Innovation and Capacity building

in Agricultural Environmental and Rural UAV Services

ICAERUS

D1.1: European Landscape of Drone Innovations and Technologies

Version A

WP1: Drone Landscape Analysis

Responsible Author: Ms Viara Bojkova (NSWR)

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EU Project Advisor	Alessandra Sasso
Project Coordinator	Spyros Fountas
Address	75 Iera Odos, 11855 Athens, GR | Agricultural University of Athens
Reply to	sfountas@aua.gr

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Contributors	Jurrian Doornbos (WU), Stratos Arampatzis (NSWR), Elena Shkurti (NSWR), Aikaterini Kasimati (AUA), Panagiotis Fratzis (AUA), Vassilis Psiroukis (AUA), Marios Anthymidis (GS), Kostas Grigoriadis (GS), Paula Oses (NMN), Salvador Calgua (NMN), Adrien Lebreton (IDELE), Kęstutis Skridaila (ART), Jonathan Minchin (EI)
Reviewer(s)	Dr.Giacomo Carli (OU)

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Participants	Contact
Agricultural University of Athens (AUA), Greece	**Spyros Fountas** sfountas@aual.gr
Wageningen University (WU), Netherlands	**João Valente** joao.valente@wur.nl
Foodscale Hub (FSH), Greece	**Grigoris Chatzikostas** gchatzikostas@gmail.com
Noosware BV (NSWR), Netherlands	**Efstratios Arampatzis** sa@noosware.com
GeoSense IKE (GS), Greece	**Dimitrios Ramnalis** ramnalis@geosense.gr
Noumena Design Research Education SL (NMN), Spain	**Aldo Sollazzo** aldo@noumena.io
Institut De l'Elevage (IDELE), France	**Jean-Marc Gautier** jean-marc.gautier@idele.fr
ART21 UAB (ART), Lithuania	**Laurynas Jukna** laurynas@art21.lt
Ecological Interaction (EI), Estonia	**Jonathan Minchin** jonathan@ecologicalinteraction.org
Hellenic Crop Protection Association (HCPA), Greece	**Francesca Ydraiou** fydraiou@esyf.gr
Agrifood Lithuania DIH (AFL), Lithuania	**Valdas Rapševičius** vrapsevicius@gmail.com
AgFutura Technologies (AGFT), North Macedonia	**Blagoja Mukanov** blagoja.mukanov@agfutura.com
The Open University (OU), United Kingdom	**Giacomo Carli** giacomo.carli@open.ac.uk

RP1 General Project Review – Revision

Expert opinion on deliverable/ Comment	Steps towards addressing it (Partner)
Revised Executive Summary	Added (NSWR)
It may well be wise to split the document in two (ch. 1-3 and ch. 4-5)?	It was suggested that splitting the document in two (chapters 1-3, and chapters 4-5) might be wise, as these parts seem to be about separate topics and can serve different audiences / interests. However, chapters 4-5 are merely the implementation of the methodology presented in Chapter 2 (and, to a bit lesser extent, in Chapter 3). Therefore, one needs to read through Chapter 2 (and, to a bit lesser extent, through Chapter 3), to fully grasp the details and significance of the Use Cases analysis which is presented in Chapters 4-5 (especially in Chapter 5). Splitting the current deliverable in two would require us to 1) include most of the current information in both new deliverables, with a lot of duplication, as the methodological part needs to precede the use case analysis, and 2) re-organise all work so that a logical structure is followed in each one of the two. Also, the overall size would not be lowered significantly, as most of the information would need to be present in both reports anyway, resulting in two (again) large deliverables. Therefore, we decided to keep the initial format of the deliverable, and yet considered the comment of the evaluators by adding the specific guidance and information in the deliverable's publishable summary (which now better details the purpose and logical flow of information in the document). (NSWR)
Terminology used	Section on UAV term has been written (WU)
Section on UAV term has been written	Section on UAV term usage appended (WU)
Drone taxonomy	Updated (WU)
Why is there a distinction between quad-, hexa-, octocopters?	Added sentences (WU)
Where would you place co-axial drones? And shouldn't HALEs, HAPSs or pseudo satellites be in this overview too? Or are they falling in one of the other categories?	Added sentences (WU)
Relevance for the taxonomy	Added sentences (WU)

Payloads - why put all types of cameras apart and then put all other possible interesting payloads in one category "domain specific"?	Updated taxonomy (WU)
"First person view" camera - how would it be included?	Updated taxonomy (WU)
Would that then be a "Visual localisation component"? And what if it does both?	Updated taxonomy (WU)
GPS adjust to GNSS	Updated taxonomy (WU)
Motors only include electrical engines. What about combustion engines?	Updated taxonomy (WU)
Support your choices	Added sentences (WU)
Pre-processing what is meant?	Updated taxonomy (WU)
Is post-processing something specific to drones? And why is the creation of indices considered as pre-processing?	Added sentences (WU)
Fig. 9 is missing a dimension on the x-axis	Fixed, it should be pixel (WU)
Fig. 10 the caption is misplaced	Fixed (WU)
Discussion on cameras - why is it limited to spectral bands?	Added sentences (WU)
Last paragraph on p.45 - literature references	Changed the sentence's meaning. A literature review was not conducted / documented (NMN)

Executive Summary

The UAVs (drones) civil market has been gradually emerging for the last 10-15 years in Europe shaping the future of a more digitised and greener world in accordance with the political priorities set out by the European Commission, European Parliament, and the Council.

ICAERUS project funded under the Horizon Europe Programme (Research and Innovation), the largest research initiative in the world, aims to contribute to the innovative developments in two of the traditional industries of the EU economy – agriculture and rural logistics – to provide a thorough understanding of the usage of multi-purpose drone applications, analyse the current practices, markets, products, initiatives and develop business and governance models to accelerate the deployment of drone applications in Europe.

This deliverable D1.1 as an integral component of the WP1 methodological approach presents a global market research analysis with an overview of the drone market and ecosystems in, the competitiveness of the European drone players and the existing drone technologies with the mounting components. This is covered in the first three chapters of the document. In addition, the report demonstrates a deep understanding of the ICAERUS use cases from a market and stakeholder's perspective, analysing the narrowly defined markets and market segments of each use case, target customers along with the stakeholders' identification and assessment of their needs complemented with a mapping of their relations and interdependencies. This is presented in the last two chapters. As such the deliverable D1.1 covers conducted work in the first ten months of the project under two major tasks:

- T1.1 Understanding the Drone Market [M1 – M42]
- T1.2 Stock-taking of Drone Technologies [M1 – M48]

The objective of T1.1 was to map stakeholders in the drone market and perform a bottom-up analysis of the needs, as well as a top-down analysis of products, services and needs of various innovators and technology providers. The objective of T1.2 was to map the landscape of drone technologies and components to assist in better understanding and integrating technological solutions. As a result of this substantial work, two enormous analyses were performed, and outcomes explained in the chapters of D1.1. For each use case, the stakeholders' network is depicted, identifying the main activities and value exchanges among the selected local stakeholders, and extracting conclusions of all these processes.

In more detail, *chapter 2* elaborates on the global markets, and the market research reveals that the competition for world innovation in drone production and services is not dominated by a sole global player or country considering various market shares from the statistical data analysis. Europe has a leading role in the production and service developments in the larger markets of Germany, France, the United Kingdom, Spain and in a few of the smaller markets like Switzerland, Norway, Austria, the Netherlands, and Belgium. In China, DJI is a global manufacturer of commercial unmanned aerial vehicles and the rest of Asia, including Japan, South Korea, and India, also contribute to this international leadership. The United States has a pioneering role in aircraft manufacturing and the production of "research & science", "stratospheric & space" apps excluding all military applications from this analysis.

Chapter 3 focuses entirely on the technological dimension of this multidisciplinary work package (WP1 *Drone Landscape Analysis)* and scopes out the technologies and applications from UAVs across a variety of research fields. Theoretically it adds more technical details to our global drone market analysis and presents the conducted work in T1.2 "Stock-taking of Drone Technologies" as a systematic tertiary literature study. It explains the terminologies used throughout the analysis and its goal is to identify the variety of UAV technologies used, the use-cases for UAV technologies and present a taxonomy of UAV technologies. Furthermore, the quality of the secondary studies is assessed, and a broader context is provided for the future of UAV literature reviews. The chapter is structured as follows: 1. planning the

review, 2. conducting the review and 3. reporting the review. In the planning stage, the need for a review is identified, research questions are specified, and the review protocol is created. In the second stage, the selection of primary studies, quality assessment, data extraction and data synthesis is performed. The third stage is reporting the review, where the review process is presented in a replicable manner to the relevant stakeholders.

From these initial chapters the readers can understand what the foundations are for building our further analysis to fully outline the drone market of the European Union. They described the intersection between market developments and technical specifications by providing the literature review of engineering publications, terminology, taxonomy, and the market research based on extensive statistical analysis. Then we continue with the last two chapters to shape a comprehensive picture of the local drone markets at a national level. *Chapters 4* and *5* pivoted solely on the project's use cases, their market segmentation and targeted customers as well as the stakeholder networks, and all is performed analytically to give a better understanding of market opportunities and value delivery in the EU member states.

The specific characteristics of the local markets in Spain, France, Greece, Lithuania and North Macedonia, the positioning of each market segment in two industrial sectors – agriculture and logistics – such as crop health assessment, drone spraying, livestock monitoring, biodiversity monitoring and small parcel deliveries show the potential of our use cases for market penetration:

- ✓ **UC1**: represents a very good commercial case of crop monitoring and vineyards disease detection in large terrains of vineyards in Catalonia (Tarragona), where there is a clear shift towards both more high-quality wine products and organic wine production among the local customers. Developing a sustainable business model for UC1 could expand the market to other regions of Spain, and to neighbouring countries.

- ✓ **UC2**: represents an optimisation process in precision agriculture, where the usage of drone spraying could increase crop yields and initially such tests were done in Japan. This case will utilise drone services in the region of Attika (Greece) to explore all benefits of automatic pesticides spraying, collecting data, and assessing the economic indicators of crop production. The success of UC2 and its potential business model could turn the agricultural sector into a technology-driven industry in a country where traditionally agriculture has had a large share of the GDP.

- ✓ **UC3**: has a large scope and aims to utilise drone monitoring of land, farming terrains and livestock. The experimental farms in French provinces of Alps utilise drones to optimise the process of livestock monitoring during times of grazing and resting. UC3 has the potential to expand to Scotland where beef cattle, goats, buffaloes, and horses are in large numbers, as well as grassland terrains are huge, and thus, drone services can be efficient.

- ✓ **UC4**: offers business solutions to land-owners and state agencies in charge of forest protection and biodiversity in Lithuania. It can utilise drone services in hot spots where natural disasters - fire, snow wind, water logging, drought and wild animal digging in forestry regions – are much more likely to happen. Its business model could expand to Scandinavia on a basis of public-private partnerships.
- ✓ **UC5**: offers a technological solution aiming to provide an overall improvement of the supply chain in goods, small packages, and medical products. UC5 has great opportunities of commercialisation and is open to the services it can offer to various customer groups for social purposes – isolated villages, mountain residences, small towns in the Balkans. It starts with a demo in North Macedonia, but with high chances of customisation, covering several neighbouring countries, it

could potentially develop a few business models such as DAAS, value added services and data exploitation.

The analysis in *chapter 4* heavily relied on statistical data of the national statistical offices, collected research data from the use case partners and publicly available data from global reports. As the civil market for drone services has been slowly developing in Europe, for part of the market forces analysis in each of the use cases it has been utilised proxy data in order to provide some initial estimations. What was realised during the preparation of this analysis was the lack of adequate documentation and statistics of the drone market in some of the EU member states.

Chapter 5 performs a stakeholder network analysis to complete the market analysis of the use cases with detailed information about the local stakeholders involved, their roles and objectives, their needs and multiple relationships expressed as value exchanges. The usefulness of this approach and the strategic implications for all five networks are demonstrated by mapping these relations, which provides an improved understanding of various exchanged transactions between all stakeholders in the network, the complexity of interactions and the delivery of value to the entire network of stakeholders. There are five main points identified throughout:

- It is summarised an initial list of stakeholders for each UC via a qualitative assessment.
- The objectives, roles and specific needs of each stakeholder were discussed.
- A template for each stakeholder's profile has been applied.
- The inputs to each stakeholder were used to develop the preliminary value flow maps.
- Different categories of value flows were represented on the maps via differing colours (blue, red, mocha light and green).

The designed maps may be applied in strategic analysis by all use case leaders to utilise *network effects* following five major steps:

1. Define a strategic value proposition.
2. Specify the value flows each stakeholder in the network can provide.
3. Select proper partners based on the initial evaluation of transactions and determine the links that transfer all the value.
4. Add cost and revenue to each offering and analyse the value network theoretically or by simulation.
5. The last three steps may be repeated several times until a satisfactory model is achieved.

