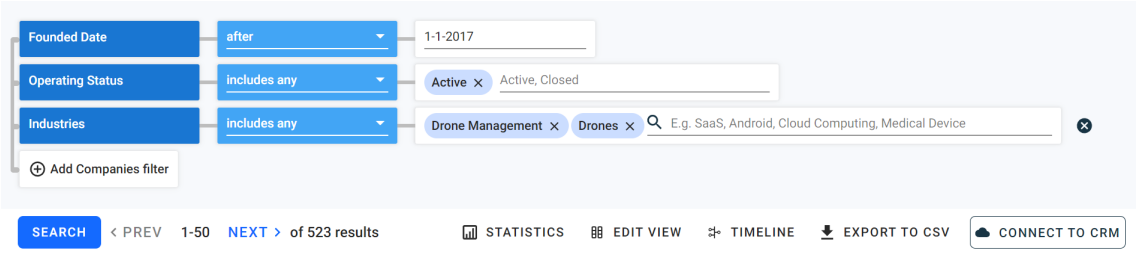


Figure 2.2: Crunch base data Part-1

2.2.2. Data collection from Crunchbase: Part II

The biggest problems we encountered when extracting newly created businesses from the beginning of 2017 is that we could only collect a limited number of drones-related or startup that would support our drone ecosystem target and aid us with our research purpose. We built an enhanced query builder with precise needed fields and additional keyword combinations to match in order to find the finest nearby businesses to help our study on the drone startup ecosystem using cutting-edge technologies. Because of the usage of many tags/key words. As shown in the images "fig 2.3" and "fig 2.4" the second method relies heavily on the "industry groups" and "industries" tags: the goal is to include all of the crunchbase keywords associated with drones (from "agriculture" to "data visualization," from "sensor" to "satellite communication," to name a few). To choose prospective firms for this study, a panel of specialists from Politecnico di Milano's Drone Observatory painstakingly selected a list of a few keywords. Attention to detail is essential in this sort of research. As a result, when using keywords to build filters, both single and plural names are considered, and in the case of acronyms, the complete name is also considered to guarantee that all possibly relevant organizations are included. Inclusions in second method extraction.The data generated from this extraction consists of 667 startups

1 "Full description" , Description , Industry Groups, Industries

2 Keywords used in the search query "drones,UAVS,RPA,AAM UAS,UAM,Evtol, vertiport,drone delivery,DAAS,EASA, and so on"

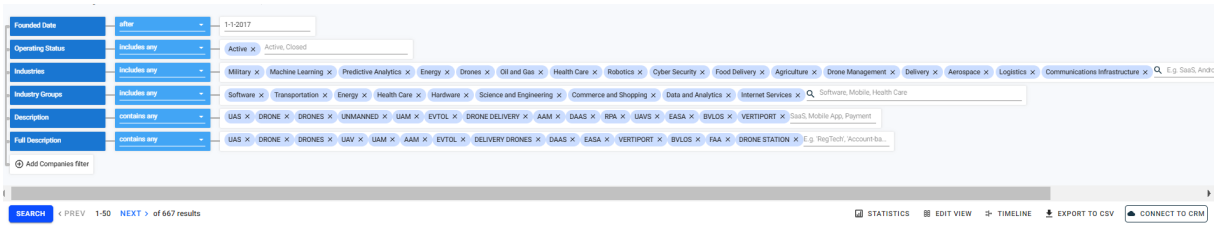


Figure 2.3: Crunch base search 2

This second method of phase-2 yields 667 startups, which is obviously greater than the first phase of method followed, and is added to the gathering data results from the prior phase-1 on Crunchbase. Following that, duplicates are removed, and a one-by-one check is conducted, always verifying the complete description that supports our goal of specific state-of-the-art drone startups, as well as the LinkedIn, Facebook, Instagram, and Twitter profiles of the new firms added to the primary database. After the first step of relevance at the initial filter techniques, the final database created by all of Crunchbase's study

#	Keywords	Result of the extraction
1	UAS	100
2	DRONE	589
3	DRONES	743
4	UNMANNED	181
5	UAM	7
6	EVTOL	29
7	DRONE DELIVERY	28
8	AAM	11
9	DAAS (DRONE AS A SERVICE)	5
10	RPA (Remotely Piloted Aircraft)	3
11	UAVS (Unmanned aircraft vehicles system)	46
12	EASA	4
13	VERTIPORT	2

Figure 2.4: Keywords Considered

has a total of 266 organizations. Further refinement on certain dimensions of analysis: company type (specialist / generalist), target market (B2B; B2G; B2B2C, or combinations thereof), Type of solution provided (product, service, or combination thereof), Type of product provided (hardware, software, or combination thereof), Hardware and software created, Application areas, Customer sectors This makes us highly relevant and closest to our startups with cutting-edge technology and its networked ecosystem, which has profited from fundings dating back at least three years from today's reference year 2022.

Characteristic	Explanation
Company name	Name of the startups
Organization name URL	Direct link to the Crunchbase page of the startup
Website	Link to the official website of the startup
Twitter	Link to the startup's Twitter account
Facebook	Link to the startup's Facebook account
LinkedIn	Link to the startup's LinkedIn account
Description	Brief description of the startup
Founded year	Year in which the startup was founded
Headquarter city	City of the startup's headquarter
Headquarter region	Region of the startup's headquarter
Headquarter state	State of the startup's headquarter
Headquarter geographical area	Geographical area of the startup's headquarter: • North America • Central-South America • Africa • Asia • Europe • Oceania • Middle Western Asia
Geographical scope	Geographical area in which the startup operates; it could be either worldwide or one of the previous geographical areas
Contact email	Email of the startup or of its founders

The image represents the overview of the table extracted After clustering and interpreting all of the essential data acquired from the crunchbase startup database, they are first rated based on the special dimension supplied by Politechnico di Milano - drone observatory, which follows to examine if the listed startup is active and genuine which belongs to the drone specific industry and should at least be able to serve the network ecosystem in order to support service / product to direct drone industry or subindustry. To locate them for our research centered point, we had to ensure that each company on the list was confirmed using its given website, Facebook/instagram, linkedin, and twitter. If we don't discover any information in any of these sites, we will remove the startup from the list after thoroughly searching additional online sources.We discovered that companies who do not have a website or any type of online platform are either closed or do not have a defined business plan, product, or service. These have no engagement with customers or other startup ecosystems, which jumps out from our analysis. By going through all of the descriptions, I was able to further confirm these startups' proximity to the drone sector. Attempting to find Year of startup formation in order to maintain track of all drone startups established between 2017 and 2022, The startup's geographical location and headquarters, as well as the extent of its business—whether inside the nation or globally. Does it make a profit? What sort of company do they run? -Generalist / specialized in the drone sector B2B, B2C, and B2B2C are the target markets. The type

Phone number	Phone number of the startup or of its founders
Founders	Name of the founders
Target market	• B2B • B2C • B2B2C
Total funding amount ($)	Total amount of money collected by the startup since its foundation (in US $)
Last funding amount ($)	Amount of money received by the startup during its last funding (in US $)
Last funding date	Date in which the startup received the last funding
Lead investors	Corresponds to the column "Top 5 investors" from Crunchbase: the 5 major entities that invested in the startup since its foundation
Offer typology	• Product • Service • Combination of product and service
Platform	Startups that offer platform solutions linking two or more sides of the market (e.g., demand and supply)
Activity typology	• Specialized: the startup focus is exclusively on drone-based products and/or services • Generalized: the startup offers also products and/or services belonging to other industries, such as IoT, AI, robotics, etc.
Product typology	• Hardware • Software • Both hardware and software
Hardware typology	• Drone platform: the drone itself, the hardware infrastructure of the machine • Payload: objects that the drone can carry (e.g., cameras, sensors, etc.) • Components (engine, battery, navigation system, controller, docking or charging station, launch and retrieval systems, etc.) • More than one of the previous
Platform typology	• Fixed wing • Rotating wing • Vertical Take-off & Landing (VTOL) • More than one of the previous
Payload typology	• Camera (thermic, 3D, video/photo shooting cameras, etc.) • Sensor (multispectral, scanner, laser, thermographic, gas detector, etc.) • Others (dispenser, speaker, parachute, etc.) • More than one of the previous
Software typology	•Aboard •Ground (includes control navigation, platforms or protocols) • Data analysis/management • More than one of the previous

Additional services	Extra-services with respect to the core value proposition of the startup: • Consulting (usually, about how to integrate drone technology within the company's activities) • Pilot provision • Fleet provision • Training (about the drone technology and its application) • Data collection/analysis • More than one of the previous
Application field	Describes to which particular context is applied the product and/or service offered by each startup; within each category, it is possible to introduce further specificity. The possible applications are listed in the lines below
Application field: Search & Rescue	• Search • Rescue
Application field: Site inspection	• Infrastructure inspection • Post environmental disaster inspection • Surveying • Environmental/agricultural inspection • Monitoring
Application field: Security & Surveillance	• Security • Safeguard • Protection • Surveillance
Application field: Unmanned Traffic Management	• Monitoring • Counter drone
Application field: Inventory	This field comprehends all the activities related to the warehouse inventory
Application field: Transport	• Delivery (of goods) • Transport (of people)
Application field: Supply	• Substance release (water, pesticides, etc.) • Maintenance
Application field: Entertainment & Media	• Photo/video • Aerial shows • Races • Graphical arts • Advertisement
Client sector	Defines the sector to which the client of each startup belongs. The possible sectors are listed in the lines below
Client sector: Agriculture	This sector includes actors operating in the agricultural sector (farmers, growers, winegrowers, etc.)
Client sector: Utilities	This sector includes actors that provide basic goods (water, sewage services, electricity, dams, natural gas, etc.)
Client sector: Entertainment & Media	This sector includes activities – run by either businesses or privates – in the field of entertainment and multimedia content creation for a set of different purposes (e.g., games, drone races, marketing campaigns, video making , photo shooting, etc.)
Client sector: Infrastructures & Buildings	This sector refers to the actors operating in that set of infrastructures allowing society and organizations to run effectively

Client sector: Environment & Society	This sector includes actors involved in the preservation of the environment, the monitoring of environmental conditions or the organization of society (bodies responsible for plantlife and wildlife protection, Public Administrations, police officers, fire fighters, etc.)
Client sector: Telecommunications	This sector includes companies operating in the field of telecommunications and Internet service provision
Client sector: Logistics & Transport	This sector includes actors operating in the logistics sector, involved in the delivery and transport of goods and people (e.g., logistics operators, transport companies, manufacturers of logistics products, etc.)
Client sector: Healthcare & Pharmaceutical	This sector includes actors involved in healthcare or pharmaceutical activities (e.g., hospitals, pharmaceutical companies, research laboratories, etc.)
Client sector: Art & Culture	This sector includes actors operating in the context of arts and culture (e.g., museums, municipal bodies, private exhibitions, etc.)
Client sector: Automotive	This sector includes all the actors involved in the automotive sector
Client sector: Insurance	This sector includes actors that run insurance activities
Client Sector: Consumer	This sector includes economic entities operating in the consumer goods industry
Client Sector: Other	This sector includes all the startups operating in a client sector which is not listed above
Client Sector: Multisector	This section includes all the startups whose offer is so generic that it could be related to all the sectors previously listed
Client Sector: Multisector	This section includes all the startups whose offer is so generic that it could be related to all the sectors previously listed
Client sector: Agriculture	This sector includes actors operating in the agricultural sector (farmers, growers, winegrowers, etc.)
Client sector: Utilities	This sector includes actors that provide basic goods (water, sewage services, electricity, dams, natural gas, etc.)
Client sector: Entertainment & Media	This sector includes activities – run by either businesses or privates – in the field of entertainment and multimedia content creation for a set of different purposes (e.g., games, drone races, marketing campaigns, video making , photo shooting, etc.)
Client sector: Infrastructures & Buildings	This sector refers to the actors operating in that set of infrastructures allowing society and organizations to run effectively

Table 2.1: Explicative table of columns in the database analyzed

of solution provided to clients, Product offerings include hardware and software, as well as application areas.More quantitative and qualitative data are processed from the resulting database, which includes financing information, investor details, and a clear picture of how this company is functioning as fundings are more appealing for those with a unique value proposition and Disruptive innovation that the market is ready to address, and their solution is leveraged with state-of-the-art technology, which is the startup's greatest strength.

Figure 2.5: Crunch base database part of section overview

2.3. Quantitative and qualitative analysis

The research stages that follow attempt to answer the first research question, which is new drone startups that are now functioning in the uav industry ecosystem on an international level, particularly born after 1.1.2017, and what their market specialty is using appropriate quantitative evidence from CrunchBase. The qualitative study, on the other side, comprises of a networked drone industry ecosystem with prospective interviews with successful entrepreneurs and emerging organisations.