This deliverable D1.1 ends with a presentation of results of all surveys and interviews conducted with stakeholders throughout the period of ten months to perform the necessary research and analysis. As such they provided the needed input in defining the networks and complement the background information collected by use case leaders in the start of the project. To summarise the results from both global surveys, the top 10 specific needs are presented as follows:

I. Drone Stakeholders

1. EU R & D projects or collaborating with universities
2. Assessment of operational risks and treatment
3. Certification and legalisation of drone services
4. Training of personnel
5. Working in a network and transferring know-how
6. EU policy directives, regulations, and compliance
7. Understanding regulatory processes and rules
8. Knowledge on optimal, environmental, and safe UAVs operational usage

9. Commercial clients
10. Access to new markets in Europe for drone applications

II. End-users

1. Training of personnel
2. EU R&D projects or collaborating with universities
3. Skilled workforce
4. EU policy directives, regulations, and compliance
5. Knowledge on optimal, environmental, and safe UAVs operational usage
6. Software development and algorithms
7. Shared values and risks
8. Access to new markets in Europe to increase food production
9. Collaborative activities and cost-sharing
10. Research-based evidence of efficiency of drone usage in rural and isolated areas of Europe

These discussions brought not only insights of the participants' needs, interests and expectations, but also insights for the ICAERUS consortium to be further progressed.

Finally, the extensive outcomes of both tasks – T1.1 and T1.2 – and more specifically the market research analysis, the engineering taxonomy and the stakeholder network analysis of all five use cases in this report will be applied in T1.3 "Comparative Analysis & Needs" to conduct a comparative analysis of use cases in WP1, and other tasks of:

- T3.3 / WP3 "Socio-economic & Environmental Impact Assessment"
- T4.1 / WP4 "Syllabus & Certification" and
- T5.6 / WP5 "Inclusive Business and Governance Models

to complete the foundation for accelerating any future deployment of European drone innovations in agriculture and logistics.

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1. Introduction

1.1 The Objective and Structure of the Document

Service innovation focuses on various aspects such as customer involvement and co-creation, especially within the concept of Open Innovation (Science 2.0) or Business Ecosystem and Smart Service System. Leading users or users with high technology readiness also play a very important role in service innovation. The Service Dominant Logic emphasises the central role of users in the innovation process, as they are the driving force of the process. Other recent research is related to the mobile services ecosystem, which is attracting a lot of attention due to smartphones, mobile network infrastructure and mobile service applications. The concept of machine intelligence has been highlighted to understand the smart services. Halloran's study also highlights the importance of IT in characterising smart service innovation[2]. This is based on three fundamentals - big data, cloud computing and intelligent systems - and thus smart services can add value to customers. The selected drone applications presented in our ICAERUS project are part of these smart services offered for the main sectoral uses of drones in Europe, which the consortium will explore and demonstrate.

The key to creating successful innovative services in various European sectors such as agriculture and rural development is to understand how value is created by a mixture of companies working together in a network. With the network concept, modern studies suggest that we should no longer focus on a specific company or industry, but on the value-creating system itself, in which the network actors – suppliers, partners, allies, public authorities and private customers – collaborate to co-produce value. Usually, network actors transform their expertise or core competence into tangible and intangible outputs that are of value to other network actors, helping each other. However, a stakeholder in the network may not have all the skills needed to offer value-added services, and thus, they face the challenge of integrating a group of network actors to create and deliver added value to customers, and to understand customers' perceptions of this added value.

For the purposes of the ICAERUS project, we will use the following operational terms:

- Initiative - they are defined as FP7-Horizon2020 or Horizon Europe projects, scientific reports, policy papers, research reports, other strategic reports, and communications.
- Use Case - ICAERUS takes a use case-based approach. Use Cases are intended to focus on the contextual analysis of a limited number of conditions and their relationships. They are intended to promote understanding of the complex relationships in agriculture, forestry, rural production and to provide knowledge about value systems.
- Applications - the project considers applications as the use of drones to achieve a specific purpose. So, it is a combination of different technologies to meet user requirements in terms of sectoral use. And the applications are focused on the concept of service.

The use cases will be further developed in WP3 ICAERUS Use Cases and Demonstration Activities, but they will be service-based and have a market vision, as WP1 will map the stakeholder networks in each use case and elaborate the process of value creation. These are the five industrial use cases from the DoW that have been proposed for consideration:

UC1: Crop monitoring Use Case (Spain, Tarragona)

UC2: Drone spraying Use Case (Greece, Attika)

UC3: Livestock monitoring Use Case (South France, Alps Provinces)

UC4: Forestry and biodiversity Use Case (Lithuania)

UC5: Rural logistics Use Case (Greece & North Macedonia)

[2] Halloran L., (2012), Value drivers for smart service technology, Doctoral dissertations, Ryerson University, Toronto

Before proceeding with the more detailed analysis of T1.1, Figure 1 presents the general methodological approach of the package. It is based on eight steps covered by all four tasks:

Figure 1 Methodological Approach of WP1

WP1 creates the foundations for the operational framework of this project. It establishes the processes and mechanics for collecting the needed background information from the stakeholders and their networks and transforms it via quantitative techniques into a valuable set of knowledge. The bottom-up approach applied in the stakeholder analysis aims to understand the needs, interests and goals of our use cases' networks, stakeholder's roles in the country's ecosystem and their dynamic developments. In complementarity, the market analysis and the applied top-down approach thoroughly research the current and potential demand and supply in the local markets of the project's use cases to better understand the needs and challenges of the European drone industry. In addition to Task 1.1, which makes the market evaluation, Task 1.2 provides the stock of drone technologies that exist now, categorise them and extract the necessary technical detail to create a taxonomy and a library of drone data analytics. The overall structure of ICAERUS ecosystem is presented in Figure 2:

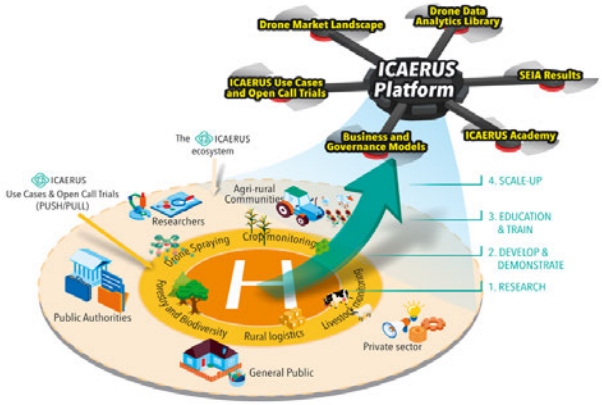

Figure 2 The ICAERUS Ecosystem and Platform

The architecture of this document is based on four major chapters. The first one focuses on the global drone market, recent trends and global players. The second chapter adds all the technical information needed about the existing and potential drone applications as well as the mounted components. The third chapter continues the analysis but narrowly defines the markets to the size fitting the project's use cases and combining this together with the stakeholder network analysis in the following chapter 5, provides us with a thorough understanding of the current industrial structures centred on the drone innovations.

2. Global Market Analysis

2.1 Strategic Management Literature Review

The strategic management literature in recent years focuses on business ecosystems as sources of competitive advantages for the individual firm. It is recognised that for innovative start-ups is more beneficial to be localised in geographical tech hubs, that often are centred around leading universities in the region. The idea of business ecosystems is rooted in the value networks theory and is seen as explaining how a group of companies can simultaneously create value by putting together their assets and skills. Zahra et al (2012) argues that the business ecosystems provide creative firms with resources and knowledge to be able to survive in a globally changing competitive environment[3]. Clarysse et al (2014) provide evidence that business ecosystems are a non-linear value creation process (often informal horizontal links) as groups of firms deliver integrated solutions to the end-users[4]. By origin, the business ecosystem is implicitly assumed to emerge as a result of previously set-up knowledge ecosystems, but the empirical results from European business ecosystems show that the companies from a particular knowledge ecosystem may not necessarily participate in the same regional business ecosystem.

What the research of Clarysse et al (2014) demonstrates also is that innovative start-ups collaborate with different partners separately and try to develop an independent network within established ecosystems, but no industrial organisation takes a central role to lead the network later into its business development.

Another aspect to this issue is that before the service or product commercialisation, actors may delay full-scale investments and the question of their role within the ecosystem may not be relevant. They begin to pay attention to it in later stages[5] after achieving modest technological milestones. Similarly, with the regulations, firms initially ignore them although they expect some regulatory monitoring and pressures to intensify later[6]. For drones initially, it was unclear whether pre-existing regulations covering manned aircrafts would also cover unmanned drones and this lack of understanding led to ambiguity in interpreting existing overlapping regulations and technical standards enforced by EASA, National Civil Aviation Authorities, ISO[7], etc.

Business ecosystems advance further by introducing the customers or a demand side of their markets (Wright, 2014)[8]. Therefore, the innovation in business ecosystems does not focus solely on the technology development, but also on the markets or the commercialisation of their services. For instance, as commercial drone applications expanded to various sectors – photography, precision agriculture, inspection, surveying, and mapping, it appears to be important to understand preferences of customers and products' attributes in their own market segments. It is now clear that while photographers seek stability and no disruptive engine noise during the filming time, farmers prefer high speed drones to cover large fields, carrying payloads for crop spraying, and thermal sensors to assess crop health[9]. Therefore,

[3] Zahra, S.A, Nambisan, S., (2012). Entrepreneurship and strategic thinking in business ecosystems, Business Horizons 55, 219-229
[4] Clarysse B., Wright M., Bruneel J., Mahajan A., (2014). Creating value in ecosystems: Crossing the chasm between knowledge and business ecosystems, Research Policy 43, 1164-1176
[5] Moeen M., Agarwal R., Sonali K.S., (2020). Building industries by building knowledge: uncertainty reduction over industry milestones, Presented at the 2019 Academy of Management Conference, and the 2019 Strategic Management Society Conference
[6] Gao C., McDonald, R., (2019). Shaping nascent industries: innovation strategy and regulatory uncertainty in personal genomics, Working Paper
[7] See more in: ICAERUS (2022/23): T1.4 Standards, Regulations and Risks
[8] Wright M., (2014) Academic entrepreneurship technology, transfer and society: where next? Journal of Technology Transfer 39 (3), 322-334
[9] Shermon A., M. Moeen, (2022), "Zooming-in or zooming out: entrants' product portfolios in the nascent drone industry", Strategic Management, John Wiley & Sons Ltd

the advancements in ecosystems knowledge open new opportunities for technical designs that were previously unknown and transfers of know-how among actors to improve overall operations.

Companies cooperate rather than compete to create and deliver solutions that meet the expectations of end-customers (Moore, 1993)[10]. For instance, Gawer et al (2002) describes how multinationals in the digital world can manage innovation through their business ecosystem as "platform leaders"[11]. Furthermore, Internet and digitisation allow business ecosystems to evolve into digital business ecosystems. Razavi et al (2010) defined the new components of the digital systems. They support a loosely coupled business interaction of firms that maintain the stability and sustainability of their dynamic environment. In contrast with conventional models, digital ecosystem is an open community without any centralised control, providing a range of services to meet the needs of small and large consumers[12].

Through collaboration in a value network, firms explore and exploit their interdependences to create and sustain a competitive advantage over isolated companies. Companies co-evolve their skills and roles in the business ecosystem. Basole et al (2013) have designed and implemented "dotlink360", a visualisation system that provides capabilities to gain systemic insight into the compositional, temporal, and connective characteristics of business ecosystems[13]. It visualises the complex and evolving interfirm relations based on formal contracts, agreements for services in specific market segments, countries, and the entire business ecosystem. Two important ingredients of any business ecosystems are:

(**1**) each partner is specialised in a specific activity, and it is the collective effort of many actors that constitute value, not the individual effort of a firm (Iansiti et al, 2004)[14]; and

(**2**) there is a need for a "keystone" company, which role is to make sure that each member of the ecosystem remains in good health (Moore, 1993).

Keystone players not only create value within the ecosystem but also share this value with other participants. They build "collaborative platforms" such as services, tools, or technologies, which are open for other players to enhance their performance[15].

2.1.1 Networks

Some authors make a distinction between business ecosystem theory and network theory, although the relation between network and business ecosystem has not been researched empirically (Wulf et al, 2017)[16]. Rong et al (2010) extracted some similarities between both theories such as the role of interaction, relationships, innovation, and knowledge[17]. Some other authors refer business ecosystems directly to network theory, seeing it as an advancement of the loosely connected partners, which no longer work in isolation and build up their own strategies (Butel, 2014)[18]. Firms are dependent upon their networked

[10] Moore, J.F. (1993). Predators and prey: a new ecology of competition, Harvard Business Review 71(3), 65-77
[11] Gawer A., Cusumano M., (2002). Platform Leadership: How Intel, Microsoft, and Cisco drive industry innovation. Harvard Business School Press, Boston, MA
[12] Razavi A.R., Krause P.J., Strommen-Bakhtiar A., (2010). From Business Ecosystems towards Digital Business Ecosystems. 4th IEEE International Conference on Digital Ecosystems and Technologies (IEEE DEST 2010)
[13] Basole R., Clear T., Hu M., Mehrotra H., Stasko J., (2013). Understanding interfirm relations in business ecosystems with interactive visualization. IEEE Transactions on Visualisation and Computer Graphics, Vol 19, No 12 (December)
[14] Iansiti M., Levien R., (2004). The Keystone advantage: What the new dynamics of Business ecosystems mean for strategy, innovation and sustainability. Harvard Business School Press, Boston MA
[15] Iansiti M., Lakhani K., (2017). Managing our hub economy. Harvard Business Review, September-October
[16] Wulf, A., Butel, L., (2017). Knowledge Sharing and collaborative relationships in business ecosystems and networks: A definition and a demarcation. Industrial Management and Data Systems, Vol. 117 Issue 7, p. 1407-1425
[17] Rong, K., Hou J., Shi Y., Lu Q., (2010). From value chain, supply network, towards business ecosystem. Industrial Engineering and Engineering Management Conference, Singapore
[18] Butel, L., (2014). Exploring the impact of a business's ecosystem on its strategic decision making. European Academy of Management Conference, Valencia

environment to survive in challenging competitive conditions (Rong et al, 2015)[19]. In some cases, the emergence of a nascent industry is very likely to threaten well-established players that operate as a network. If then the actors from this established network decide to orchestrate a new generation of knowledge and reconfigure novel complementary services to obstruct the newcomers, it is the nascent industry that risks dying (Moeen et al, 2020).
Furthermore, Wulf et al, (2017) applied the technique of expert interviews as part of a larger exploratory multiple case study of several European networks (Germany and Italy) within different business ecosystems, to find out about business ecosystem structures, roles played, and strategies taken. Experts were specifically recruited by the investigation of the innovation network support of the state of Germany. The results overwhelmingly demonstrated how all participants define business ecosystems with elements that are observable in networks, for instance, formal and informal relations among actors, but saw them as bigger structural entity than networks. Business ecosystems were perceived as a network of networks, containing elements that the network theory describes, but without the same number of interactions between partners. Networks were perceived as closer entities than business ecosystems. Summarising it, Wulf et al (2017) study confirms that any business ecosystem consists of different network entities shaped by distinct network structures that provide various routes for sharing knowledge, depending on the role or function of this network within the business ecosystem.

Therefore, business ecosystem theory offers a broader approach to understanding business network structures and potential competitive strategies. It offers researchers a wider methodological basis to understand how firms or actors cooperate and collaborate within this large business environment, and within narrower working groups or other network relations. For example, several scientists and researchers may have to experiment with different approaches before they can reach the successful outcome and generate knowledge within their network's groups. This was the case with the development of insect-resistant crops by Agracetus, Agrigenetics, Plant Genetic Systems (PGS), Monsanto and other labs that worked in parallel to embed Bt genes in plants. Most of these experimental crops were unsuccessful until the PGS succeeded in gene truncations and Monsanto found promoter genes to boost Bt expression[20].

After commercialisation, a better understanding of the promising technological solutions and customer segmentation creates two mixed shifts: (1) the nature of knowledge generated by the network shifts to deepening the technological paradigms and identifying the most tradable value propositions; and (2) such understanding is a critical base for actors in the network to begin attending to ecosystem rules and institutions, to develop customised value chains, create social legitimacy and navigate regulatory regimes. Commercialisation heralds also shifts in the composition of actors and their focus on profitability and value creation. It enables the engagement in market-based mechanisms to capture economic value from each actor's shared knowledge. These tendencies are facilitated by the enhanced conditions for intellectual property protection and development of shared understanding. Then actors focus on selecting mechanisms for actions towards blocking rivals and their access to relevant knowledge. These mechanisms include the use of favourable positions relative to rivals by technology and corporate control, as well as the use of legal barriers by early entrants to extend monopoly positions in product and resource markets (Moeen et al, 2020).

2.1.2 Value Network Approach

In modern days, industries such as telecommunications, defence, agricultural biotechnology, or aeronautics consist of networks of organisations in a constant flux, rather than in a static manner, each working with many others to deliver a final product or service. De Reuver defines a value network as:

[19] Rong, K., Shi, Y., (Eds) (2015), Business Ecosystems Constructs, Configurations, and the Nurturing Process, Palgrave Macmillan, Basingstoke
[20] Moeen, M., & Mitchell, W. (2020). How do Pre-entrants during the industry incubation stage choose between alliances and acquisitions? Working Paper

"a dynamic network of actors working together to generate customer value and network value by means of a specific service offering, in which tangible and intangible value is exchanged between the actors involved"[21].

In this way value networks have been applied to the complex systems in such industries to analyse business models. The framework developed by European universities examines the exchange of goods and services, monetary benefits and intangible benefits circulating within a value network. The exchange of intangible benefits is of increasing importance. In addition, the value network approach has been used to illustrate where economic power is located within the industry through the introduction of *bottlenecks* and *gate keeping functions* and this is documented in the literature[22]. Furthermore, in the United Kingdom, other scholars in Eaton et al (2010) at the London School of Economics used *control points* and *triggers* to identify different model scenarios for mobile services, which research was based on work produced by the Value Chain Dynamics Working Group, part of the MIT Communications Futures Programme[23].

Sutherland (2009) offered a different model by creating the stakeholder value network analysis of the US Aeronautics & Astronautics industry by connecting each stakeholder using the inputs identified[24]. Each defined input to a stakeholder became an output of the originating stakeholder. Theoretically, the sum of all inputs provides a complete set of the value-delivering interactions within the network. In this value network model, the author identifies "value flows" and "value maps" to indicate the output of one stakeholder as the input to another – this represents the delivery of value within the network. The model consists of a qualitative stakeholder analysis initially, and then a quantitative value network analysis which relies on surveys to define the value interaction and channelling, and consequently validates the major stakeholders' value exchanges through meetings with experts. The model quantifies the flows by calculating the value scores, which provides a basis for creating simplified stakeholder value maps.

The stakeholder theory attracts attention in academic research too, since maintaining an appropriate balance among stakeholder interests and gaining their support includes potential benefits for the central firm[25]. A stakeholder in project business literature exhibits similar characteristics to the business ecosystem actor as a term of the ecosystem. WP1's network approach modifies and tailors the MIT methodology of Sutherland (2009) to our use cases as the drone applications entering various industries with multi-purpose functionalities resemble the network structure of the aeronautics industry. Thus, one of the aims of WP1 is to explore the stakeholder networks and to define the value channelling among the major stakeholders of our five use cases.

[21] De Reuver, G., (2009). Governing Mobile service innovation in Co-evolving value networks. Department of Information and Communication Technology, Technische Universiteit Delft, Delft
[22] Ballon P., (2009). Control and Value in Mobile communications: A Political Economy of the reconfiguration of business models in the European Mobile Industry. IBBT-SMIT, VUB, Brussels
[23] Eaton B.D., Elaluf-Calderwood S., Sorensen, C., (2010). A Methodology for Analysing Business Model Dynamics for Mobile Services using Control Points and Triggers. Information Systems and Innovation Group, Department of Management, LSE
[24] Sutherland, T., (2009). Stakeholder Value Network Analysis for Space-based Earth observations. Master Thesis for MSc in Aeronautics and Astronautics and MSc in Technology & Policy. Department of Aeronautics & Astronautics and Engineering Systems Division, MIT
[25] Mok, K., Shen, G., Yang, J., (2015). Stakeholder Management Studies in Mega Construction projects: A Review and Future Directions. International Journal of Project Management, 33: 446-57

2.2 Drone Market Research Analysis

This section focuses on the current global trends, products and services offered in Europe and worldwide which shows the general market information that shapes the landscape of drone ecosystems. Drones carry out a variety of tasks which allows automation by replacing labour and leads to cost savings and safety benefits. The emergence of drone technology in recent years led to the creation of value-added services, new jobs in many business activities, an increase of government investments in aircraft systems, and proper planning of existing infrastructure investments[26].

2.2.1 Current and Potential Usage of Drones

The private sector divides the usage into governmental and non-governmental use of drones. The utilisation for governmental purposes consists of two segments: military and non-military (state flights or security-related; non-state flights incl. safety-related). For instance, in the United States currently Agility Prime, US Air Force and Elroy Air have the mandate to field an initial operational capability by 2023 of the next generation of unmanned Vertical Take-off and Landing (VTOL)[27] aerial systems to meet both government and commercial needs. They will validate and evaluate a specific platform value and capability for the needs of the US Air Force[28]. In Europe, for instance, Pipistrel has been very active in aircraft platforms segment in the last years where they developed innovative high-tech solutions for the specific needs of private customers[29].

On the other hand, in academic literature, Shermon & Moeen (2022) classified the industries adopted drones into five usage segments[30]: 1) photography and videography; 2) short distance inspection; 3) long-distance surveying; 4) precision agriculture and 5) aerial supply chain management.

Typical for the drone usage in these five segments is for the drones to perform common tasks for multiple industries, and some technical differences are required in the specifications to effectively perform those tasks. For instance, for agriculture and long-distance surveying, the suitable drones usually can scout large areas speedily. Drones with a fixed-wing airframe architecture are faster, while longer battery life and autonomous navigation helps with flying BVLOS[31]. For supply-chain and remote delivery tasks, drones typically hover in place and fly long distances, therefore hybrid types with multiple rotors mounted on the fixed-wing airframes are favoured in such cases.

In terms of the payloads, in precision agriculture thermal sensors are acceptable, but multi- or hyper-spectral sensors provide more accurate vegetation data. Naturally, payloads vary in weight, position, and signal interference with the navigation system. That's why, it is important to appropriately match technical specifications of a drone with the nature of the task to efficiently meet customer needs.

In real terms, by calculations of the PwC, based on their drone industry intelligence, the industrial sectors that expect to see the largest gains in adoption of drone applications in our decade by 2030 in another large market for drone services and various applications – the United Kingdom – are Public and Defence, Health & Education; Agriculture, Mining, Water, Gas and Electricity; Transport and Logistics[32].

[26] Source: 2020 Deloitte Access Economics, Deloitte Touché Tohmatsu
[27] VTOL: an aircraft that can take off and land vertically without relying on a runway
[28] See more: *www.airforce.com*
[29] See more: *https://pipistrelaircraft.eu*
[30] Shermon A., M. Moeen, (2022), "Zooming-in or zooming out: entrants' product portfolios in the nascent drone industry", Strategic Management, John Wiley & Sons Ltd
[31] BVLOS: Beyond Visual Line of Sight – operations where the person in charge of operating the drone can't physically see it during some or all of its flight
[32] PwC, "Skies without limits, v2.0: The potential to take the UK's economy to new heights", July 2022

Nearly 1 million drones are expected to be operative in the UK by 2030 as the sectors that can adopt drone services and capitalise on the benefits such as cost savings will have the competitive advantage. The stronger the competition within an industry, the greater the impetus for a first mover advantage in the perspective of adoption. By contrast, in the United States, the Federal Aviation Authority claims that there are 863,895 registered drones and 256,138 certified remote pilots already in December 2021. The expectations for having more than 1 million operative drones in the US by the end of this decade are easily achievable in such a large market. Globally, businesses that operate in smaller markets and subsequently higher operating costs will benefit more from new technologies such as drone applications, and this can help bring them more cost savings and rationalisation of the business processes.