2.3.1. Econometric model development

An econometric model is generated using the application Tableau based on the information gathered in the final database (we are more focused on startups that secured investment in the previous 3-5 years from the current year 2022). This Model is a strong visual and data interpretation program that allows us to utilize excel or CSV data retrieved from the crunch base straight in the tableau workbook with the assistance of its inbuilt data filtering to have a specified set of data used for easy and user friendly association between two known or unknown variables to find out its statistical and logical regression

with its automated produced graphs, charts, tables, and much more to explore from there intuitively. The second econometric model attempts to answer the final research question by eventually locating a startup with a potential product, service, or combination of both into the business, with disruptive innovation attracting investments from a variety of investors and filtering out the top 1 to 6 investors from the available database. This time, the statistical approach is followed with thankfulness for the use of tableau software, which enabled the interpretation of this data into valuable visual informatics for clear comprehension of numbers and variables.

2.3.2. Interview

In parallel, a subset of five relevant startups is interviewed, selected from the subset of the 266 startups analyzed. The questions of the interview aim at better understanding the in-depth of the startup and the process of value proposition building and technology advantages from a founders' perspective,Organiation perspective ,Innovation point of view, How Drone Ecosystem helps the mid scaled drone startup, Selection of type of drones and so on . To do that, few main questions are asked to the interviewees:

1. Does the drone industry's innovativeness and disruptive technology play a significant role in market penetration and extracting value at a low cost? Which Business Model is Best for Long-Term Drone Industry Survivability?

This question provides us with a realistic view on how a drone startup works with innovation and technology to get a competitive position in the industry. How do they perceive the expanding number of new drone startups, their competitiveness, and future technologies? Will it seek to continue and sustain their pace or fade away quickly, as many startups have in previous years (2017 to 2022)? Based on experience, which Drone startup is more investment attractive and based on their opinion on business model fit for the drone industry survivability.

2. Which drone industries do you think have the most practical business potential with drones and UAV technologies in the coming year 2023 and beyond? 2. What model of drone do you think has the greatest performance and commercial applications?

This question provides us with a possible target sector in which they believe drones can have practical use cases and opportunities for business. It also provides the current drone type they prefer for better outcomes and cost effectiveness when compared to all other types of drones.

3. Is there a drone ecosystem in this era of smart transportation and self-driving cars?

What is the current situation of the Drone Ecosystem in the context of the global drone industry?

This particular question provides a more extensive explanation regarding ecosystem and how this drone industry startup has a similar ecosystem and how effective they are playing a role in innovation and assisting their peers in making this business more sustainable and advanced with technical breakthroughs.

4. Could you kindly provide us with three benefits and three drawbacks of the global drone industry, with its interconnected ecosystem of multiple sectors and startups? Have you worked on any joint projects/services/product development with similar drone industry partners or suppliers in the last three years? Please mention any ecosystem startups with whom you have previously worked on successful projects and with whom you are comfortable working as suppliers / vendors.

This was the fourth and last question, and it described their organization's experience benefitting from ecosystem peers in the comparable drone sector from a commercial standpoint. They have certain benefits and disadvantages in the ecology. They have at least three ecosystem firms with whom they have completed a successful project.

All of the questions are open-ended in order providing each respondent as much flexibility as possible to share the organisation and their own opinions. In reality, the goal is to learn from each response what entrepreneurs think about creative companies and their business models, and to finally identify some of the trends identified in the literature research (just to name a few,Startups active and closed,Typology of drones,Offer typology-Product or service). The insights gained from interviews with the founders may aid in the development of relevant considerations that combine the findings of the entire study and provide their survey with forms that are subsequently qualitatively derived from the survey results based on the aforementioned questions.

3 | Quantitative analysis results

This chapter includes the findings of the census analysis reported in the preceding part, as well as the results of the two econometric models developed to address the two key research questions. The first section of this chapter provides a detailed look at the key elements of the firms in the census, divided into three sections. The first provides a broad examination of the characteristics of the number of organizations in the drone business, including age, geographical distribution of headquarters, and national legal form most often used throughout the sector. Following an overview, the next sections of the census description compare funded and unbacked enterprises, as well as a final detailed study of startups that obtained external capital. As a consequence, the chapter proceeds with a full discussion of the RQ2 findings. All assumptions and features of the statistical analysis are specifically evaluated, and a detailed explanation of the data obtained is conducted. In this method, numerous important criteria influencing the amount of money a drone startup obtains are found. As a result, key characteristics of startups that may have an influence on venture capital, business angels, funds and banks, and innovation-focused initiatives are identified and thoroughly analyzed.

3.1. Census results

The statistics shown here are the results of a study of the 266 startups collected through the methodology outlined in the previous chapter, and they offer an overview of the features of the world drone startup industry. As shown in the Graph Figure 3.1, the bulk of companies evaluated were founded between 2017 and 2022, with newborns decreasing steadily in recent years.

The great majority of drone companies created between 2017 and 2022 have their headquarters in, the United States, and Canada together referred to as North America, with 102 startups contributing approximately 38% of the total 266 startups evaluated for research. However, the European Union, which ranks second with 84 firms in the drone sector (31%), also plays an important role in the growth of the global drone industry. Aside from that, Asia has a prominent presence of 57 startups, with 21% of them being

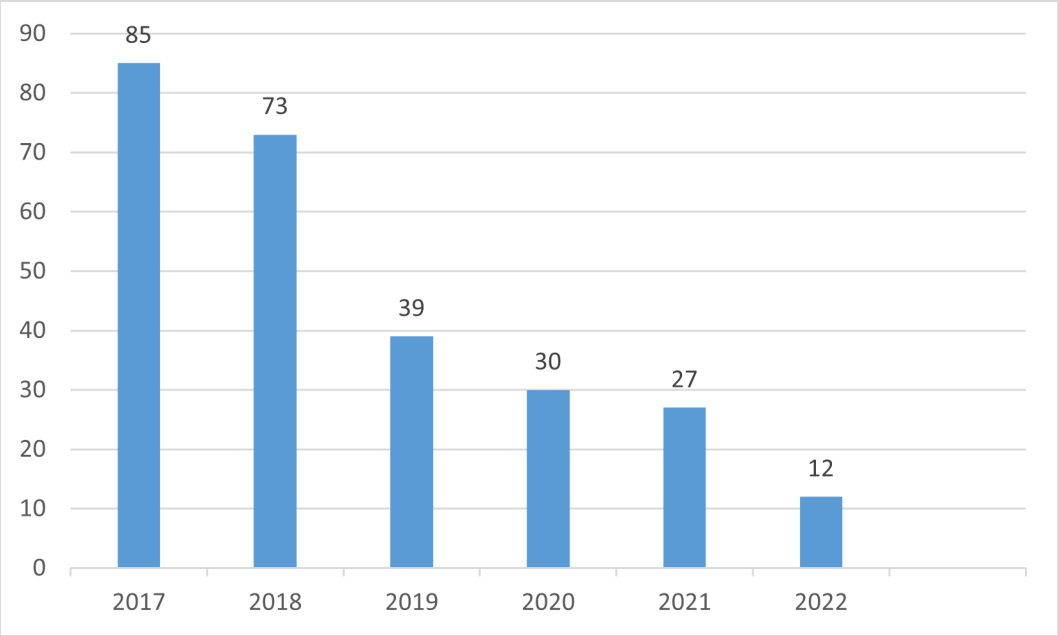


Figure 3.1: The distribution of startups according to the year of foundation

global startups. Oceania, Africa, South Central Asia, and Middle Western Asia have a little role, with 23 drone startups operating in these four areas accounting for 8% of all startups included for analysis. Refer to the figure 3.2

The startup failure rate in the drone industry has been analysed using crunchbase data by adding the filters Active and Closed Organizations, and keywords linked with startups: Drone, Drones, UAV, Unmanned aerial vehicle from 2017 to 2022. Where we can learn that in 2017, there were 928 active drone companies whereas 45 startups were closed down. With reference to 2017 statistics, there had been a significant reduction in active new companies in the following year 2018, with a 68% reduction and a 42% fall in subsequent closed startups. 2019 had 378 active and 6 closed startups, 2020 had 211 active and 3 closed startups, 2021 had 88 active and just 1 closed company, and 2022 had 21 active and none closed startups. The graph shows that the number of new active entrants has decreased over time, resulting in a lower rate of startup departure from the market. This demonstrates that the sector and its environment are becoming more efficient and competitive, causing little harm to other peer players in the startup drone ecosystem.Refer to the figure 3.3

Looking at the financials of the startups based on their headquarters, the bulk of the fundings (almost $1.9 billion) are with the startups (68 out of 266) situated in the United States, followed by $896 million with Germany as headquarters and $219 million with Japan. These companies rank second and third in the list of top fundings with just 6