2.2.2 Global Drone Manufacturers

Drone producers are spread all over the world with the largest concentration in the United States. They specialise on different market segments and often collaborate on developing new drone technology. The twelfth well-known manufacturers and start-ups are as follows:

1. *Airbus* (EU) – working on two passenger drones and a commercial parcel delivery drone.
2. *DJI* (Shenzhen, China) – DJI[33] is a global manufacturer of commercial unmanned aerial vehicles for aerial photography and videography. It also designs and produces camera gimbals, action cameras, camera stabilizers, flight platforms, propulsion systems and flight control systems.
3. *Bell* (US helicopter manufacturer) – developing a passenger drone and a delivery drone.
4. *Boeing* (US) – prototyping a cargo air vehicle, known as a heavy-lifter carrying up to 225kg.
5. *Elroy Air* (San Francisco, California) – developed the Chaparral as a Vertical Take-Off and Landing (VTOL) aerial cargo platform. The vehicle can land, deposit cargo, pick up another load, and take-off again, all in just a few minutes and without operator interaction. The design of this pre-production Chaparral C1 vehicle (autonomous VTOL aerial cargo platform) was unveiled in January 2022[34].
6. *Embraer* (Brazil) – developing a passenger drone EmbraerX and is prototyping a delivery drone in collaboration with Elroy Air (US).
7. *Hyundai* (South Korea) – unveiled a LLAS vehicle concept “Hyundai S – A1” with the view of supporting an air-taxi network, which was created in partnership with Uber Elevate[35].
8. *DRAGONFLY UAS* (US) – it launched in 2015 with a mission to provide cost effective and low risk drone technology solutions. Now it is operative in more than 14 countries over four continents[36].
9. *Yamaha* (Japan) – Yamaha remotely piloted helicopters are designed for a wide range of industrial applications, and they were originally engineered for agricultural spraying on rice paddies in Japan (1991). Now Yamaha machines have applications for rice, wine grapes, invasive weeds, tree fruit, sugar cane and volcanic sensing, and are approved for operations in Japan, Korea, Thailand, Australia, New Zealand, and the United States.
10. *Parrot SA* (France) – a manufacturer of commercial drones covering equipment and software. Its product comprises ANAFI Ai and ANAFI USA. The design and engineering are made in Europe.
11. *MicroDrones* (Germany) – produces a series of drones and associated software for a range of applications including mapping, surveying, construction, agriculture, and mining.
12. *Yuneec* (Hong Kong) – is a global leader in multirotor drones and UAV technology. Manufacturer of remote-controlled aircraft designed to conduct aerial photography. Its aircraft ranges from manned aircraft, electric drones, and audio-controlled helicopters to micro-copters and camera supported quadcopters and hexacopters.

In addition, a consortium of manufacturers – *Boeing, Embraer, Bell, and Pipistrel Aircraft* (Czech & Slovak) – are also Uber Elevate vehicle partners. *Uber Elevate* (US) as a newly created venture and its two parent

[33] See: www.dji.com
[34] See: https://elroyair.com
[35] See: https://www.uber.com/us/en/elevate/
[36] See: https://www.dragonflyuas.com

companies, Uber and Joby Aviation[37], agreed to integrate their respective services into each other's apps in Dec. 2020, as this allows seamless integration between ground and air travel for future customers.

What it is observed nowadays is the manufacturers of drone aircrafts are either well established airplane producers such as Airbus, Boeing, Lockheed Martin, Embraer, or completely new funded start-ups that managed to raise capitals on various platforms in the US and Europe, enter the drone production markets, competing with the incumbents and aiming ambitiously to challenge the old players.

2.2.3 Professional Drone operations and Market sectors

Drone operations are grouped by the engineers into (a) aerial work and (b) commercial air transport. Aerial work is an aircraft operation (commercial or non-commercial) where an aircraft is used for specialised services such as agriculture, construction, photography, surveying, observation, patrol, search and rescue, or aerial advertisement. It includes commercial and non-commercial flights; flight training and instructions; test flights, demos, positioning, and air show. Commercial air transport includes cargo and passenger transportation. Drone applications for non-military activities take place in these market sectors[38]:

1. Aerial Photography, Audio-Visual production – flight operations relative to the production of aerial imagery for educational & publicity & informational purposes
2. Agriculture, Fishery, Fish Farming, Forestry – flight operations relative to farming (crop cultivation & livestock breeding), inshore & offshore fishing, fish farming, tree cultivation
3. Air show / Racing – flight operations carried out within the context of a public air show or race
4. Aircraft system or sub-system Production – flight operations relative to the research & development and production of drone systems or sub-systems
5. Cinema & TV industry & media – flight operations for the cinema & TV industry relative to the production of feature & documentary films and the creation of special effects
6. Construction & Real estate – flight operations for various purposes relative to all phases of construction & related promotional & sales activities. All applications except maintenance
7. Demonstration – flight operations carried out for regulatory authorities (certification) or customers
8. Entertainment & Artistic expression & sport – flight operations for public entertainment purposes, artistic expression, sporting events and drone races
9. Environmental protection & conservation – flight operations carried out with the purpose to contribute to maintaining or restoring the quality of the natural environment and protecting wildlife
10. Ferry / Positioning – delivery flights for the purpose of returning a drone to its base of operations, delivering a new drone from its place of manufacturing to its customer, flying a drone from one base of operations to another, or flying a drone to or from a maintenance facility for repairs, overhaul or other work
11. Flight training / Instruction – flight operations conducted by flight schools for the purpose of training /instruction of drone pilots (Duo & Solo flights), qualification verification of pilot license holder (check flights) & flights conducted to maintain pilot competence
12. Heritage site & Historical monument – flight operations relative to the discovery, conservation, documentation & management of historical (incl. archaeological) sites & monuments
13. Humanitarian Aid – flight operations carried out by or for international agencies and non-governmental organisations (NGOs) within the context of natural and man-made disasters or emergency situations with the purpose to assist people in need
14. Insurance (Accident & Claim investigation) – flight operations carried out by or for insurance firms
15. Maintenance – flight operations for maintenance purposes (e.g., on aircraft hulls, buildings, critical infrastructure, industrial installations, offshore platforms, power plants, powerlines, pipelines, refineries, ships, solar &wind turbine farms)

[37] See: https://www.jobyaviation.com

[38] Source: The Professional Drone Operations Market, First Edition, June 2021, Blyenburgh & Co, France

16. Mining & exploration – flight operations related to exploration, mining, and quarry exploration. All applications, except maintenance
17. News Gathering & Broadcasting – flight operations carried out for journalistic purposes
18. Policy Compliance & Obtaining legal proof – flight missions conducted by or for international, regional, or national governmental organisations, or by contractors to such organisations, to verify compliance with specific policies and/or to obtain specific legal proof of non-compliance and/or obtain legal proof
19. Public services & Safety – flight operations carried out by or for civil protection /defence organisations, emergency services, fire brigades &firefighting services, public services, rescue services and utility companies, relative to safety of the public
20. Remote Operation – Non-sensing: flight operations with drones equipped with non-imaging payloads, or without any payload, for specific purposes
21. Remote Operation – Sensing: flight operations with drones equipped with imaging & non-imaging payloads for specific remote sensing purposes
22. Research and Science – flight operations conducted for private or public research or scientific purposes. Includes flight operations carried out for the purpose of testing, experimentation, or validation of new concepts and/or technologies for company internal assessment purposes
23. Security & Law Enforcement – flight operations carried out by or for municipal, regional or state police, border guards, coast guard, custom authorities, harbour authorities, authorities responsible for public safety or critical infrastructure /sensitive industrial site management
24. Transport – flight carried out for the carriage & delivery of goods of persons
25. Utility Companies (public & private) – flight carried out by a corporate entity or governmental agency performing a public service which is subject to governmental regulation (e.g., communications, gas, railways, transportation, water management, Wi-Fi provision). All applications, except maintenance

Flight missions in the market sectors above can be classified as:

Table 1 Flight mission purposes

1. Advertising	16. Observation
2. Aerobatics, special effects & sport	17. Patrolling
3. Aerial photography & film /video	18. Relief flight
4. Broadcasting	19. Search & rescue
5. Deterring	20. Security
6. Dispensing	21. Sensing
7. Exploration	22. Sky painting & writing
8. Fire fighting	23. Special purpose
9. Identification	24. Spotting
10. Inspection	25. Spraying
11. Localisation	26. Surveillance
12. Manipulation	27. Surveying
13. Mapping	28. Test /Experimental
14. Measuring	29. Tracking
15. Monitoring	30 Transport – Goods & Passengers 31. Validation

Source: The Professional Drone Operations Market, Edition 1, June 2021, France

In addition, payloads are elements not needed for flights, but carried for the purpose of achieving specific mission objectives. Imaging payloads (gimballed and non-gimballed) include, amongst others:

- Corona Effect Imager; Digital Photo Camera; Digital Video Camera; Electric-Optical (EO)
- Film camera; Flash LiDAR; Hyperspectral; Infrared (IR); Light Detection & Ranging (LiDAR)
- Laser Scanner; Light Intensification; Line Scanner; Multi-layer Laser; Multispectral – Optical
- Multispectral – Thermal; Near Infrared; Radar; Radar – Ground Penetrating; Radar – maritime; Solid State Photon Counter; Synthetic Aperture Radar.

Sensing and non-sensing payloads are the elements on a drone that permit the capture of non-imagery data and the recording or transmission of such data, and components permitting to perform other non-sensing mission specific activities.

2.2.4 Market Segmentation – Europe, US, China

Acceleration in drone technological development has rapidly occurred since 2010, which was possible due to the higher integration of drones with smart phone applications in a combination with camera, GPS tech and technology for consumer market drones. This further deepened after 2015 with new market entry and a tripling of investment that resulted in greater sophistication of drone functionality and a wider range of market segments[39]. Prior to 2010, drones were adopted only for a limited number of activities for the military, academic communities, government agencies and hobbyists. As a result of this limited usage, there was no well-established market classification and segmentation of drone operations that was used in a systematic way by all scientists, engineers, economists, and industry experts. Many differing classifications and segmentations are suggested by one or another edition, particularly differences can be observed in reports produced by teams in various continents.

Therefore, the drone industry has been emerging gradually and as a recent phenomenon, one industry report[40] that we consider here offers the following segments:

Tier I. Leisure purposes – High definition / full high-definition video, basic flight control software

- Premium specs brought down to mass market price points.

Tier II. Producer – Consumer "Prosumer": Gimbal, detachable full high definition / ultra-high-definition camera, range sensors.

- Most rapid innovation: machine vision, image processing, range sensors and robotics (autonomous control systems).

Tier III. Professional purposes – Large payload, extended range and flight time, advanced sensors

- End-to-end solutions to customer, from drone design to software and cloud-based services; Greatest variation in look, price and specification.

In many sectors commercial drone applications are in the early to middle stages of development, which offers various categorisations of drone technology (see Table 2) and drone apps. The categories presented below are based on the technology data collected in Australia by Deloitte Touché Tohmatsu. There is huge potential for market growth along with the benefits of improving efficiency of production and increased safety as drones take over higher risk tasks previously done by workers. Drone technology will be able to create new markets, particularly in the sectors where the technology is in early to middle stages of development, and then they will diversify and make more complex the classification and segmentation.

Table 2 Technology-based categories

1. Aerial photography	Late stage

[39] International Transport Forum (2018), "(Un)certain Skies? Drones in the World of Tomorrow", OECD

[40] Concepts from Oppenhiemer, Drone Industry Report, Equity Research, Industry Update, February 2016

2. Aerial patrol (border control and public safety)	Late stage
3. Precision agriculture	Late stage
4. Emergency management	Middle stage
5. Construction /real estate images and monitoring	Middle stage
6. Infrastructure monitoring	Middle stage
7. Film making and other media uses	Middle stage
8. Oil and gas exploration	Middle stage
9. Weather forecasting and meteorological research	Middle stage
10. Mail and small package delivery	Early stage

Source : 2020 Deloitte Access Economics, Deloitte Touché Tohmatsu, Sydney

Quantity produced and development per country

There are about 16-17 types of drones or so-called RPAS[41] worldwide produced and flying. The start-ups involved in the production of drones are less capital intensive, often funded by venture capitalists, who can react quickly to the market changes and needs but have no real experience from the aviation industry. The production in 2021 is presented in actual numbers in Table 3 per country:

Table 3 All categories production, 2021

Austria	12	0.57
Belgium	13	0.62
Bulgaria	6	0.28
Czech Republic	15	0.72
Denmark	7	0.33
Estonia	5	0.24
Finland	4	0.19
France	97	4.64
Germany	92	4.40
Greece	4	0.19
Hungary	7	0.33
Ireland	6	0.28
Italy	31	1.48
Latvia	10	0.48
Lithuania	1	0.05
Netherlands	23	1.10
Norway	17	0.81
Poland	35	1.67
Portugal	11	0.53
Romania	5	0.24

[41] RPAS – Remotely Piloted Aircraft Systems (popularly called as UAVs or drones)

Slovakia	4	0.19
Slovenia	11	0.53
Spain	41	1.96
Sweden	10	0.48
Switzerland	26	1.24
UK	74	3.54
Total Europe	567	**27.09**
Only EU-member states	450	21.50
Other countries outside EU		
USA	420	**20.10**
Japan	49	2.34
China	288	**13.80**
South Korea	51	2.44
India	34	1.63
Israel	132	6.30

Source: RPAS The Global Perspective Volume 1, 2022

The total number of producers was 726 spreads over 68 countries in early 2022. The European Union is represented by 23 countries or 34% of all country-producers. If Norway, Switzerland, and the UK are added to the list, Europe has a market share of 38% of all countries producing drones. And Europe manufactured 27% of the total production in 2021, which proves the existence of industrial facilities, business networks, larger digital ecosystems and expert skills needed to accomplish such a market share. Other large producers are the United States, China, Israel, and a few Asian states. In terms of manufacturing all categories of RPAS, the US is in the second position after Europe with a market share of 20%. India as an Asian representor comes after South Korea and Japan. Also, Israel has an impressive position in this market, having developed and produced more drones than Japan and South Korea taken together (see Fig.3).

In Europe, there are a few large drone producers and markets – in 2021, the German market was worth €840 million ($995.76 million), and the Swiss market was worth CHF435.4 million ($475.62M). There are approximately 430,700 drones flying in Germany and 56,000 in Switzerland in total, which puts Germany in number 1 and Switzerland in number 9 in Europe. The commercial market in Germany is expected to grow at a rate of 14.5% CAGR for the next 5 years, while in Switzerland – the expected rate is 11% CAGR. Until 2021, Switzerland allowed several types of companies to test their drones and services before bringing them to market. Currently, there is a debate to the regulatory path that the country should take regarding the ratification of regulations EU 2019/947 and EU2019/945.

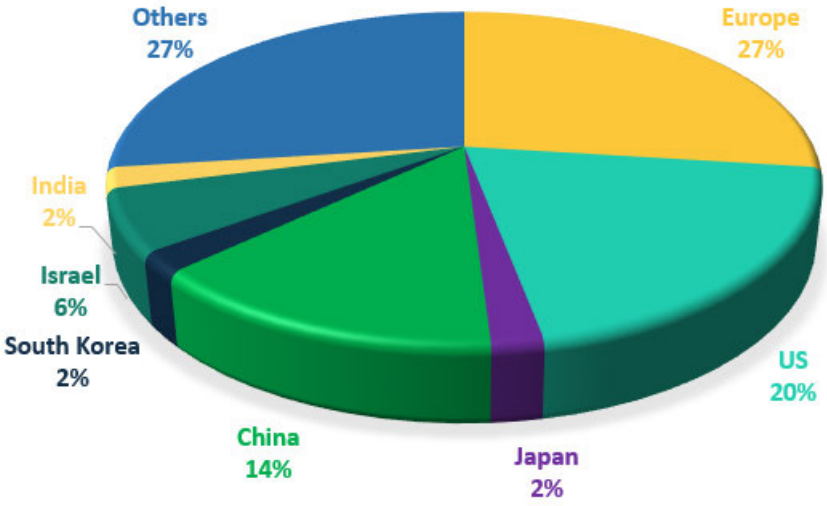

Figure 3 All categories production, 2021

The quantity of applications is grouped below in Table 4 and demonstrates the importance of commercial apps used for civil purposes, which accounts for more than 40% of all apps. The military apps have a 26% share of all apps as well as the dual-purpose applications. Of all these applications, 56% have been developed and ready to enter the market and only 6.5% are at the level of a proof-of-concept demonstrator.

Table 4 Quantity of drone applications

Applications	Number
Civil / Commercial apps	910
Military	543
Dual purpose	553
Research & Science	32
Developmental	51
Stratospheric & Space	3

Source: RPAS The Global Perspective Volume 1, 2022

The apps distribution by country follows below in Table 5, which clearly indicates the competitive edge in “civil and commercial applications” that Europe owns as Germany and France are leading the contest. Then Table 6 presents the data of produced “research and science applications”.

Table 5 Civil and commercial applications per country

Country	Total number of applications	(%) Market share of the world production
Austria	7	0.77
Belgium	9	0.99
Bulgaria	3	0.33
Czech Republic	11	1.21
Denmark	2	0.22
Estonia, Lithuania	0	0
Finland	4	0.44

France	67	7.36
Germany	63	6.92
Greece	2	0.22
Hungary	5	0.55
Ireland	5	0.55
Italy	21	2.31
Latvia	6	0.66
Netherlands	14	1.54
Norway	10	1.09
Poland	4	0.44
Portugal	3	0.33
Romania	0	0
Slovakia	1	0.1
Slovenia	5	0.55
Spain	12	1.32
Sweden	7	0.77
Switzerland	21	2.31
UK	37	4.06
Total Europe	319	**35**
Only EU-member states	251	27.6
Other countries outside EU		
USA	165	**18.13**
Japan	46	5.05
China	176	**19.34**
South Korea	16	1.75

Source: RPAS The Global Perspective Volume 1, 2022

A market share of 35% belonged to Europe in manufacturing commercial applications for the civil society purposes in 2021. Switzerland and the UK as non-EU states, make up 6.4% of the market size.

In terms of research & science aircrafts and applications the presented statistics demonstrates the advantages of the US in this market segment. Europe had in total 10 drones dedicated to research and science or 31% market share (2021). These are projects run by various European universities. In the US, there are 14 produced drones in 2021 used solely for scientific purposes, developed with the involvement of universities, NASA Research centres and companies such as Boeing, Lockheed Martin, and others. Plus, two Space Apps and one Stratospheric App have been developed and run only in the US. In the UK, Cranfield University Aerospace Department cooperates with firms to develop research aircrafts as part of the UK airframe. The European Union has had half (21.87%) of the US market share in producing drone

applications for research & science. Obviously, China is far behind in this contest as it ran merely one drone for science with a market share of 3.12% (2021).

Table 6 Research and science applications per country

Country	Total number of applications	(%) Market share of the world production
Austria	2	6.25
Belgium	2	6.25
Italy	2	6.25
Norway	1	3.12
Portugal	1	3.12
Switzerland	1	3.12
UK	1	3.12
Total Europe	10	**31.25**
Only EU-member states	7	21.87
Other countries outside EU		
USA	14	**43.75**
China	1	**3.12**

Source: RPAS The Global Perspective Volume 1, 2022

In developmental aircrafts and applications Europe has had a pioneering role with nearly 61% market share with the leading positions of the UK, Germany, the Netherlands, and Romania. Universities have a significant involvement in the Netherlands while in Germany and the UK companies play a more important role. The US has had only 4 developmental drones with a market share of 7.8%, and Japan has 2% share. Top drone applications take place primarily within the energy sector (14%), followed by 12% in construction and 9% in agriculture. Combined, they represent 35% of all civil drone applications and they are the top three in terms of industry.

2.2.5 Drone Service Providers

Terra Drone, a major Japanese drone service operator and system integrator, is the biggest provider of drone service worldwide. They have presence in more than 25 countries, focusing on geographical data acquisition, industrial inspections, and high-end aerial imagery, using unmanned aircraft UAVs.

Table 7 Top 10 drone service providers, 2020

	Company	Category	Region	Market share (appr.)
1.	**Terra Drone** *https://www.terra-drone.net/global/*	Mapping/ Surveying, Inspection	Japan	60%
2.	**Aerodyne Group (DT3)** *https://aerodyne.group*	Mapping /Surveying, Inspection	Malaysia	58%

3.	**Cyberhawk** *https://thecyberhawk.com*	Mapping /Surveying, Inspection	UK	50%
4.	**Measure (an AgEagle Company)** *https://www.measure.com/company*	Mapping /Surveying, Inspection	US	38%
5.	**Skylark Drones** *https://www.skylarkdrones.com*	Mapping /Surveying, Inspection	India	32%
6.	**Sky Futures** *http://www.sky-futures.com/about-us*	Mapping /Surveying, Inspection	UK	22%
7.	**Falcon Eye Drones** *https://www.feds.ae/about*	Mapping /Surveying, Inspection	United Arab Emirates	17%
8.	**Avitas System (A Baker Hughes venture)** *https://myavitassystems.com*	Mapping /Surveying, Inspection	US	15%
9.	**Sharpershape** *https://sharpershape.com*	Mapping /Surveying, Inspection	Finland (EU)	13%
10.	**AUAV (Vertech Group)** *https://www.auav.com.au*	Mapping /Surveying, Inspection	Australia	12%

Source: Drone Industry Insights, 2020 (DRONEII.com), Germany

In the list of top 10 providers for 2020, there are two British drone operators and a Finnish company, taken the 3rd, 6th, and 9th rank. The other seven operators are based outside Europe (see Table 7). Since the UK is not part of the European Union anymore, it appears that the EU is represented by only one Finnish drone operator in the top ten providers' list with a small share of 13% of the global market.

2.2.6 Drone Software Developers

This section presents ten software developers with their technological solutions:

1. Scanifly[42] (US) – develops a drone-based 3D modelling software that automates and centralises the manual day-to-day tasks in the solar workflow.
2. Sentera[43] (US) – develops an agricultural data analytics technology designed to deliver agronomic insights that improve cultivation outcomes. The company's technology includes customisable drones, sensors, interpretive software, and data management systems that unify website, mobile, desktop, and application program interfaces to deliver easy-to-understand reports, enabling clients to gather data, develop insights, and take actions to optimise outcomes.
3. Skycatch[44] (US) – develops an aerial intelligence platform intended to provide enterprise-grade drone mapping and data analytics. The company focuses on indexing and extracting critical information from the physical world, and uses a combination of hardware, software, and artificial intelligence to deliver high-precision data at unprecedented speed and ease of use.
4. Altitude Angel[45] (UK) – develops the next-generation cloud technologies for automated air traffic control drones. The GuardianUTM (Unmanned Traffic Management) platform provides essential

[42] https://scanifly.com
[43] https://sentera.com
[44] https://skycatch.com
[45] https://altitudeangel.com

safety and foundation services to drone pilots, manufacturers, and developers to deliver enhanced situational awareness.

5. PrecisionHawk[46] (US) – provides drone and UAV remote sensing applications and data processing services in energy, agriculture, and telecom. The company's platform blends multiple layers of data sources collected through satellite, manned aircraft, drones, and ground crew's artificial intelligence-powered analytics, delivering a single, streamlined point of access to geospatial intelligence, enabling clients to turn drone imagery into actionable insights.
6. Atlantic Drone Pros, LLC[47] (US) – offers software solutions for unmanned aircraft, optics, ground controllers, and aircraft systems. The company develops a flight and fleet management system that uses artificial intelligence and machine learning to generate flight plans, monitor aircraft traffic and weather, and handle and mitigate emergencies.
7. DroneDeploy[48] (US) – a provider of cloud-control software solutions for drones which include automated flight safety checks, workflows, and real-time mapping and data processing. The company has partnered with leading drone manufacturers like DJI to provide its software to end users in a variety of industries, including agriculture, real estate, mining, construction, inspection, surveying, and many other commercial and consumer arenas.
8. Auterion[49] (Switzerland) – a software company bringing open-source and open-standards into the mobile robotics industry for a simplified user and deployment experience through connected and autonomous fleets of drones in the air and on the ground. This allows for easy data collection, cargo delivery or ISR missions with data integration into existing or new workflows.
9. MicroDrones[50] (Germany) – produces a series of drones and associated software for a range of applications including mapping, surveying, construction, agriculture, and mining.
10. Kespry[51] (US) – provides drone systems for commercial markets. It is designed to enable capture, analysis, and sharing of aerial data for use in aggregate mining, agriculture, and other industries where aerial topography analysis is important.

2.2.7 Drone Innovators

In the United Kingdom, the Civil Aviation Authority together with the UK Research & Innovation work to accelerate the progress of new technologies and advanced aviation solutions to deliver the third revolution in aviation. The projects that are funded[52] demonstrate the potential societal benefits such as:

(a) Ensuring safety; (b) Transitioning to cleaner forms of flight;
(c) Real-world demonstrations with the involvement of public bodies and regulators.

There are several highly innovative projects focusing on different market segments such as international humanitarian medical logistics; urban mobility such as air-taxis and airports for eVTOL aircraft; testing solar powered drones for deliveries of pathology samples; autonomous beyond visual line of sight drone services; leading-edge unmanned aircraft “drones” and artificial intelligence technologies, paving the way for cheaper, more reliable, and accessible improvements in safety; an advanced drone system for autonomous flights in industrial environment.

In conclusion, the competition for world innovation in drone production and services is apparently not dominated by merely one global player or country based on the market shares of world production presented in Table 3, 5 and 6. Europe has a leading role in the production and service developments in the larger markets of Germany, France, the United Kingdom, Spain and in a few of the smaller markets

[46] https://precisionhawk.com
[47] https://atlanticdronepros.com
[48] https://dronedeploy.com
[49] https://auterion.com
[50] https://microdrones.com
[51] https://kespry.com
[52] Funded under the Future Flight Challenge at UKRI in 2022

like Switzerland, Norway, Austria, the Netherlands, and Belgium. China has a competitive edge in the commercial drone applications and drone production as DJI is a global manufacturer of commercial unmanned aerial vehicles. The rest of Asia, including Japan, South Korea and India, also contribute to this international leadership. Excluding the military applications from this analysis, the United States has a pioneering role in aircraft manufacturing, and the production of "research & science", "stratospheric & space" apps. Many start-ups emerge in the US and UK business ecosystems with the participation of leading universities and science bodies that design new applications and create markets.