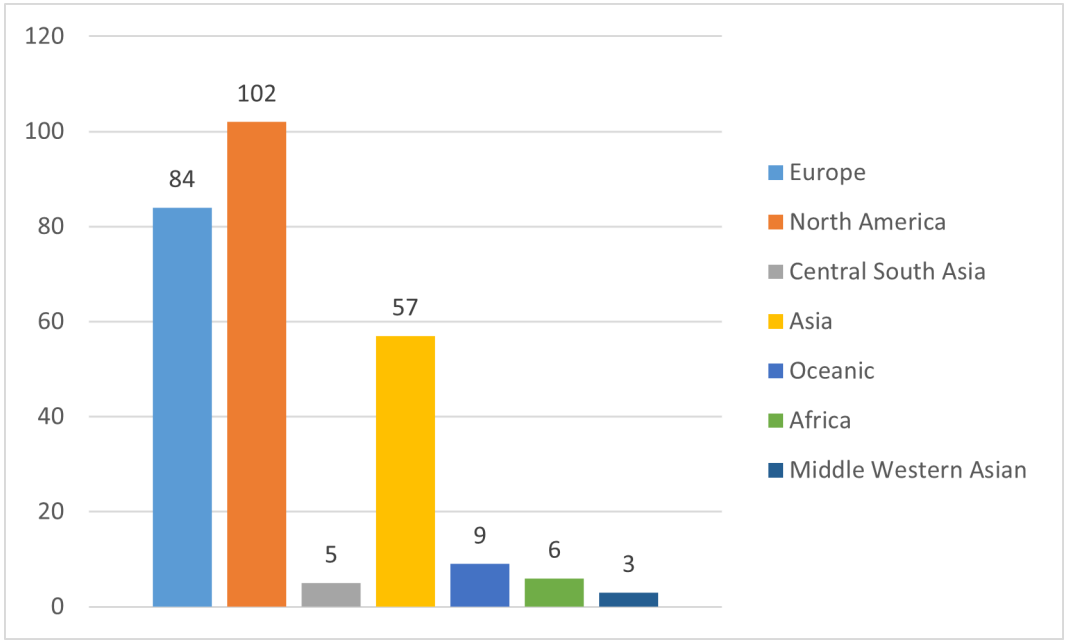


Figure 3.2: Geographical distribution of startups analyzed

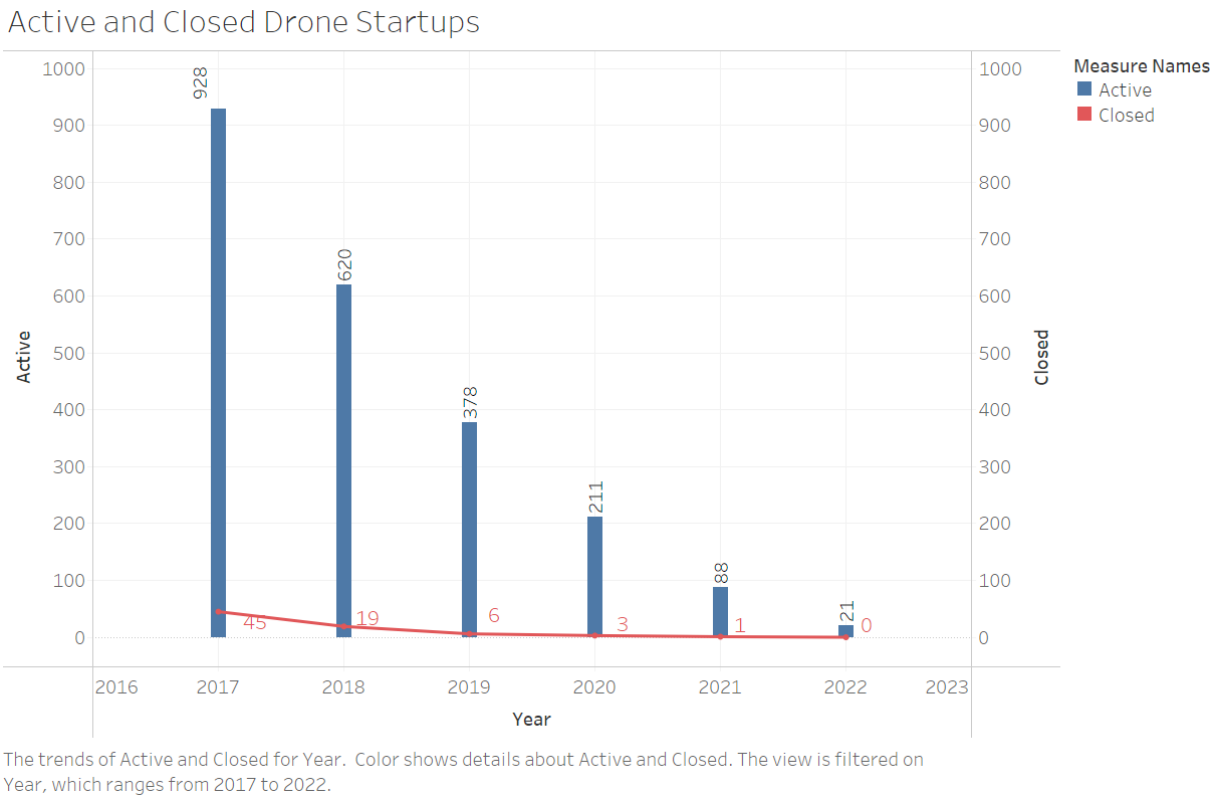


Figure 3.3: Active and closed startups graph

startups in both countries.Refer to the figure 3.4

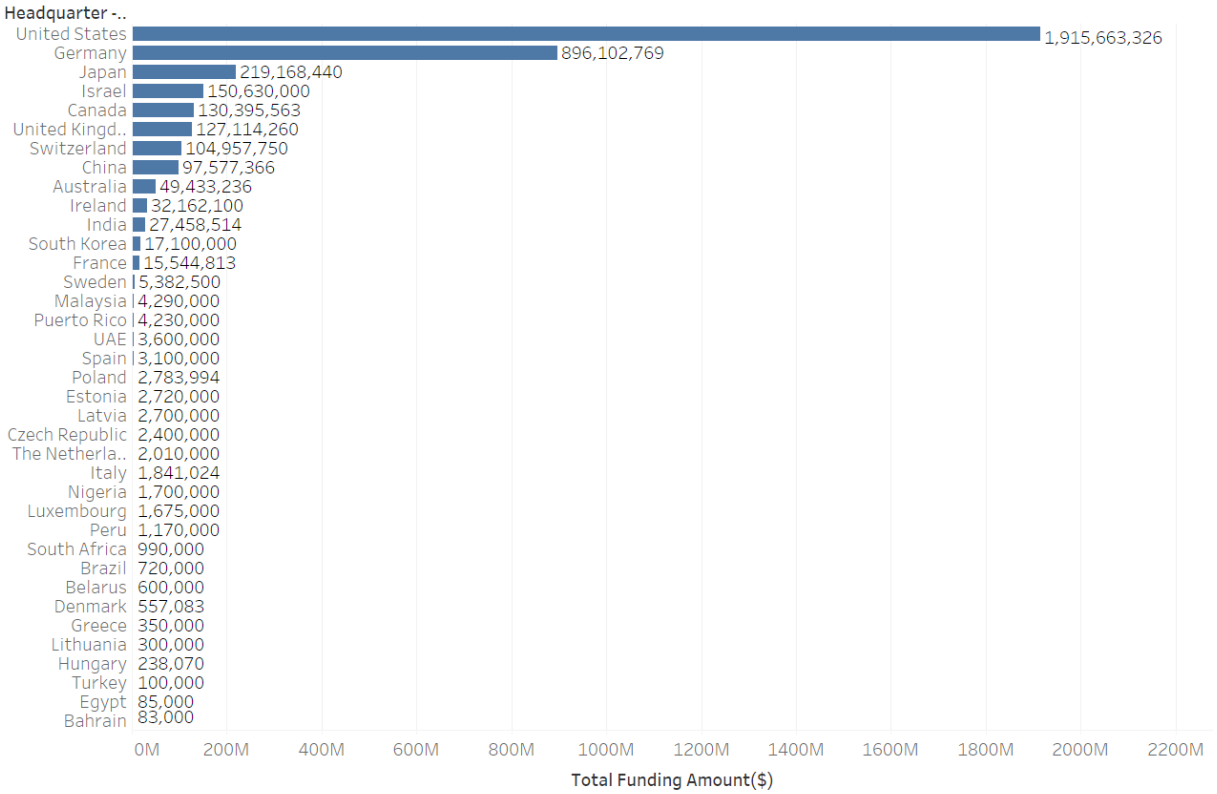


Figure 3.4: Distribution of fundings received according to the headquarters' country.

Total funding for the drone startup from the 266 listed out from the crunch base from the year of startups from 2017 was the record highest in total funding of 760 Million with an average of 11 Million per startup overall out of 266 startup, where we can see decline in the overall total funding in 2018 as 315 Million with an average of 5 Million, and it gradually decreasing in the eventual years 2019 to 2022.Ref to figure 3.5

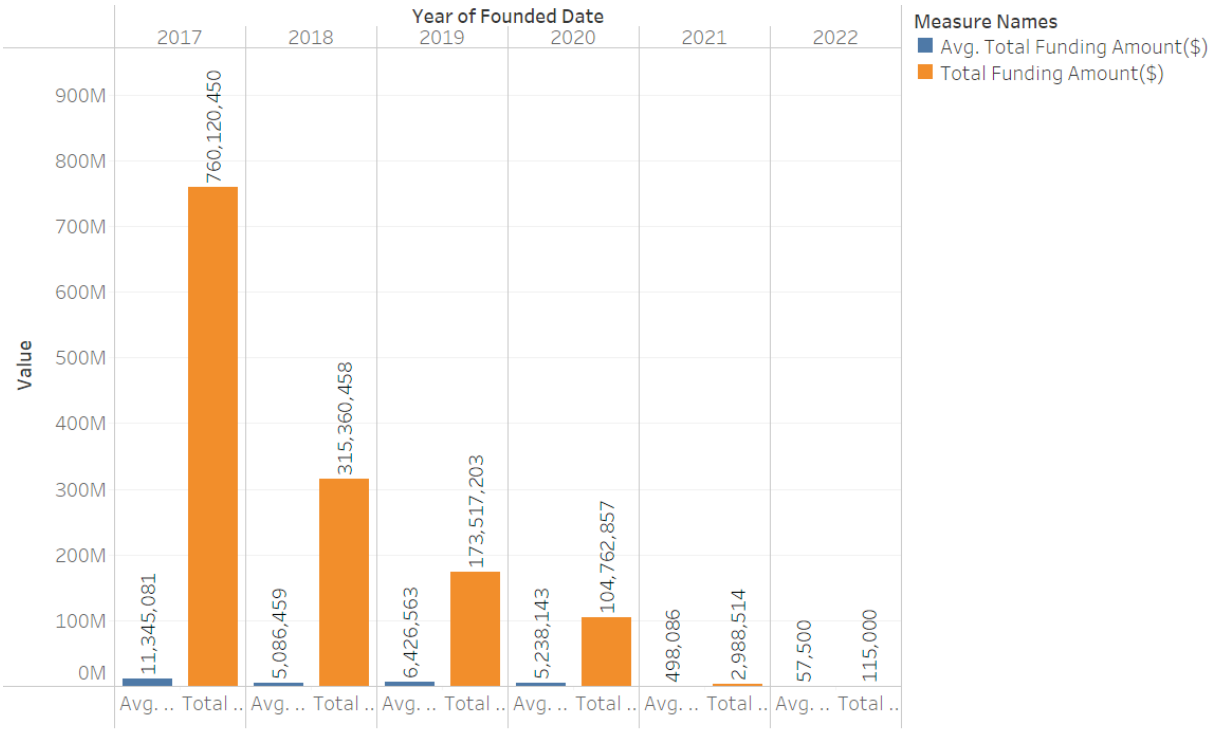


Figure 3.5: Funding per year graph

The latest funding for startups within the last 3 - 4 years, i.e. 2019 to 2022, which clearly gives us the statistics of the latest funding has been incrementally increasing over years, it was seen that at 2019 had $50 Million, at pandemic scenario start in year 2020 fundings were $96 Million, post pandemic years in 2021 fundings were $291 Million, and in current year 2022 the fundings have grown upto $414 Million. Drone companies have significantly more potential, and it is estimated that based on historical patterns, it will reach $700+ million by 2023 and will exceed $1.5 billion in investment in 2025[1] .Refer to the figure 3.6

The majority of market with drone startups has mainly with B2B, where we can see its 63% of B2B market target, followed by second highest as B2G with 18%, not to mention B2C which stands third with 13%, and where the minority 6% were found to follow the B2B2C Market. The 266 chosen startups served as the basis for the market studies. Refer to Figure 3.7

[1]A Report From Levitate Capital:The Future of the Drone Economy

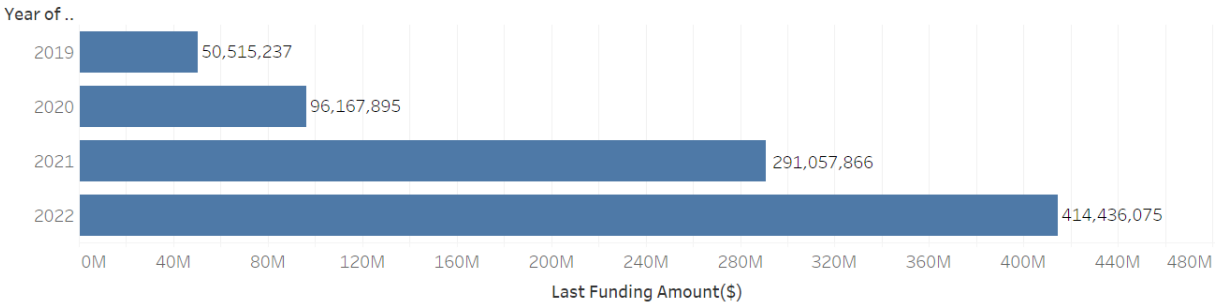


Figure 3.6: Last Funding per year graph

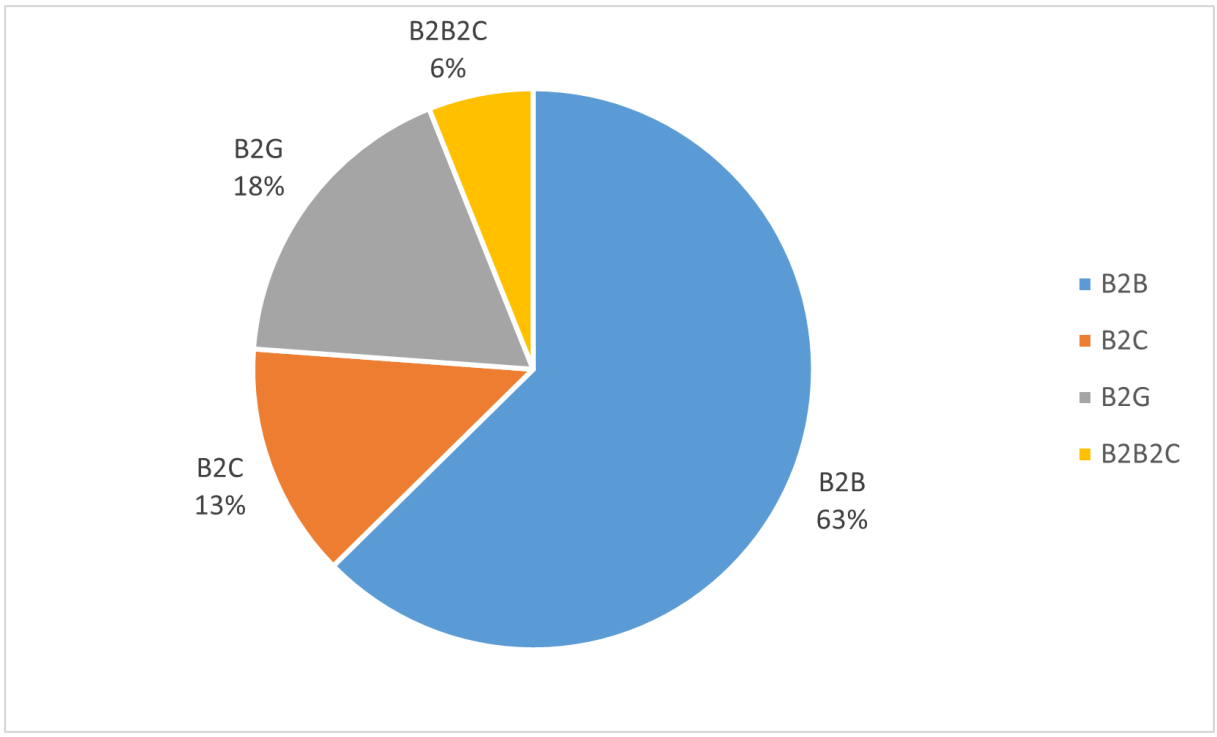


Figure 3.7: Startup Distribution with target market

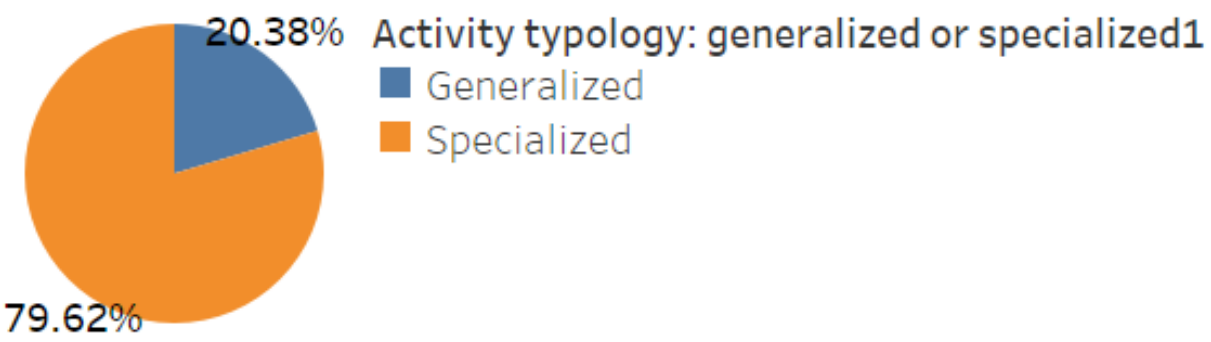


Figure 3.8: Activity Typology - Generalized and Specialized

The drone market itself is propelled by its unique product or services, and so they must be innovative and competitive in the rapidly growing market, and so they have more focus on specialized on specific type of customer or product that makes them survive in the industry(like example: Flyability[2] -Which focuses only on inspection drones products and services, but there are some other players who are generalized startups that have drone and relevant business in their addition to their existing business model or key activities(like example: Autel[3] is one of the world's leading providers of automotive intelligent diagnostics, inspection products and services startups and eventually they started autel consumer and commercial drones under the same primary business but different key activities.) In this case of the startups listed on crunchbase, we can see that 80% of the companies are specialized to drones and related products or services, while the generalized players are less than 20%.Refer to Figure 3.8