3. Drone Technologies

3.1 Methodology

This section scopes out the technologies and applications from UAVs across a variety of research fields, adds more technical details to our global drone market analysis and presents the conducted work in T1.2 "Stock-taking of Drone Technologies" as a systematic tertiary literature study. Different from a systematic literature study, a tertiary study aggregates information only from secondary studies on the subject matter[53]. The goal of this tertiary study is to identify the variety of UAV technologies used, the use-cases for UAV technologies and present a taxonomy of UAV technologies. Furthermore, the quality of the secondary studies is assessed, and a broader context is provided for the future of UAV literature reviews. The process of a systematic literature review is set in three stages: 1. planning the review, 2. conducting the review and 3. reporting the review[54]. In the planning stage, the need for a review is identified, research questions are specified, and the review protocol is created. For the second stage, conducting the review, the selection of primary studies, quality assessment, data extraction and data synthesis is performed. The third stage is reporting the review, where the review process is presented in a replicable manner to the relevant stakeholders.

Research Questions

The aim of the review is to identify UAV technologies and use-cases, develop a taxonomy, assess the quality of literature reviews, and provide prospects in UAV literature reviews. This is done by answering the main research question:

How are UAV technologies categorised and how can this inform UAV technology decision making for practitioners? This question is broken into the following sub-questions:

I. RQ1. Which problems/services do the drone-projects solve/provide?
II. RQ2. Which technologies are used in academia (universities and research-oriented institutions)?
III. RQ3. How do found technologies and services interrelate to each other
IV. RQ4. How can this review inform UAV technology characteristics for the Use-Cases?

Overview of process

In the flowchart in Fig. 4, the overall process of the data acquisition and extraction is presented. The top part deals with the search process and in/exclusion of articles. Continuing down, the relevant information is extracted from the literature reviews into additional datasets. Finally, information of the payloads and UAVs is augmented with a grey-literature search.

The search process

To cast a wide net for the search, three databases, and one indexing system were searched for articles. The searched databases were IEEE Xplore, ACM and Clarivate "Web Of Science", the Elsevier Scopus indexing system was also queried for articles. The search was executed on 08/08/2022, for IEEE Xplore

[53] Kitchenham, B. et al. (2010), Systematic literature reviews in software engineering – A tertiary study. Information and Software Technology 52, 792–805. issn: 0950-5849
[54] Kitchenham B. et al. (2010)

and ACM, Scopus was searched on 09/08/2022 and “Web Of Science” was searched on 09/09/2022. All the databases had the following query for all fields (title, keywords, abstract).

” UAV” AND (“review of studies” OR “structured review” OR ”systematic review” OR ”literature review” OR ”literature analysis” OR ”literature survey”)

The usage of Drone, RPAS and UAS would increase results beyond UAV. Scopus indicates 317 documents between 2012-2022 in the above search term. Whilst adding RPAS, Drone or UAS increases this to 515. However, the number of ‘false positives’ also increases dramatically. For example, UAS is also used in urology for “ureteral access sheath”. And the term drone is central to melitollogy, the study of bees. Furthermore, due to the focus on academic systematic literature reviews, the term UAV is the most present and widespread word, therefore true positives are not increased siginificantly. When discussing UAV technology from the academic literature review perspective, UAV is the chosen term, however RPAS, UAS and drone are also relevent, and various usages of the term are encouraged for use. Therefore it is recommended for future research to include “RPAS”, “UAS” and “drone” in the search query to cover all possible permutations of the flying platform.

Furthermore, to acquire all relevant information based on the recent usage of UAVs, the results were limited to be from 2012 onward. These queries resulted in a total of 608 studies.

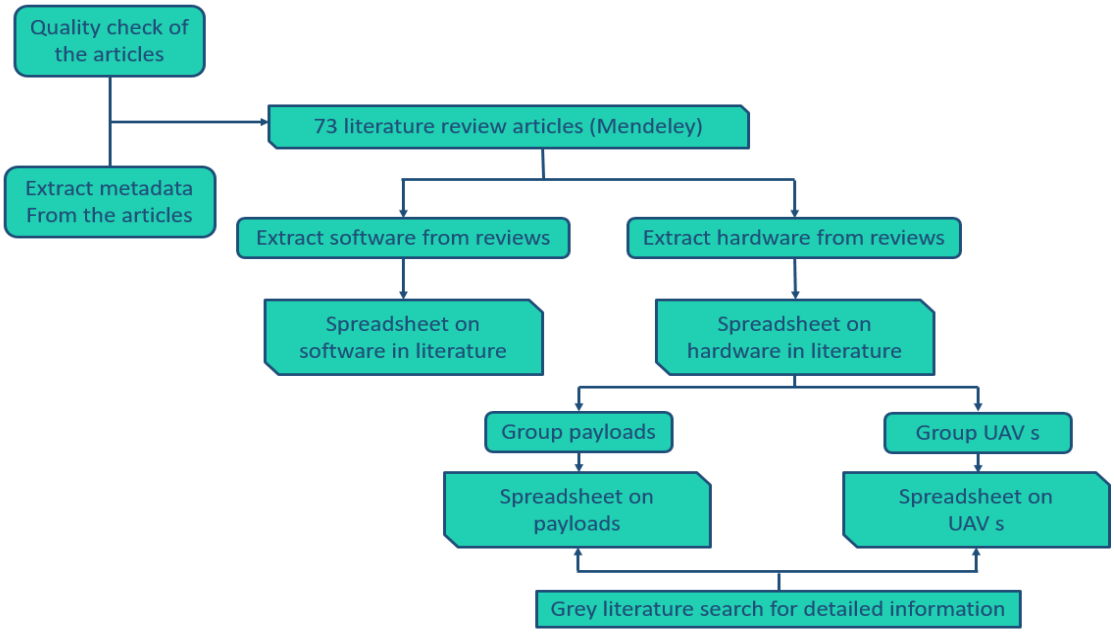

Figure 4 Data extraction flowchart

Study selection

The 608 studies were included following a process adapted from the PRISMA standard[55]. These steps can be seen in figure 5. The most important inclusion step was whether the review is *’based on a defined search process’*, taken from Kitchenham et al[56]. This means that the exact search queries and which search databases were clearly presented in the article in the form of text or figures. These inclusions led to the final inclusion of 73 systematic literature review articles.

Quality assessment

[55] Page, M. J. et al. (2021), The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. Systematic Reviews 10, 1–11. issn: 20464053. https://systematicreviewsjournal.biomedcentral.com/articles/ 10.1186/s13643-021-01626-4

[56] Kitchenham, B. et al. (2010), Systematic literature reviews in software engineering – A tertiary study. Information and Software Technology 52, 792–805. issn: 0950-5849

Each review was evaluated according to four criteria presented in Kitchenham et al., who adopted it from NIHR[57] . This quality check was executed by the first author. The criteria cover the following questions:

- Are the review's inclusion and exclusion criteria described and relevant?
- Is the literature search likely to have covered all relevant studies?
- Did the reviewers assess the quality/validity of the included studies?
- Were the basic data/studies adequately described?

These questions from Kitchenham et al were scored (Y = 1, P = 0.5, N = 0) according to the following answers:

Question 1: Y (Yes), the inclusion criteria are explicitly defined in the paper; P (Partly), the inclusion criteria are implicit; N (No), the inclusion criteria are not defined and can-not be readily inferred.

Question 2: Y (Yes), the authors have either searched four or more digital libraries and included additional search strategies or identified and referenced all journals addressing the topic of interest; P (Partly), the authors have searched 2 or 3 digital libraries with no extra search strategies, or searched a defined but restricted set of journals and conference proceedings; N (No), the authors have searched up to 1 digital libraries or an extremely restricted set of journals.

Question 3: Y (Yes), the authors have explicitly defined quality criteria and extracted them from each primary study; P (Partly), the research question involves quality issues that are addressed by the study; N (No), explicit quality assessment of individual papers has been attempted or quality data has been extracted but not used.

Question 4: Y, (Yes) Information is presented about each paper so that the data summaries can clearly be traced to relevant papers; P, (Partly) only summary information is presented about individual papers e.g. papers are grouped into categories but it is not possible to link individual studies to each category; N, (No) the results of the individual studies are not specified i.e. the individual primary studies are not cited.

Data extraction process

The data extraction process is presented in the lower half of Fig 4. For the reviews, information on number of primary sources, date-range of queries and whether it included grey literature[58] was extracted. Whether the article included these structured details on the primary source was also noted in this extraction. In reviews presenting the software and hardware used in the primary sources, this data was also extracted. However, only when it was presented in a structured and detailed manner traceable to their primary sources, as tables in the paper, or published as supplementary material. These variables were stored in new data extraction tables.

As all the reviews were written by different authors and from different backgrounds, the naming conventions, as well as the type of information that was extracted was not standardised. This means that there was little overlap between the reviews in variables included in their data extraction of the primary sources. To overcome this problem, a data-cleaning step was included to make variables group-able and comparable. For example, payload naming conventions: different spellings for the MicaSense MCA lite Multispectral sensor would all be renamed to: 'MicaSense MCA-Lite'. This type of standardisation was more problematic when reviewers overlooked critical details, such as different model types of the DJI Phantom 3 model. As the 'DJI Phantom 3' itself does not exist, but a 'DJI Phantom 3 Professional' does exist. Such cases were left as is and cleaning the name would be done with the most detailed information that was provided.

[57] NIHR Centre for Reviews and Dissemination. About DARE (2015), https: //www.crd.york.ac.uk/CRDWeb/AboutPage.asp

[58] Grey Literature, or evidence not published in commercial publications can make important contributions to a systematic review.

Grey literature search

In a grey literature search, information not available in primary sources, can be added upon to give other information that is not usually reported in published work[59]. This was the case for many payload and UAV models acquired in the data-extraction process. The UAV and payload models that were extracted in the previous step were grouped into the unique models. This grouping formed the basis for a grey literature search, in which additional information on every unique piece of hardware was acquired. This search was executed by entering the model's name into Google Search and going through the first five results on the page.

A website was selected as a primary source if it was capable of giving the most information possible. For the validity of this data, the manufacturer of the hardware was given priority over webstores, which in turn were given priority over blog posts and review articles. The reason being that manufacturers and webstores have this information more systematically presented and have an interest to give the most detailed information on their product. However, this also means that this table can have errors and biases to what manufacturers would want to present as the main features of the product. The URL and the accessing date were noted in this search.

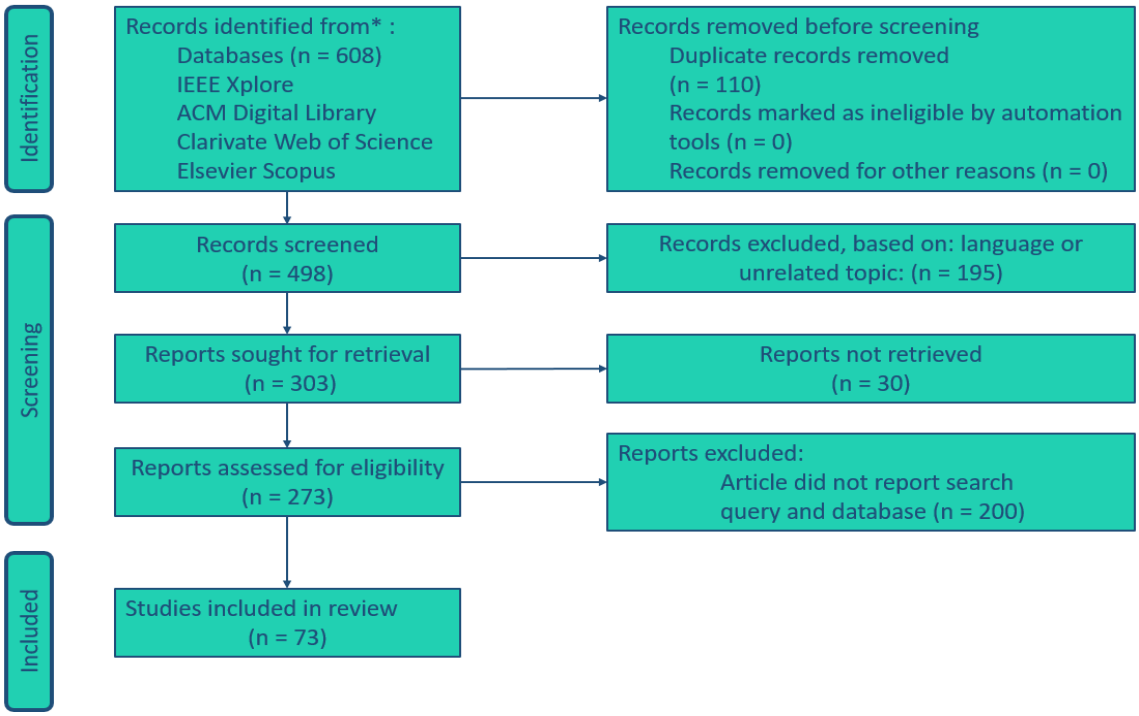

Figure 5 Article selection and extraction flowchart

The various literature review terms are:" review of studies"," structured review", "systematic review", "literature review", "literature analysis" and "literature survey".

3.2 Results

Taxonomy of UAV Technology

UAV technology is a large and broad term, where different fields use the term with different connotations and meanings. Taxonomies can help create a shared knowledge representation and ways to communicate in interdisciplinary teams[60]. This taxonomy presents different technologies as identified by their implementation in hardware or software. Important to understand is that each block, relation and end-point

[59] Garousi, V., Felderer, M. & M¨antyl¨a, M. (2019), Guidelines for including grey literature and conducting multivocal literature reviews in software engineering. *Information and Software Technology* 106, 101–121

[60] Kitchenham, B. A. & Charters, S. (2007), Guidelines for performing Systematic Literature Reviews in Software Engineering tech. rep. (Keele University & Durham University); Costin, A. M., Eastman, C. & Issa, R. R. (2017), The Need for Taxonomies in the Ontological Approach for Interoperability of Heterogeneous Information Models. Congress on Computing in Civil Engineering, Proceedings 9-17

can be a research field on its own, and there is no clear beginning or end to UAV-technologies, as it lends from other technological developments. Furthermore, it is based on existing literature reviews and their data-extraction, this methodology results in a focus on technologies that have been applied, and an exclusion of the state-of-the-art within the taxonomy. However, new technologies, designs, platforms and sensors are always updating, making the taxonomy an ever-evolving, changing artefact. This results in a requirement to perform periodic updates to the Taxonomy, based on new insights and aspects.

The main distinction that is made is between hardware technologies and software technologies. Under hardware technologies we understand platforms, components, and payloads. Platforms are the different UAV designs, such as multirotors and fixed-wing aircraft; this branch ends with some examples of off-the-shelf systems. The multirotor category can also be subdivided into quad-, hexa-, and octocopters, which denotes the amount of motors on the aircraft. This is to clarify that such copters are indeed a subset of the multirotor family. Payloads are important in many UAV applications, as the bird's-eye perspective that the UAV offers is unique and essential for its usability. Many different payloads and sensors exist, and important is to note the domain-specific sensors, such as gas-sensors, microphones, lights, sprayers, and parcel systems. Components are what is used on a UAV platform to be able to fly, such as batteries, motors and inertial measurement units (IMU) for balance. The most important part here is the flight-controller, which interfaces the motors, sensors and inputs to a central computing chip.

This is also where the first intersection between hardware and software exists, firmware. Firmware in this case controls the direct balance, stability and control of the aircraft, by integrating various sensor and input values, and sending information to the motors to maintain flight and balance. In addition, it deals with communication protocols between ground stations or other networks. Certain flight controllers can only run certain firmware. Under this control section of UAVs are also path planning, auto-piloting and fleet management.

Under software analysis, a decision was made to split between in-flight versus post-flight processing. From the literature, a very wide gamut of programs were used, for an even wider field of applications and usages. Therefore, every intersection and semantic distinction in this area can be separated, readjusted and relinked for each specific application and usage. Various pre-processing steps exist for UAV usages, and deal with creating large maps of the sensed area (orthomosaics) from digital and multispectral observations or combining various laser scans from a LiDAR. Under post-processing, analysis methodologies are presented, which can be physical modelling of remotely sensed objects using PROSAIL for example, or more towards machine learning methodologies to infer classifications, cluster the data or detect objects in the images. From a taxonomy-point-of-view, the software-side is a much contested, improving, and changing area for UAV-techonolgies. Which can be seen as large taxonomies on themselves, requiring more attention in future steps.

There is a lot of detail in UAV technologies, and all these details can be of importance to a UAV use case. In UAV technology many fields meet, from robotics, electrical engineering, remote sensing and communications to name a few. This is also a strength of UAV technology: every individual field improves year over year, which improves a specific section of UAV technology, enabling new use-cases and/or abilities.

UAV Platforms

DJI is by far the most used brand in primary studies. This indicates that one manufacturer has the largest share of the UAV market, mainly by developing multi-rotor platforms. Furthermore, senseFly exclusively develops fixed-wing type UAVs. HiSystems, microdrones, 3DR and AscTec have all gone out of business or merged into largest companies, such as Intel or Leica. Other UAV manufacturers such as Parrot and

Autel seem to be missing in the included articles. Finally, custom-built UAVs are a significant share of published research.

The reported UAV platforms show off two main designs, the multi-rotor and fixed-wing aircraft (Fig. 8). The main separation between these designs is visualised in Fig 8. With one axis showing weight, whilst the other shows flight time. A multirotor is capable of high manoeuvrability and has seen the most development and use in the past years. However, a fixed-wing aircraft is capable of longer flying times at similar weights to a multirotor. This trade-off in flying times, weight and capabilities is at the heart of UAV platform development and future applications.

This is also shown in UAV reviews covering new technologies: improved autonomy[61], edge computing[62] and flying networks[63] are enabled by improved state-of-the-art developments in other technological fields.

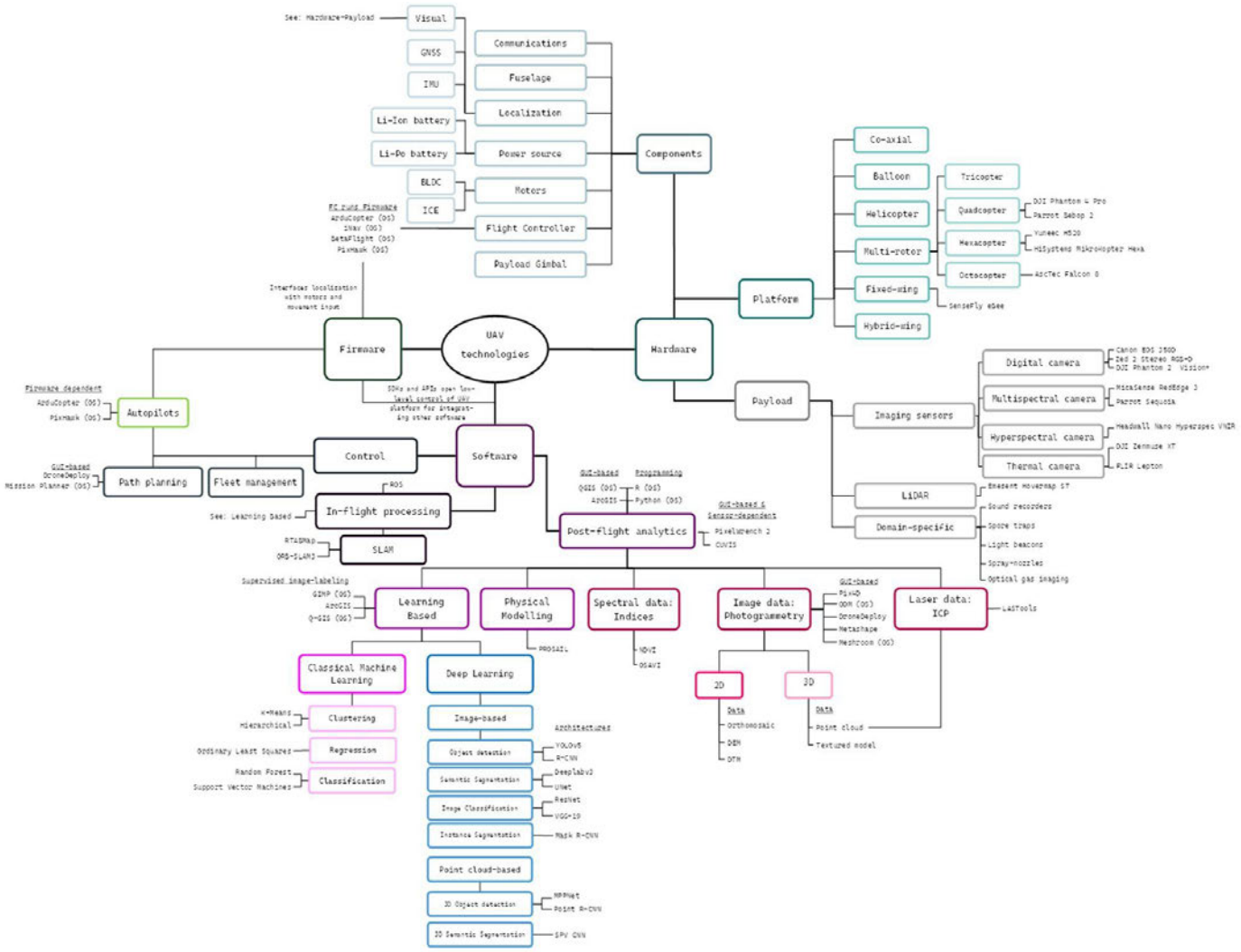

Figure 5 Taxonomy of UAV technologies

[61] Mualla, Y. et al. (2019), Agent-based simulation of unmanned aerial vehicles in civilian applications: A systematic literature review and research directions. Future Generation Computer Systems 100, 344–364; Dushime, K., Nkenyereye, L., Yoo, S. K. & Song, J. (2021), A Review on Collision Avoidance Systems for Unmanned Aerial Vehicles in 2021 International Conference on Information and Communication Technology Convergence (ICTC), 1150 -1155

[62] Fatima, N., Saxena, P. & Gupta, M. (2022), Integration of multi-access edge computing with unmanned aerial vehicles: Current techniques, open issues and research directions. Physical Communication 52. issn: 1874-4907

[63] Jameii, S. M., Zamirnaddafi, R. S. & Rezabakhsh, R. (2022), Internet of Flying Things security: A systematic review. Concurrency and Computation Practice & Experience. issn: 1532-0626; Ghazali, M., Teoh, K. & Rahiman, W. (2021), A Systematic Review of Real-Time Deployments of UAV-Based LoRa Communication Network. IEEE Access 9, 124817–124830