[2]https://www.flyability.com/?hsLang=en
[3]https://www.autel.com/diagnostictools.jhtml

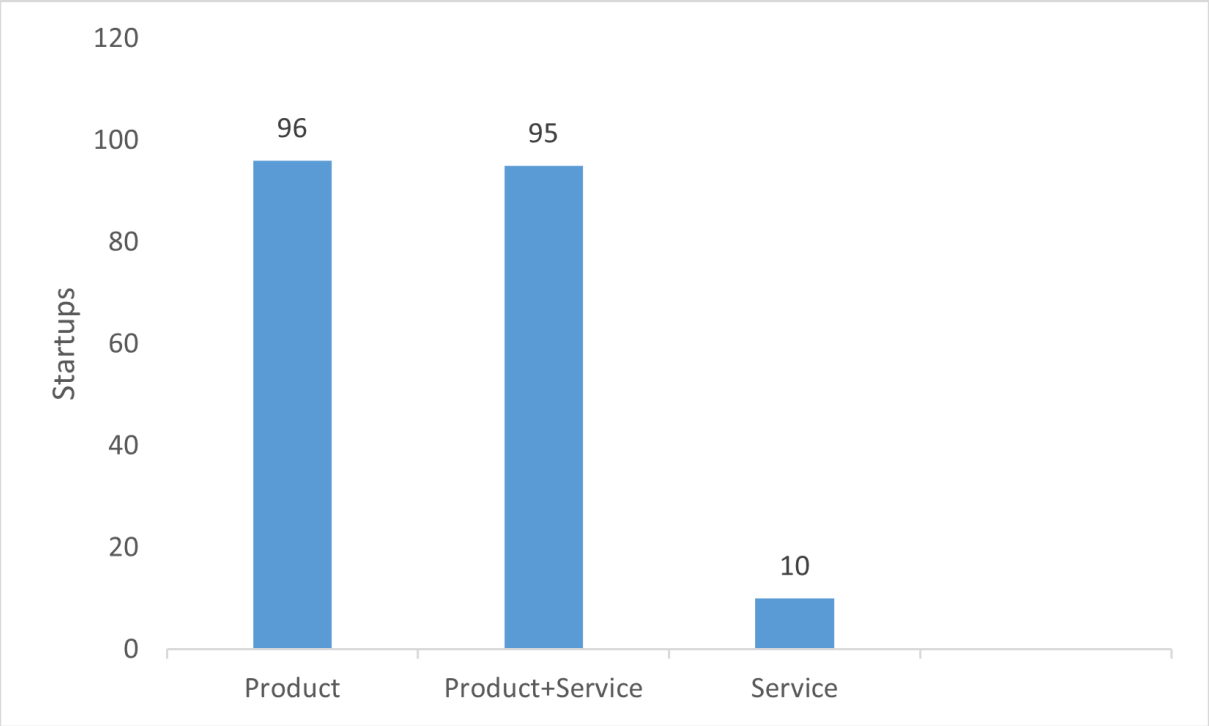


Figure 3.9: Offer Typology - Product and Services

Nearly half of the companies in the sample (48%) develop products, (5%) offer services, and (47%) have quite a hybrid product and service model. These companies are ideally benefiting greatly from the drone ecosystem or are known to be consortiums. In this manner, a company makes the strategic choice to enter the Product+ Service market once it has received large market infusion, raised sufficient funds, and scaled to provide on-demand innovative products (Better example is DJI[4] , as they started as only hardware company in the beginning stages and then after their global market demand and product success they are now in the stage of Product and Service).Refer to Figure 3.9 and Figure 3.10

[4]DJI manufactures commercial unmanned aerial vehicles (drones) for aerial photography and videography https://www.dji.com/it

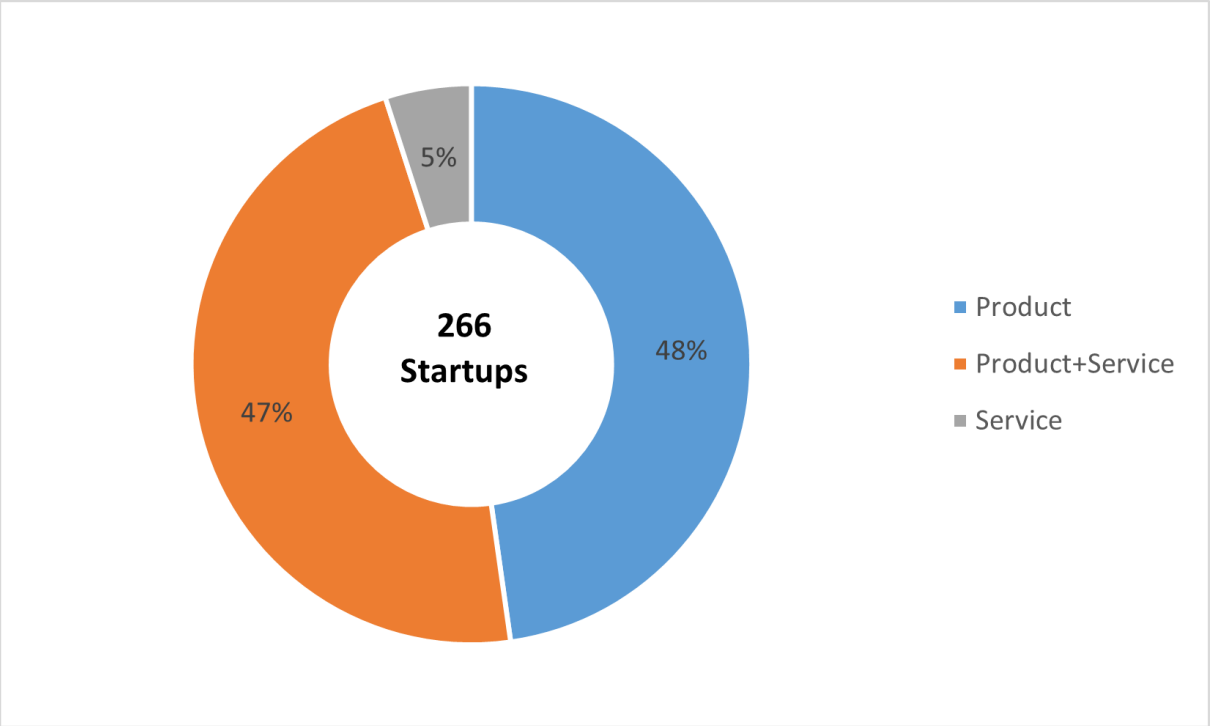


Figure 3.10: Offer Typology - Product and Services

In the case of 191 startups which provide products based on previous findings, their hardware and software capabilities are further analyzed. Service startups are not product startups,Hence they are avoided. Looking on the analyses 28% of the firms on this list rely largely on their hardware expertise, 20% rely only on software as their commercial selling point, and Majority 52% use a hybrid startup strategy of hardware and software. This is because the drone industry is a highly competitive and overly sought-after industry in which companies must compete by making both hardware and software as indigenous as possible in order to maximize cost benefits, keep the product patented and protected, and gain a dominant market position with a niche product. Refer to Figure 3.10 and Figure 3.11

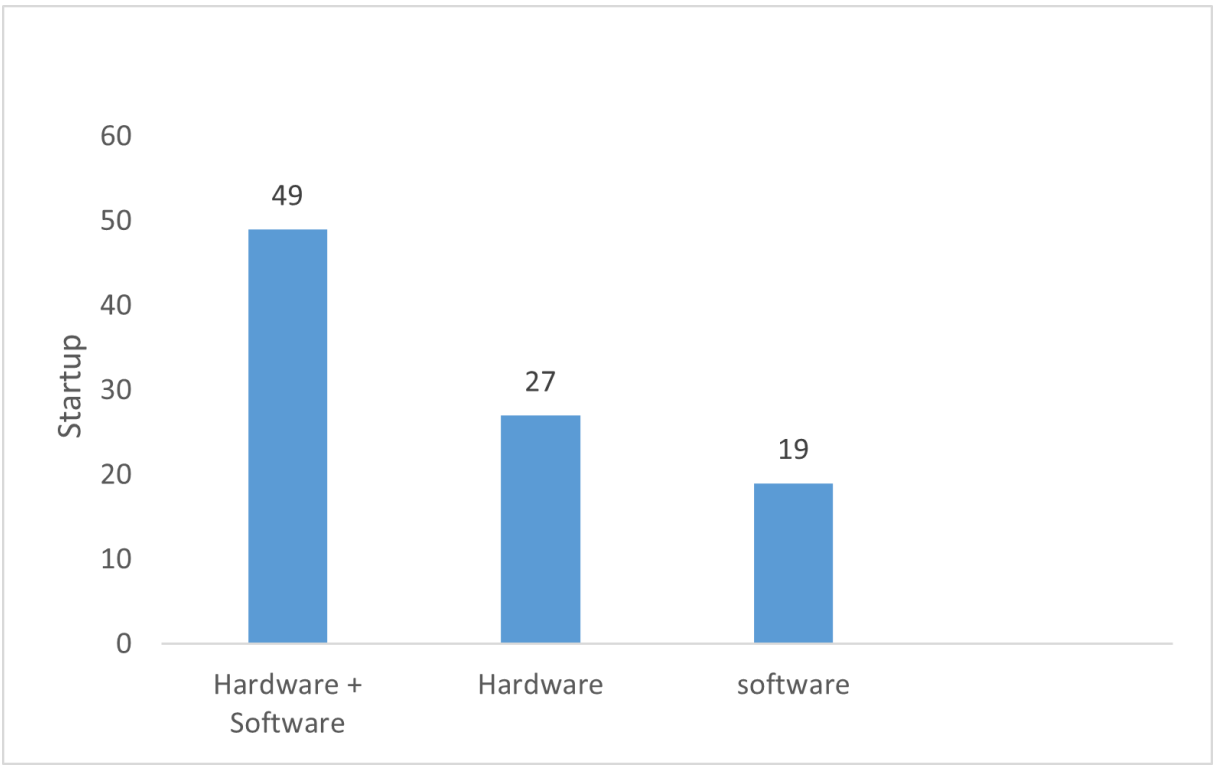


Figure 3.11: Product Typology - Hardware and Software

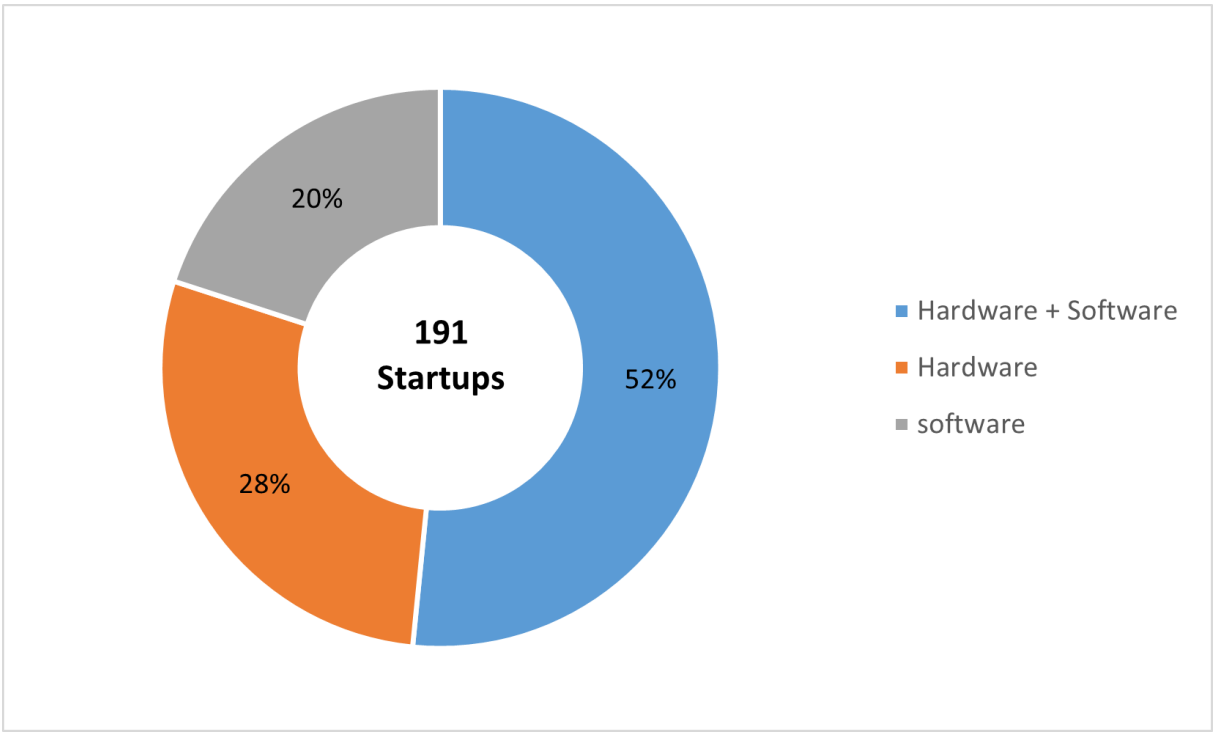


Figure 3.12: Product Typology Percentage Pie Chart - Hardware and Software

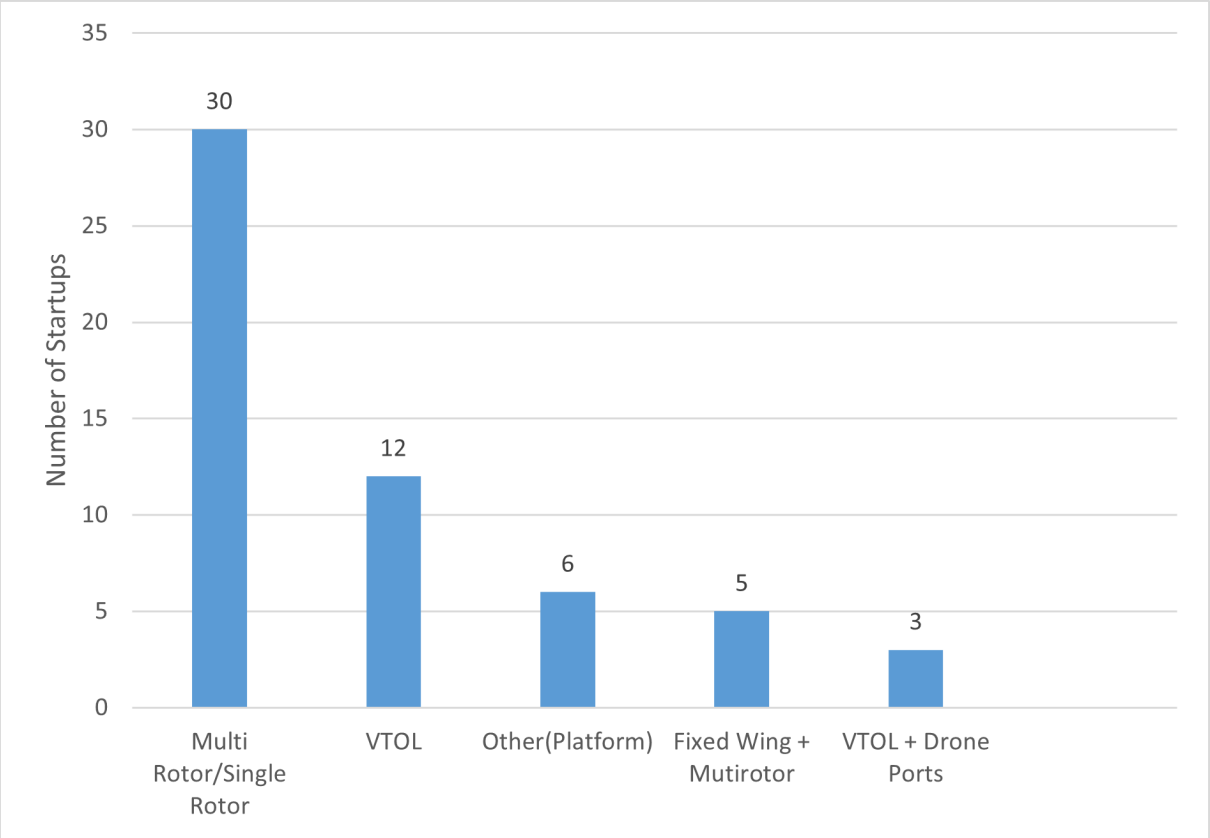


Figure 3.13: Typology of Drones :Startup and its product

Drone Startups' most convenient and adaptable choice of drone as a product is always Multirotor Drones, as seen by the sample drone startups' choice of drone selection from 2017 to 2022. Because of the number of single rotor (helicopter type) drone startups was quite low, we combined them into a single category titled Multirotor/Single Rotor: Which ideally functions with one or more rotor blades generating thrust to hover in the air, having significant benefits over particular applications such as aerial photography, tall structure inspections, logistics transport of packages, and so on. Based on the previous data analysis, we can see that out of 95 hardware-based drone products, 30 companies use Multirotor/Single Rotor as their core product. In addition, we may now observe VTOL (Vertical Take-Off and Landing) Drones, which are a fusion of a multirotor and a fixed wing aircraft. VTOL, on the other hand, offers greater benefits than Multirotor Drones, such as a longer range of operation (15km-100km), BVLOS (Beyond Visual Line of Sight) operations, autonomous flying, more effective battery utilization, and therefore heavier payloads may be air lifted. Other Platforms with 6 Startups include Vertiports, Drone Port, Done Stations, and Startup which specifically provide operational Drone Stations which is much needed in today's Drone operations which has to adhere and have all the regulatory standards (EASA, FAA) to operate in airspace with any possible type of drones

including Air taxis which transport Humans with UAM (Urban Air Mobility) and AAM (Autonomous Aerial Mobility) (Advanced Air Mobility).

Fixed Wing Drones are those that operate as standard aircraft do with a scaled version of it and various propulsion options -Electric or Fuel Engine. The only disadvantage is that it requires a runway approach or launch operation (Catapult launch system) and landing recovery, which are traditional aircraft operations. These are mostly found in military establishments and are not commonly found in commercial drone startups, though e-VTOL versions are becoming more commercially successful. With the extracted data horizon, only one Fixed Wing operating startup was found, so this category is combined with the drone startups that operate both Fixed Wing + Multirotor with 5 startups as operational ready fleets, each with its own advantages that make an operational ready in case situations like Search and Rescue, Humanitarian, Logistics, Long Range Security operations, Geographical Mapping and Surveys, and so forth. VTOL and Drone Ports with three startups in this extracted data that have just recently been airworthy since the FAA and EASA regulations have been in force with civil drone operations and their use in U-space regulated since 2017. These startups have been operating UAVs / Drones in the VTOL Category for commercial operations, specifically in AAM,UAM, and Vertiports and, as in the case of Air Taxis, Manned transportation with Urban transportations, Medical supplies deliveries, (SAR) Search and Rescue with various drones and operational station known as drone port for regulating the operations, (UTM) Unmanned Traffic Management, situational awareness, and safe pilots operation procedure.Refer to Figure 3.13

Looking at the software products at different drone startups are more wide and so we have limited them with 5 major different typology of software being produced as a unique products to serve the drone and related indutry within the ecosystem. 25% of software solutions are based on navigation and route planning, which are utilized in cave and tunnel inspection and interior navigation. The next 24% of software is data management, cloud storage, AI-based analysis, and processing data from drones into valuable information and data with business intelligence. 3rd lowest 21% with software product based on the communication and geo locations, which are mainly used for data transmition and communication with advanced fast and less latency band width ,like 5g enabled drone for long distance transport like BVLOS (Beyond Visual Line of Sight), geolocation based are similar to advanced live tracking of the object like Global positioning system (GPS) , Global navigation satellite system (GNSS) and many other precise location finder softwares . The last two lowest were software integrator products, which are the ones who make communication with drones and necessary sensors and make the hardware and soft-

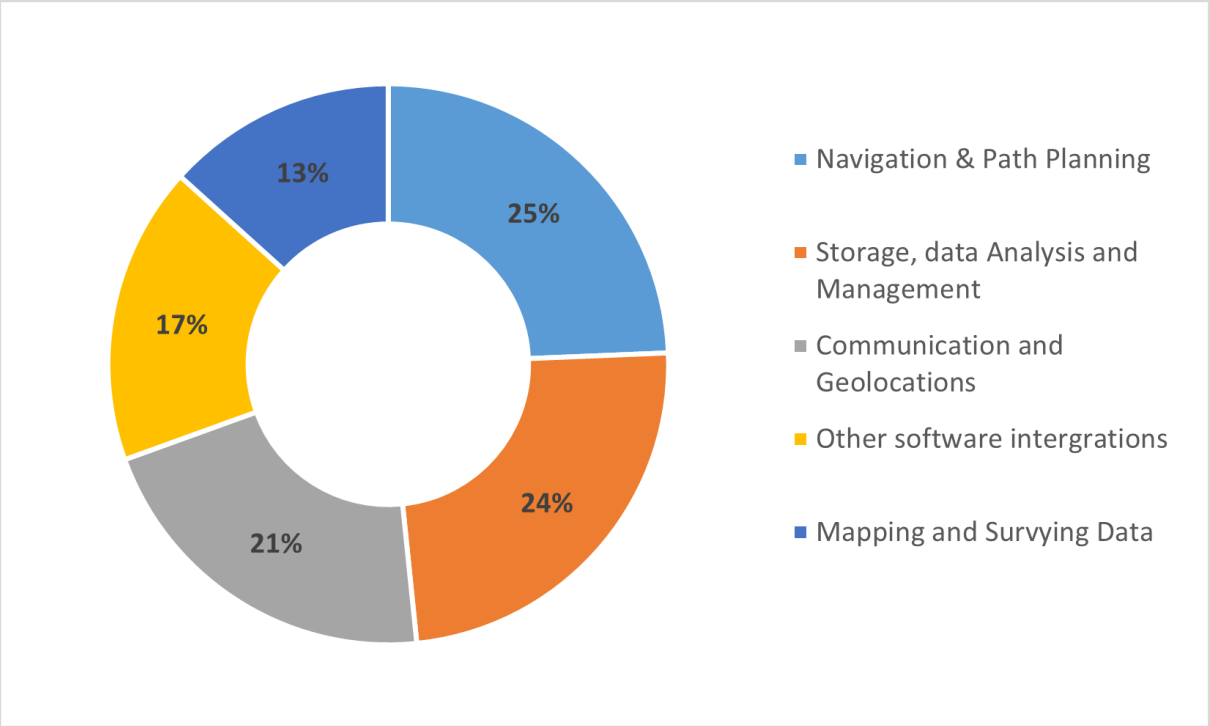


Figure 3.14: Typology of software produced by startups

ware integration and testing for any quality or technical glitches, and the last one is mapping and surveillance, which these software convert the aerial image information into 3d geographical information that is used in environmental research and tracking the forest density and resources.Refer to Figure 3.14

3.2. Interviews Results

The qualitative component of the mixed-method analysis is comprised of interviews with five international startups; these companies were chosen because they represent some of the most innovative realities in the drone startup industry, and they were interviewed with the goal of integrating and cross-validating results in previous analyses. A description based on the interviewers is provided for each startup.

WINGCOPTER

- Wingcopter[5] is a German-based business created in 2017 in Darmstadt, Germany by Jonathan Hesselbarth, Tom Plümmer, and Ansgar Kadura, specialized in the manufacturing of fixed-wing unmanned aircraft systems (UAS), commonly known as eVTOL Drones and supplier of drone delivery services. The organization has five years of expertise in delivery drone operations, having worked in numerous geographical locations ranging from the Arctic to the Middle Eastern desert, and from isolated islands in the South Pacific to San Diego Bay in the United States. Their product, Wingcopter 198(W 198), delivers where and when it is required. The W 198, which is based on patented tilt-rotor technology, outperforms previous performance and durability standards with Wingcopter 178 (W 178), making it an ideal all-weather delivery drone that can resist severe winds and rain.Corecam Capital Partners contributed several million euros in the startup as seed funding in 2020. Wingcopter secured $22 million in its Seris A investment round in January 2021, with plans to expand into the United States of America. Among its backers is Xplorer Capital, which has previously invested in Uber and self-driving vehicle startup Zoox. REWE Group, Salvia, and XAI technologies led a $42 million Series A extension round in May 2022. Company plans to use the funding to expand its drone delivery services internationally. A portion of the funds will be utilized to recruit close to 80 new employee, boost production, and enhance R&D.

- EVA[6], located in Syracuse, New York, that creates drone infrastructure for urban and non-urban regions in order to make the future of drone applications more sus-

[5]https://wingcopter.com/
[6]https://eva-labs.com/

tainable, operational, secure, and scalable. EVA owns an extensive drone infrastructure with different stations that allow for the delivery of various payload sizes. Edge cloud capabilities, quantum key encryption, on-time delivery, e-commerce, and a logistics marketplace where companies may meet drone operators to convey products and more are among the services offered. EVA has received $370K in investment across 6 rounds. EVA's most recent investment round was a $0.1M Convertible Note issued on March 17, 2022. EVA delivers end-to-end technology for large-scale drone operations. Its stations and operating system enable drones to do infrastructure monitoring, logistics, and disaster relief tasks for a fraction of the current cost. EVA fills this need by constructing Off Grid Vertical Stations (V-Stations), a modular, deployable system that enables Unmanned Aerial Vehicles (UAVs) to take off, land, charge, switch batteries, and transport payloads. EVA provides the first complete ground-to-sky capability, enabling drones and robots to communicate seamlessly through its network of Vertical Stations. EVA's locations in North America, Europe, and Japan allow its B2B clients to quickly execute the turnkey solution. EVA serves as the foundation for the drone industry 2.0 by protecting them from the environment, storing and processing their data, and controlling them to execute life-sustaining tasks. These stations will have sophisticated operating systems that can support any kind of drone, and they will be modular, allowing them to join to build networks or complete drone corridors.

- Vyorius[7]is a drone-based software product startup headquartered in Chicago, Illinois, that was founded in 2021. They are a Software as a Service (SaaS) platform for mobile unmanned robots, offering direct plug and play while centralizing all command, control, supervision, management, asset tracking, and maintenance functions. Their AI systems use the collected data to forecast maintenance, discover efficient vehicles in the fleet, and optimize resources through operational analytics. A recent fundraising round was secured by a venture capital-backed company. Vyorius has received $94.9K in financing over 4 rounds. Their most recent financing came from a Pre-Seed round on July 28, 2021. It offers a product ecosystem that specializes in providing support for practically every sort of drone, robot, and autonomous

[7]https://www.vyorius.com/

system. Ground stations, operation management, maintenance management, client management, simulator, precision landing, AI-enabled video, and live streaming are just a few of their products. Where they have full product software solutions for fleet management, process automation, and operation optimization exclusive for drones.

- Aridro[8] are experts in the field of Robotic Engineering, striving always to bring the best engineering ideas and solutions to help others in their endeavours. Founded in 2021, in Germany. we are invested in our Research & Development in the field of Robotics, specifically in the remotely operated robots. With all the years of research, we have developed high performing drones each with a specific purpose, they are made for Heavy lifting payload, Long endurance flights, Quick response to drones, Surveillance and Cinematography.We are located in the beautiful state of Saxony in Germany, surrounded by the beautiful mountain range and the Engineering firms that are among them. We get our mechanical components engineered and made locally, which allows us to partner with a variety of Mechanical, structural and Electronics engineers to work with

- Acquahmeyer [9]is a 2017 agricultural drone technology firm that offers whole crop pest nutrition control services in Ghana and beyond. There team consists of German-trained pilots and technicians with extensive expertise, an international entomologist, a plant nutritionist, and other highly skilled auxiliary personnel. In addition, they provide professional aerial filmmaking and photography, as well as extensive post-production services for all types of aerial applications. AcquahMeyer Dronetech provides drone operators with work shops that provide the finest quality commercial UAV / RPAS training. Recently incubated at the ESA BIC Northern Germany, 2021. AcquahMeyer Drone Tech enhances industrial processes by using an end-to-end automated system that includes drones, sensors, agricultural equipment, artificial intelligence, intelligently trained software, and data processing. Renewable energy, infrastructure, agriculture, and security all demand efficient, accurate, ac-

[8]https://www.aridro-robotics.com/
[9]https://amdronetech.com/

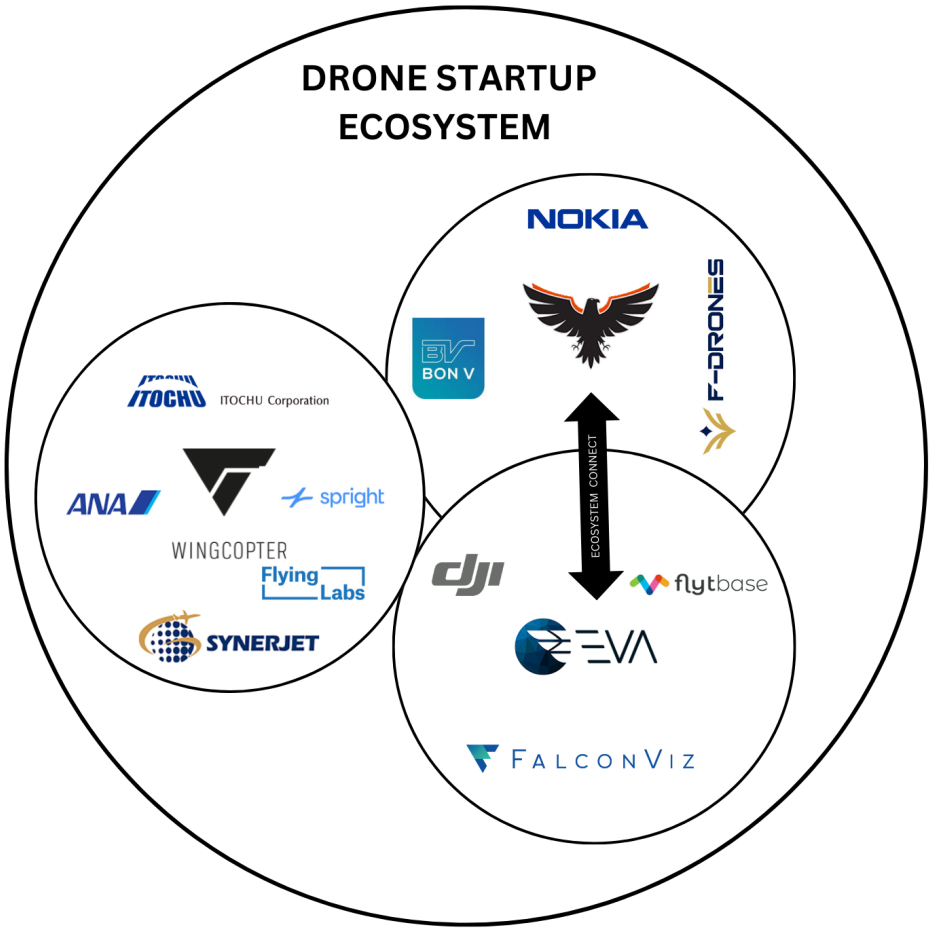


Figure 3.15: Drone Ecosystem Map:Based on Interviewed Startups'

cessible, and secure methods of reducing costs and time while improving overall performance. AcquahMeyer reacts in real time to changes in different industrial areas.

3.2.1. Ecosystem Map:Based on Interview and survey

Based on interviews and surveys with three different international startups, we were able to clearly understand their relationship and network they have closely bonded to have an innovative product or service in the drone industry, which we can have two different instances inside a big circuit as the ecosystem environment where all various kinds of established drone companies, startups, enthusiasts, researchers, and other related technology providers are included within. In the first scenario, we have Wingcopter, which

manufactures state-of-the-art unique eVTOL delivery drones that no other company can provide with triple drop mechanism and patented tilt rotor mechanism, or more payload capability, thanks to the ecosystem through which their potential customer or partner could find a significant advantage in utilizing their product or services. They are now a bonded ecosystem, through which they may reap reciprocal advantages such as technology transfers, service transfers, brand distribution in their host nation, and many other possibilities. Not only that, but they also have cross-cultural business opportunities in their ecosystem. For example, they have signed a deal with a university in drone logistics to help research facilities with organic sample deliveries, which means that in the future they will have a large number of similar customers within the scope of the ecosystem or even far away from a new client who will be a part of the ecosystem. Second, two drone startups, EVA and Vyorius, are connected within a drone ecosystem through which they can mutually benefit from the demand that each other can provide. In this case, EVA has their drone infrastructure facilities and Vyorius, as a software service provider, has a beneficial business understanding with their potential clients, making this ecosystem a lively place for different startups with a lot more growing.

4 | Discussion of results

Starting with a review of the literature on the concept of startups, the purpose of this thesis was to analyze the global industry of drone startups with its state of the art technology advantages, to understand the ecosystem, and to investigate how investment opportunities influence startup tech classification and market strategy. This thesis attempted to address two primary research questions, in particular, using a comprehensive literature review and a mixed-methodology analysis:

RQ 1) How many new drone companies are now functioning on an international level in the drone business, especially those founded after 1.1.2017, and what are their market specializations?

RQ 2) What are these drone ecosystems and their operational categories? How does the market and investment prospects help the sector of cutting-edge drone technology?

This chapter presents an overview of the drone startup sector, state-of-the-art technology, and their ecosystem, explaining its impact on attracting and retaining new investment opportunities, and provides acknowledgement of research results such as through interviews with representatives and founders of the drone startups. Overall, it provides a collection of considerations derived from the analyses provided in earlier chapters that provide full answers to this thesis' research concerns.

4.1. An overview of the drone startups' industry

This thesis analyzed the worldwide business of drone companies by combining online open database, Crunchbase, and gathering data on about 667 firms founded on or after 2017. A sample of 266 firms was carefully selected and studied based on the date the most recent funding was received. These methods enabled us to answer to RQ1: "How many new drone startups are currently operating in the drone industry at an international level specifically born after 1.1.2017 and which are their market specialization?".

Furthermore, certain information that was not immediately included in the datasets were obtained through a broad scouting search that mostly used the businesses' websites and

social networks. We can see that 2017 had the highest number of drone startups founded on a global scale of 85, with the main reason being the clear regulatory released by the FAA for Drone operations and its legal considerations (Lin, C. A. et al. 2018), which encouraged entrepreneurs in the western part of the world to enter the drone business, resulting in the highest spike of drone startups on a global scale in 2017. Starting to witness decline from 2018 to end 2022 were characterized by a much lower number of new companies, which may be due to a variety of factors, such as possible gaps in the update of the database about many active drone startups, the Covid-19 crisis of 2020, which consistently slowed the birth of new firms, and recent war scenario in beginning 2022 Russia-Ukraine War effects with global economic slowdown.

Indeed, the pandemic and subsequent worldwide crisis created severe uncertainty in various businesses, while decreasing the survival rate of existing ones (Ozili, P. K. et al. 2023) and the conflict situation between Russia and Ukraine has caused direct trade to be shut down between the West and Russia, which has begun to have an impact on European industries, the economy, and slowing down with business and inflation rising as these wars persist without an end date. (Prohorovs,A. 2022). This has a huge impact on the drone industry as well, with Europe as the second largest drone startup being economically hit with the rise of inflation and its impact on rising prices with raw material, gas, and oil prices skyrocketing, having left many tech companies in a difficult financial position in the ongoing economic slowdown with rapid increase in inflation, which would also be another major reason for current years startups being at a record low.

Despite the war and economic crisis, the drone industry has captured the headlines with many drone-based military strategies which have helped situation awareness and saved millions of people's lives with commercial drones which gather surveillance and intelligence data (Pong, B. 2022)

Looking at the regional distribution of companies, we can observe that North America has 38% of the total 102 startups dispersed since 2017, followed by Europe (31% with 84 drone startups), Asia (21% with 57 drone startups), and the rest of the world. with 23 startups.

In the beginning of 2017, the western had more investment possibilities, which was the major reason for these firms to be established, and restrictions for new tech startups were greatly simplified, which was another cause for a larger growth in their drone industry. Europe, on the other hand, is nearby and has the largest startup environment for drone firms, with Germany alone spending $0.8 billion in drone startups.

Despite the fact that overall average fundings have been reported at 11 million across

the time horizon from 2017, abruptly dropping to 5-6 million in consecutive years from 2018 to 2021, and the lowest ever fundings were recorded during the Covid-19 pandemic scenarios, However, after the post-pandemic circumstances in 2021 and 2022, fundings for drone startups have progressively increased, reaching $414 million in the current year 2022. Which obviously indicates that the drone sector is picking up speed in terms of finance, new incumbents, and technology in the global context.

Another important finding comes from the sector market study. Drone startup that aims its business and customer target based on their Business to Business (B2B) which in our analysis we found 63% of the drone business are followed by B2B Target market and Business to Government (B2G) which holds its market with 18% globally and last to target with Business to Consumer (B2C) which holds its market with 13%. Given that the bulk of startups' target market is predominantly B2B, this is a foregone conclusion. These fundings are assessed based on the target sector of the start-up firm, as well as the result is consistent with the number of 266 selected startups that served as the base for the market analyzed.

Drone industry startups are more focused on specialized 80% products as their key business selling point, as there is a 20% minority of drone startups which are generalized in the sectors but are still being into various other business segments (for instance, Xiomi Mi[1]- A leading smartphone manufacturers based in China and with various other technology businesses holds the grip of drone industry as well with their commercial camera drones).

Taking a more in-depth look at the product and service based drone startups with a sample size of 266, we discovered that majority of the firms use drones as a product or a mix of product and services, and these startups tend to attract more capital than exclusively service provider drone startups. Looking specifically at the 191 product-based startups from the shortlist, 20% of these startups relied on software as their product, while the other 80% focused on hardware or Hardware + Software startups. Finally, these drone startups depend mostly on their typology of drone with their best use case application keeping many parameters and aspects to make the best output desire from the drone as possible, based on these 266 startup sample we discovered after tremendous investigation that the first to go option was with Multi rotor type drones, and the second best pick was VTOL drones, apart from that there were several drone startups which have drone ports as their product. We identified a few occasions where certain startups were serving as a product or service with multiple combinations of drones (for example, two distinct types of drones employed in their fleet of aircraft such as Fixed wing + Multirotor, VTOL +

[1]https://www.fimi.com/

Drone Port).

4.2. Major factors influencing the amount of fundings received by a startup in the drone industry

Analyzing the attributes of some startups that may make them attractive to different potential investors yielded several important insights. First, using crunchbase funding statistical information, it was possible to find investment intervals and last funding received, as well as more precise information about the investors and different investment options. For the purposes of the analysis, four major investment rounds were identified: seed/angel round, Series A, Series B, Series C, and Pre-Public round. To have a thorough grasp of fundings for drone startups, we must first understand that investment attractiveness and the capacity to prove that their product or service can capture the market, most of the prospective clients, and more the possibilities of product sales or demand grow with the technology or innovative they are, the more that investments come in place. A drone startup with a unique product and disruptive technology that has been protected and reserves a patent on the name of the founder or within the organization has the greatest number of investment opportunities, which may benefit both the investor as well as the organisation, as they would already have a clear vision with the drone product and their target customers in the market. Investors are more interested in tangible products, and then in companies that operate a dual method of product and service, which has much more benefits and is scalable in the future, and most founders believe this is the best and safe strategy to rely on, as technology innovation and the threat of obsolescence are most probable to occur if they take a long time to come to market.

Investors in North America and Europe have exhibited much more investment signals to these drone enterprises with near-future products based on hardware with associated software in recent years. As an example, take Skydio[2]is more an indigenous manufacturer of specialized inspection drones that offers products and solutions, specifically in products they have both hardware state-of-the-art technology processed inspection drones that they manufacture themselves and developed AI software product that they have a greater selling strategy of product as one time cost, and software with subscription model based, which they have a safer business model and this is a mixed method strategy. Target market that the startup focuses on with their product or service with B2B, B2C, or B2G, where investors like to have short term profits with B2C market as the product reaches out to more public customers they benefit the most out of it, on the other hand

[2]https://www.skydio.com/

in the organizations perspective they always want to have a safe long term business growth, which their options will mostly stay at B2B, or even at some fast growing startup companies opt to gain a profit with B2G and B2B2C.

The last investment aspect for growing startups is financial and investment guidance, as well as grants and funding for innovation and entrepreneurs. Seed funds are available from national committees in countries such as the EU Startup Grant, and the United States has a similar financing option for startup founders who have a suitable prototype, ideation, or even business plan with which they can come up with the product and business plan and benefit from seed money. Some viable options include accelerators, incubator programs, and university spin-offs, which have provided numerous drone businesses with much more probable future funding prospects as they develop their products with their assistance.

5 | Conclusions

This final chapter summarizes the research process used to answer the thesis's two main research questions, drawing some conclusions from the findings and analysing the contributions made to the academic literature. Finally, it discusses the research limitations as well as potential hints and pathways for future research.

5.1. Contribution to the academic literature

The purpose of this thesis was to investigate the intriguing reality of global drone startups, their strategy for developing cutting-edge technology and striving to achieve commercial benefits in the drone sector, and the factors that influence their choices. To overcome these research challenges, a mixed-method strategy was adopted. First, a census of startups working in the drone industry throughout the world was performed using data from the Crunchbase database between 2017 and 2022. The insights gained during this phase into the industry provided an answer to the first research issue. Second, a quantitative study was conducted, which involved the development of an econometric model. This approach was used to identify discrete clusters based on given starting criteria, each of which belongs to a certain category. The model was subsequently developed by taking into account a set of features that potentially explain why major players exist in an ecosystem, and how they benefit from collaborating with other peer drone startup ecosystems. In parallel, three international startups' founders were interviewed, with the goal of better understanding founders' and organizations' perceptions of current innovative and technology-oriented drone-based startups, as well as how sustainable they will be with product and service typology, drone typology, and other investment attractiveness to fortify the business. The econometric model and interviews provided an answer to the second study question. There is currently little literature in the global market for the expanding drone industry on cutting-edge drone tech startups and their ecosystems. Despite the numerous theories that have been developed and the availability of papers on the topic of technology startups, Internet - of - things (IoT),Artificial Intelligence (Ai),Machin Learning (ML) Drones in various disciplines, there appear to be no studies that investigate

state-of-the-art drone technologies used in startups and drone ecosystems with modern networks all over the world in the field of drones. The mapping and study of the global drone startups industry revealed its nascent state in comparison to other innovative industries, which can be attributed to a variety of factors, including still inadequate or unfavorable legislation in many countries and people's complete lack of understanding of this technology. Nonetheless, unmanned aerial vehicles (UAVs) have a lot of promise in a variety of sectors and might serve in everything from inspections to maintenance, mapping to surveillance, delivering goods to transporting people, producing entertainment content to establishing marketing campaigns. The econometric model identified different typologies of drone businesses formed each year from 2017 to 2022, as well as their activity, services, and product type. Furthermore, the model attempted to explain how startups choose between different business models based on a set of variables such as the startup's age, the distribution of active or closed startups for each year, the number of founders, the funding received on a geographical scope, and its target market. Finally, the interviews combined the previous stages by showing the startup's genuine scenario from the founders' perspective and illustrating some of the primary reasons for drone firms' success with their target market and technological choices. Overall, the mixed strategy adopted in this thesis allowed for cross-validation of the data, providing light on the developing sector of drone companies.To conclude, the results stemming from this research provide a significant contribution to the academic landscape within this particular field, studying a reality that has not been investigated so far.

5.2. Limitations of the research and future developments

To our knowledge, this is one of the first studies to concentrate on the Current Active Drone startup with its advantages over the drone ecosystem and their state of the art technology which plays a important role in the nacent global drone market , taking into consideration a detailed analysis of the companies' demographic, product, and finance features over a significant period of time (Last 5years). However, research is a complicated process that leads to the development of new scientific information. As a result, it is understandable that it has certain limitations.

Crunchbase data information published there may have gaps in its updating, especially in such a fast-changing environment as that of innovative drone startups. In this case, several changes may occur in a relatively short period of time, making it more difficult to obtain the essential information and maintain the database up to current. Due to

human limitations or incorrect information, partial incorrectness and incompleteness in their filling or updating may occur; for example, new drone startups (Acquahmeyer drone Tech,Garuda Aerospace,and so on) with which I had personal experience working were not included in database, when this research was performed data relative to funding of some startups were missing, most of the details about business typology (B2B,B2C, or B2B2C), leading to an unoptimized final database. Another limitation is that the econometric model, like any other streamlined model of reality, is based on hypothesis; as a result, different upstream assumptions about the characteristics of the business models or their explaining variables could have resulted in different results, which were not investigated in this work.

Another major drawback is that these databases are primarily focused on the western part of the world, with many Asian counterpart drone startups being negligible, but in reality, based on other sources, the data base is inaccurate, and much more startups exist when looking into the Asian and eastern parts of the world as well.

Extensive research on startup drones and its ecosystem was profoundly a hug branch of network associated with the drone industry ecosystem, which would be a greater view of perspective as these analyses cannot fit for our objective of time frame 2017 to 2022, as some of the external resources analysis provide all the industry which serve directly or indirectly in many forms and creating a massive ecosystem as such.

There is room for further research development after the limited timeframe to investigate the whole drone industry. The first would be the drone ecosystem, where there may be one or more instances where many startups could benefit from each other's specialized technology, which today's tech startups have been making a business strategy for growth within ecosystem, which also favourably impact the financial stability of the drone startups. Secondly, this thesis may be utilized as a foundation for future comparative study on other developing technology ecosystems to get a comprehensive picture of the ecosystem startups' technical, financial, cost advantages, and ease of market penetration. At the end of the day, most Drone Startup founders consider it a great opportunity for a win-win situation to have a global corporate network and attract potential customer. Finally, research on innovative and disruptive technology within drone sectors or even other associated industries will be a never-ending chance for prospective learning and may be a complete deal for UAV and Drones companies in today's rapidly expanding industry.

Bibliography

Abdalla, A. S., & Marojevic, V. (2021). Communications standards for unmanned aircraft systems: The 3GPP perspective and research drivers. IEEE Communications Standards Magazine, 5(1), 70-77.

Aissi, M., Moumen, Y., Berrich, J., Bouchentouf, T., Bourhaleb, M., & Rahmoun, M. (2020, December). Autonomous solar USV with an automated launch and recovery system for UAV: State of the art and Design. In 2020 IEEE 2nd International Conference on Electronics, Control, Optimization and Computer Science (ICECOCS) (pp. 1-6). IEEE.

Amponis, G., Lagkas, T., Zevgara, M., Katsikas, G., Xirofotos, T., Moscholios, I., & Sarigiannidis, P. (2022). Drones in B5G/6G Networks as Flying Base Stations. Drones, 6(2), 39.

Andrade, R. O., & Yoo, S. G. (2019). A comprehensive study of the use of LoRa in the development of smart cities. Applied Sciences, 9(22), 4753.

Armour, C., & Ross, J. (2017). The health and well-being of military drone operators and intelligence analysts: A systematic review. Military Psychology, 29(2), 83-98.

Barick, S., & Singhal, C. (2022). Multi-UAV Assisted IoT NOMA Uplink Communication System for Disaster Scenario. IEEE Access, 10, 34058-34068.

Chehri, A., Jeon, G., Fofana, I., Imran, A., & Saadane, R. (2021). Accelerating Power Grid Monitoring with Flying Robots and Artificial Intelligence. IEEE Communications Standards Magazine, 5(4), 48-54.

Choi, D. S., Sung, C. S., & Park, J. Y. (2020). How does technology startups increase innovative performance? The study of technology startups on innovation focusing on employment change in Korea. Sustainability, 12(2), 551.

Finnegan, P. (2017). World Civil Unmanned Aerial Systems: Teal Market Profile and Forecast. TEAL CROUP: Fairfax, VA, USA.

GILARDI, S., & COMINOTTO, R. (2019). The financing of entrepreneurial projects in emerging industries: the drone case.

Greenwood, F. (2021). Assessing the impact of drones in the global covid response.

Hernández, C., & González, D. (2016). Study of the start-up ecosystem in Lima, Peru: Collective case study. Latin American Business Review, 17(2), 115-137.

Kollmann, T., Stöckmann, C., Hensellek, S., & Kensbock, J. (2016). European startup monitor 2016. Graz: Universität Duisburg-Essen Lehrstuhl für E-Business.

Koshta, N., Devi, Y., & Patra, S. (2021). Aerial bots in the supply chain: A new ally to combat COVID-19. Technology in Society, 66, 101646.

Kunovjanek, M., & Wankmüller, C. (2021). Containing the COVID-19 pandemic with drones-Feasibility of a drone enabled back-up transport system. Transport Policy, 106, 141-152.

Lin, C. A., Shah, K., Mauntel, L. C. C., & Shah, S. A. (2018). Drone delivery of medications: Review of the landscape and legal considerations. The Bulletin of the American Society of Hospital Pharmacists, 75(3), 153-158.

Maghazei, O., Lewis, M. A., & Netland, T. H. (2022). Emerging technologies and the use case: A multi-year study of drone adoption. Journal of Operations Management.

Mammarella, M., Comba, L., Biglia, A., Dabbene, F., & Gay, P. (2021). Cooperation of unmanned systems for agricultural applications: A theoretical framework. Biosystems Engineering.

Mao, X., Cheng, J., Li, Y., & Zhang, Y. (2020, July). International Investment Strategies of Chinese High-Tech Company——In the Example of DJI'Four Flyings Strategy. In 4th International Symposium on Business Corporation and Development in South-East and South Asia under B&R Initiative (ISBCD 2019) (pp. 193-198). Atlantis Press.

Maritz, A., Perenyi, A., De Waal, G., & Buck, C. (2020). Entrepreneurship as the unsung hero during the current COVID-19 economic crisis: Australian perspectives. Sustainability, 12(11), 4612.

Martins, B. O., Lavallée, C., & Silkoset, A. (2021). Drone Use for COVID-19 Related Problems: Techno-solutionism and its Societal Implications. Global Policy, 12(5), 603-612.

Mathew, A. O., Jha, A. N., Lingappa, A. K., & Sinha, P. (2021). Attitude towards drone food delivery services—role of innovativeness, perceived risk, and green image. Journal of Open Innovation: Technology, Market, and Complexity, 7(2), 144.

Motoyama, Y., & Knowlton, K. (2017). Examining the connections within the startup

ecosystem: A case study of St. Louis. Entrepreneurship Research Journal, 7(1).

Nyaaba, A. A., & Ayamga, M. (2021). Intricacies of medical drones in healthcare delivery: Implications for Africa. Technology in Society, 66, 101624.

Ozili, P. K., & Arun, T. (2023). Spillover of COVID-19: impact on the Global Economy. In Managing Inflation and Supply Chain Disruptions in the Global Economy (pp. 41-61). IGI Global.

Pong, B. (2022). The Art of Drone Warfare. Journal of War & Culture Studies, 15(4), 377-387.

Prohorovs, A. (2022). Russia's war in Ukraine: Consequences for European countries' businesses and economies. Journal of Risk and Financial Management, 15(7), 295.

Rahman, M. F. F., Fan, S., Zhang, Y., & Chen, L. (2021). A comparative study on application of unmanned aerial vehicle systems in agriculture. Agriculture, 11(1), 22.

Rauch, M., & Ansari, S. (2022). Waging war from remote cubicles: How workers cope with technologies that disrupt the meaning and morality of their work. Organization Science, 33(1), 83-104.

Rejeb, A., Rejeb, K., Simske, S., & Treiblmaier, H. (2021). Humanitarian drones: A review and research agenda. Internet of Things, 16, 100434.

Sarafin, G. A. (2020). Creating Value in Multi-Actor Environments: Understanding the value propositions of digital service ecosystems.

Shavarani, S. M., Golabi, M., & Izbirak, G. (2021). A capacitated biobjective location problem with uniformly distributed demands in the UAV-supported delivery operation. International Transactions in Operational Research, 28(6), 3220-3243.

Skala, A. (2022). Sustainable Transport and Mobility—Oriented Innovative Startups and Business Models. Sustainability, 14(9), 5519.

Spanaki, K., Karafili, E., Sivarajah, U., Despoudi, S., & Irani, Z. (2022). Artificial intelligence and food security: swarm intelligence of AgriTech drones for smart AgriFood operations. Production Planning & Control, 33(16), 1498-1516.

Späti, K., Huber, R., & Finger, R. (2021). Benefits of increasing information accuracy in variable rate technologies. Ecological Economics, 185, 107047.

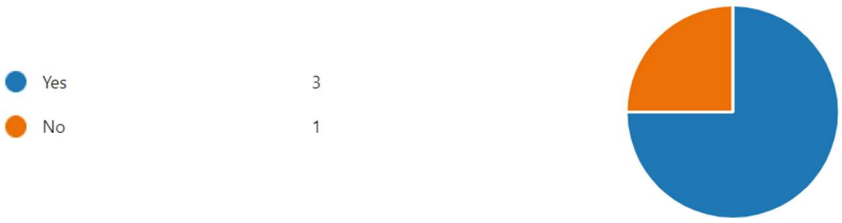
Yaprak, Ü., Kılıç, F., & Okumuş, A. (2021). Is the Covid-19 pandemic strong enough to change the online order delivery methods? Changes in the relationship between atti-

tude and behavior towards order delivery by drone. Technological Forecasting and Social Change, 169, 120829.

A | Appendix A

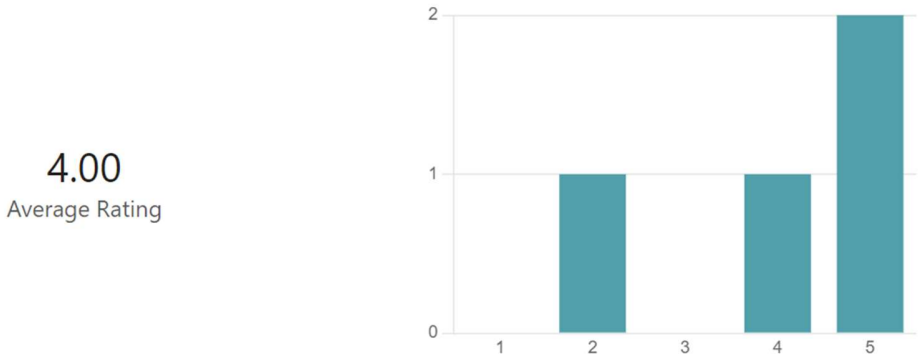
4. Does the innovativeness and disruptive technology in the drone industry is playing major role in market penetration and capturing value at an easy advantage? (0 point)

More Details



5. Does the innovativeness and disruptive technology in the drone industry is playing major role in market penetration and capturing value at an easy advantage? (0 point)

More Details



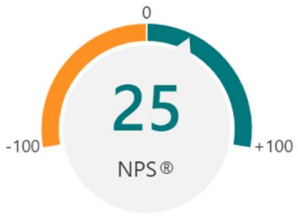
7. How do you see these growing new startups in drone market, competitiveness, and state of the art technology. Will it strive to continue and keep their pace or fade out soon just like many startups which had dissolved in recent years (2017 to 2022) (0 point)

More Details

8. How do you see these growing new startups in drone market, competitiveness, and state of the art technology. Will it strive to continue and keep their pace or fade out soon just like many startups which had dissolved in recent years (2017 to 2022) (0 point)

More Details

Promoters	1
Passives	3
Detractors	0



10. Based on your experience, which Drone startup is more investment attractive ? (0 point)

More Details

Drone startup with Product Based	1
Drone startup with Service Based	1
Drone startup with Both Produc...	3

11. Which Drone sectors you prefer has practical market potential with drones and UAV technologies in coming year 2023 onwards. (0 point)

More Details

Logistics / Transportation	4
Medical / Healthcare	4
Security / Military	4
Industrial / Commercial	2
Agriculture / Forestry	3

12. What reasons, you might think that a drone startup fails at early stages? (0 point)

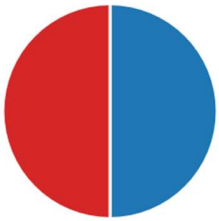
More Details

Technology Obsolesce Reasons	0
Financial / Improper Fund Usag...	1
Inappropriate Product / Services	1
Non Organized Business Model	1
Competition	1

13. Which type of drone do you prefer to be used for best performance and better commercial applications ? (0 point)

More Details

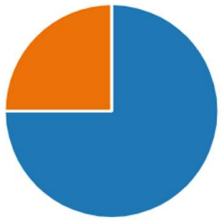
Multirotor	2
Fixed wing	0
Single Rotor/Helicopter	0
VTOL Aircrafts	2



14. Is there a drone ecosystem in this age of growing smart transportation and autonomous vehicles? (0 point)

More Details

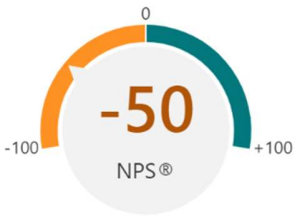
Yes	3
No	1
Maybe	0



15. What is the present state of the Drone Ecosystem in the global drone industry scenario? (0 point)

More Details

Promoters	0
Passives	2
Detractors	2



20. Which Business Model is Best for Long-Term Survivability in the Drone Industry? (0 point)

More Details

B2B	1
B2C	0
B2G	3
B2B2C	0

B | Appendix B

6. Does the innovativeness and disruptive technology in the drone industry is playing major role in market penetration and capturing value at an easy advantage?

4 Responses

1	anonymous	IP - Innovative technology makes it easy to sell OP - Innovative, disruptive technology provides higher margin
2	anonymous	Drone technology is disrupting the aviation industry , the most regulated one. So safety and security is paramount but at same time making it more efficient and cheaper is also important.
3	anonymous	Personal: Right now the most open markets utilising drones don't need innovative disruptive technologies. All they need is a camera in the sky and utilize the data in a certain way. A lot of work then becomes the task of software. Endurance and data accuracy then remains the top priority. Org: If we move away from existing usecases towards agriculture,delivery etc. innovative technologies play a bigger role. And the better these technologies enable safe, cheap and faster solutions the more penetration they get in the market.
4	anonymous	To be recognized in a market and to sell products innovativeness alone wont be enough, the competitors in current drone market are already well established and well funded, a new technology which even if it is disruptive wont help in penetrating the market. It may help with publicity. To enter market and make profit, the product needs to be made cheaper more robust than the competitor.

9. How do you see these growing new startups in drone market, competitiveness, and state of the art technology. Will it strive to continue and keep their pace or fade out soon just...

4 Responses

1	anonymous	IP - Startups will have to innovate to survive OP - Same as above
2	anonymous	I foresee that technology is still in early development stages, so I would see that some of the technology choices will scale and become the default standard while others will fizzle out.
3	anonymous	Individual: I see that hardware will be a commodity and the only value will be in terms of the end application. The startups targeting scalable solutions will sustain and grow. Technology moat will play a role at scale. Org: Technology that enables business to perform any task will be sustainable and thus we see a lot of value in operational efficiency and reducing humans.
4	anonymous	If a company is only focused on Drones in these days they wont survive longer competing with Chinese manufacturing. to survive in the market a company needs to over more solutions and more branches of products, not just

16. Is there a drone ecosystem in this age of growing smart transportation and autonomous vehicles? What is the present state of the Drone Ecosystem in the global drone industry...

4 Responses

1	anonymous	Yes, and individuals are building the ecosystem Yes, companies encourage the creation of ecosystem for increase revenue
2	anonymous	It is still evolving and integration with various other modes has started to happen but yet to be fully developed.
3	anonymous	Individual: Nascent stage. Experimental flights will eventually lead to business understanding. The need to reduce human and save cost will help this industry to progress. Org: Our organisation is focused on building a digital infrastructure to enable scaled fleet operations, of which delivery is one of the target segments. As the flights increase operations will become a hassle and we are solving specifically that.
4	anonymous	DJI is the only eco system that has more influence on the world population.

17. Could you please offer us three advantages and three disadvantages of the global drone market, with its interconnected ecosystem of many industries and startups?

4 Responses

1	anonymous	Advantage - Shared sales teams - Increased number of sales leads, could lead to revenue eventually - Smaller startups can't provide entireties of solution needed by customer,but a consortium (ecosystem) can do it Disadvantage - Lack of trust among members - Lack of transparencies in lead sharing
2	anonymous	Advantages: faster, time and reach in difficult terrains . Disadvantages: high cost, lack of standards, safety and security still under test phases
3	anonymous	Advantage: 1. Information sharing 2. Faster learning curve 3. Collaboration Disadvantages: 1. Competition 2. Supply chain issues 3. Lack of clarity
4	anonymous	Advantages 1.Funding 2.Product expertise can be shared 3.critical feedback Disadvantage 1. High expectations to satisfy 2. Needed large funding to begin with 3. Convincing a larger crowd to release your product

19. Please list any (3-6) ecosystem startups that you have associated with past successful projects and feel comfortable working with as suppliers / vendors.

4 Responses

ID ↑	Name	Responses
1	anonymous	FalconViz DJI Flytbase
2	anonymous	Wingcopter, synerjet, Itochu
3	anonymous	EVA NOKIA BONV
4	anonymous	Web developers Marketing firms with new surveys in hands Social media handlers addictive manufacturing firms local parts suppliers

List of Figures

List of Tables

Acknowledgements

I would like to thank Professor Vincenzo Butticè for his invaluable expertise and encouragement during the development of this study, as well as Ing. Paola Olivares and Ing. Sveva Gallo from Politecnico di Milano's Drones and Advanced Air Mobility Observatory for their invaluable patience and feedback. Thank you for your continuous encouragement and for enabling me to be an active participant in the Observatory's research activities, allowing me to improve my skills and understanding on a daily basis.

Special thanks to Drone experts Neeraj Bansal (Wingcopter), Sid Venkat (EVA), Nishant Singh Rana (Vyorius), and Jan Neuhauß (Aridro Robotics) provided surveys and interviews to enhance my qualitative study.

Finally, I must express my heartfelt gratitude to my family and friends for their unwavering support and encouragement during my two years of study at Politecnico di Milano, as well as the process of researching and writing my thesis. This achievement would not have been achievable without their support.

Author

Balaji Venkatesh Babu