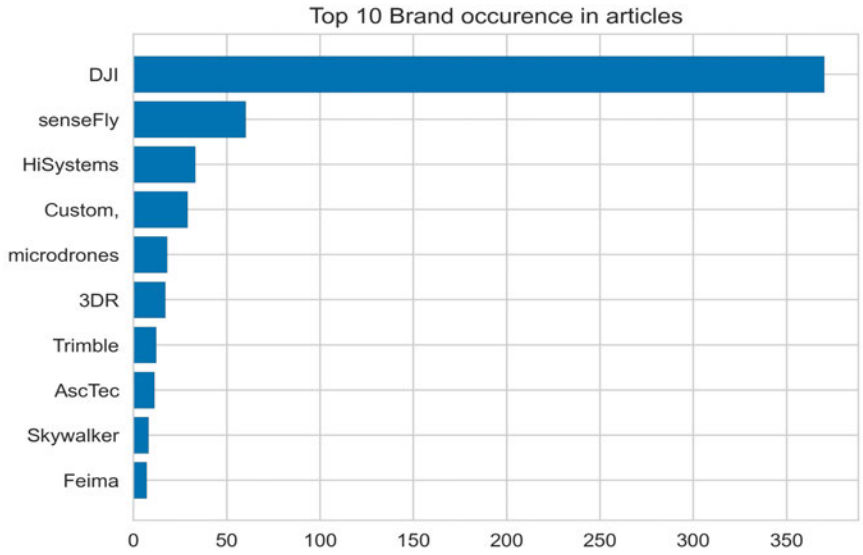

Figure 6 Brand popularity from included articles in the reviews

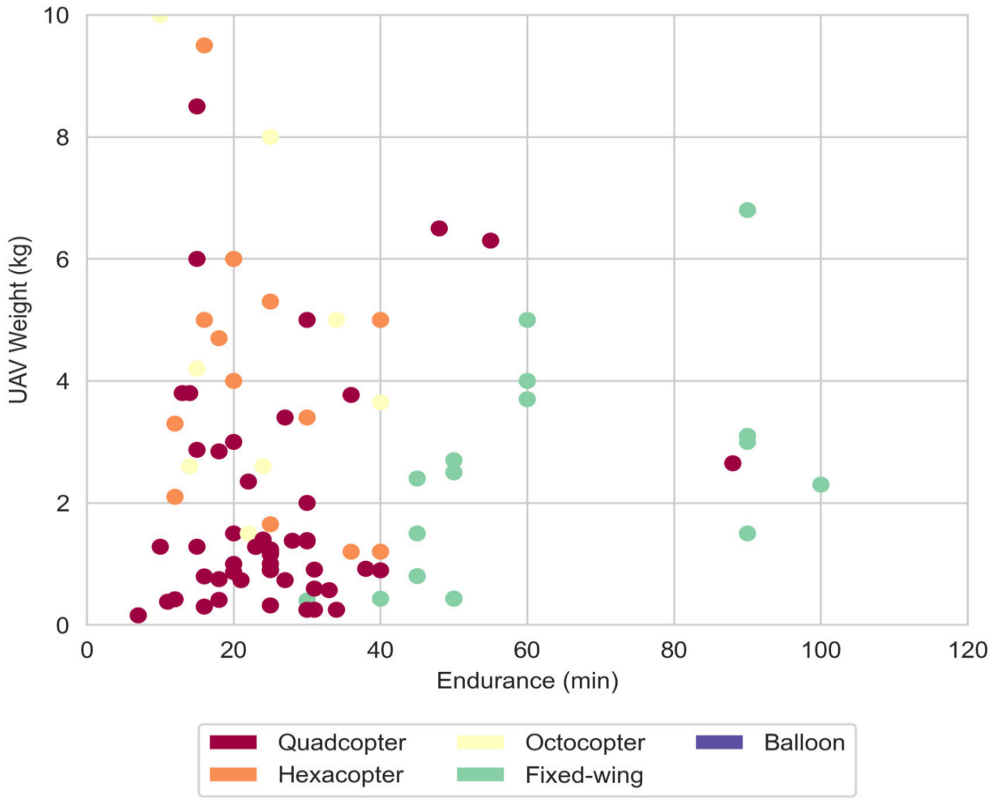

Figure 7 Weight vs. flight time trade-off for various designs

Sensor technologies for UAVs

There is a wide variety of sensors used in UAV-based research. Different sensors offer different perspectives on the sensed object. The objectives of the research therefore influence which sensors are used. In the literature, five main sensor categories have been found. These categories are digital cameras, multispectral cameras, hyperspectral cameras, thermal cameras, and LiDAR. The cameras sense the environment by capturing light, this is often denoted as colour which are various wavelengths in the electromagnetic spectrum. Digital cameras sense the environment in three different bands: red, green and blue. Multispectral cameras often increase the number of bands to include near-infrared and infrared. At

the sacrifice of increased cost and reduced resolution. Hyperspectral sensors acquire many narrow bands of light, usually in the range of blue to infrared. Thermal cameras acquire a single band, in the thermal-infrared range, which is related to temperature. LiDAR is a different type of sensor, which does not acquire images, but 3D information. It acquires the 3D information by calculating the time between emitting a light source and the light's return to the sensor. By rotating the sensor multiple times per second, a 360-degree field of view is captured, with hundreds of thousands of observations per second.

In Fig 9, various sensors are visualised as resolution vs. number of bands, coloured per sensor. The figure shows how different sensing modalities are clearly delineated by offering different solutions to perceiving the environment.

For everything apart from digital cameras, advanced processing software is required to acquire information from the sensor, and the results are more difficult to interpret, compared to an RGB image. Furthermore, the software and firmware of these sensors needs to be integrated for an advanced payload to function within the UAV-platform, in order to sense at the correct moments. This software dependency is clear in Table 8, where sensor manufacturers also provide software. Some manufacturers offer subscription-only software to use the sensor, making the capabilities of a sensor dependent on a monthly payment. In addition, the built-in digital cameras are usually stabilised and well-integrated in the software of the UAV. For the other sensor types, custom mounting options are to be developed for the application. These factors introduce more variables that influence the final observations. Variables include vibration, the accuracy of location estimates, the UAV's balance, and the sensor's angle.

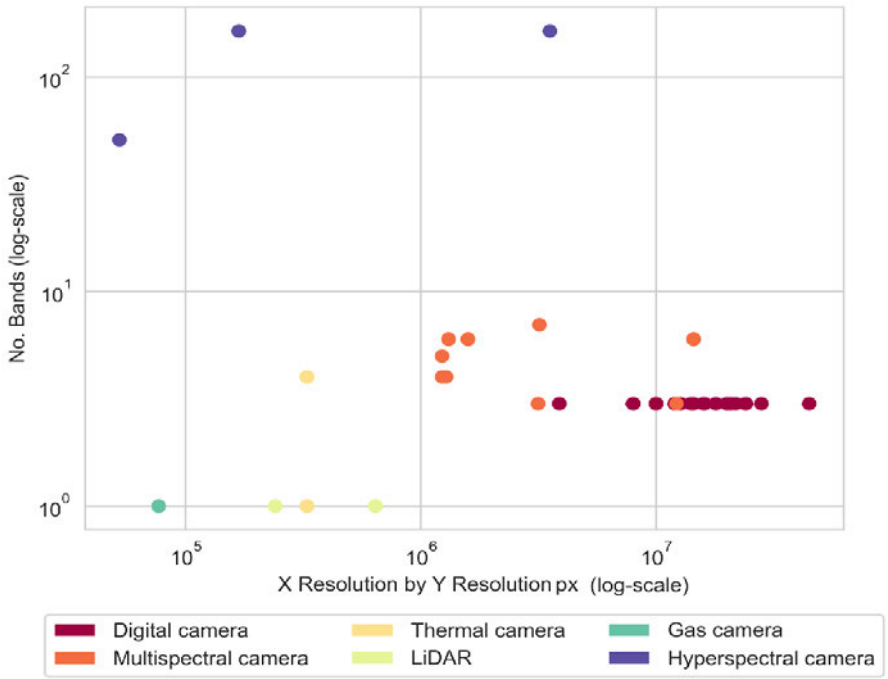

Figure 8 No. Bands vs. resolution trade-off in UAV sensors

Resolution for LiDAR is calculated by taking the points per second. The Gas camera is a highly recent development with extremely low resolution, at a single band for a high cost. It is used to perceive particle content in the air. Hyperspectral sensors have a high amount of bands, at the cost of resolution, whereas the digital camera offers a high amount of resolution, at only 3 bands.

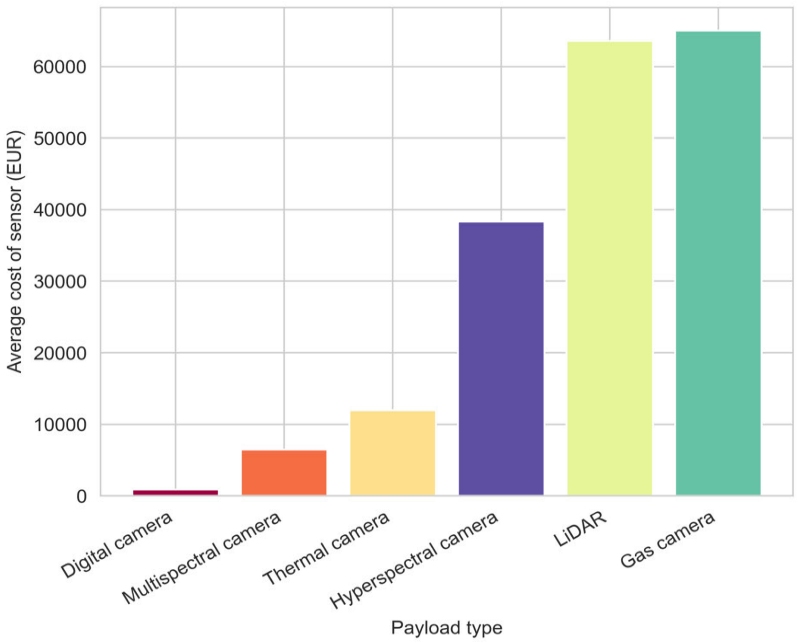

Figure 9 Average cost of used sensors in articles

Cost breakdown explains the wide adoption and popularity of digital cameras over alternatives in UAV technologies. However, for specific applications, the digital camera is not sufficient, requiring high-investment cost for LiDAR, Gas and Hyperspectral sensors.

Next to the features, cost also separates the different sensors (Fig 10). Digital camera technology has gone down significantly in cost in the past decades and is often built-in on commercial UAV platforms, making it accessible to a wide range of users. Multispectral and thermal sensors (around 10,000 euros) are often an order of magnitude higher in cost compared to digital cameras (around 1,000 euros) and can only be bought at speciality suppliers or directly from the manufacturer. Hyperspectral and LiDAR sensors are again an order of magnitude more expensive, ranging between 50,000 and 150,000 euros. Depending on the UAV application, the sensor cost can be the highest required investment. More detailed information can be found in Annex I.

The direction of future developments is therefore that the cost is expected to go down across all sensing modalities. Or at a fixed cost, resolution and sensitivity increases in the coming years. These developments drive easier accessibility to UAV-based sensing or more detailed insights acquired from UAV-based sensing.

Comparison between sensor-modalities as presented above might be limiting. It is also within each sensing modality where important distinctions should be made, and valueable insights exist: insights between competitors, insights of implementations and therefore insights into specific usability across use-cases. For instance, in many camera's two dominant modes of light-acquisition exist: snapshot and line-scanning. These implementations are usually mutually exclusive, and a possible user must make the decision beforehand on which is best to use. Snapshot acquires all light simultaneous on the sensor, after which it reads the whole image matrix. A line-scan measures the sensor line-by-line, and returns the whole image. This line-scane matrix can resolve in a 'rolling' shutter effect, as not every pixel on the image is from the exact same moment in time. Furthermore, within hyperspectral imaging, a major difference can be found between pushbroom versus matrix sensors. Where a pushbroom scans a single line (just the 'y-axis') and by moving the UAV forward, acuiqring a whole image. Whereas in the matrix method a complete 'x-y image' is acquired. Such distinctions warrant further exploration and emphasis in next steps.

Software of UAV technologies

Software is the core of many UAV systems. From autopilot software, path planning, and control to monitoring, image analysis and photogrammetry, the software is central in UAV technology. In the reviews, 32 different software packages, for 10 different usages have been reported, the list in Table 8 is no means a comprehensive list, but contains the software extracted from the reviews. Every software function and application require prerequisite knowledge to be able to understand the results and variables that are reported. This is clear in the articles, as different UAV applications make selective use of the software. A forestry study might gleam over the flight planning of a UAV, but report on the r^2 values of the biomass estimate. Whereas a study on UAVs for mobile-edge networks, trajectory planning will be covered in-depth. However, factors like flight height in the path planning, angle of the sensor, how the train-test data splitting is executed, out-of-sample accuracy scores, which photogrammetry package was selected, the photogrammetry settings, combined to drive the end result for a UAV project. For additional information on cost and software service type, see Annex II.

Table 8 Software packages in UAV search

Type	**Software name**	**Price (EUR)**	**Notes**
Flight control	**DJI GO**	FREE	**Flight app for DJI**
Flight planning	MA Vinci Mission Planner	FREE	ArduPilot open-source project for autopiloting UAVs
	Pix4D Capture	Discontinued	
	DroneDeploy	Starting: 300 EUR per month	
	DJI Flight Planner	FREE	
Image Editors	**Adobe Photoshop**	25 EUR/month	**Data labelling**
	GIMP 2	FREE	Open source photoshop program
Image Rectification	Rese Apps PARGE	Request quote	
Multispectral pre-processing	**Pixel Wrench 2**	FREE	**Specific to Tetracam sensors**
Hyperspectral pre-processing	CUVIS	Upon request	Specific to Cubert sensors
	Per Class Mira	Request Quote	Leading software for hyperspectral imagery, owned by HeadWall
	CSIRO Scyllarus	FREE	
Thermal pre-processing	Workswell Core Player	Upon request	Specific to Workswell sensors
Photogrammetry suites	**OpenDroneMap**	FREE	**Open-source UAV photogrammetry**
	Leica Photogrammetry suite	Discontinued	

	AgiSoft Photoscan Professional	Discontinued	
	AgiSoft Metashape	Starting: 180 EUR	
	DroneDeploy	Starting: 300 EUR per month	
	Pix4D	Starting: 216,67 EUR/month	
	MICMAC	FREE	
	Smart3DCapture	Discontinued	
Point Cloud Processing	**Cloud Compare** LASTools	FREE FREE	
Geo-information package	**BAS SOCET GXP**	Request quote	**Remote sensing + Photogrammetry suite**
	eCognition Developer	Request quote	Remote sensing focused
	Harris GeoSpatial	Request quote	
	ENVI; ERDAS Imagine	Request quote	
	ESRI ArcGIS Pro ESRI ArcMap	Discontinued	
	GRASS GIS; SAGA GIS Q-GIS	FREE	
Programming languages for Data analysis, using Machine or Deep learning methods	Python; R MATLAB	FREE 860 EUR/year	

4. Use Cases' Market Research Analysis

This chapter focuses on the market research analysis of the project's use cases with inputs gathered from the use case partners to define the market structure of each of them, including an analysis of the market segmentation, market forces such as demand and supply, and customer segments. This work was conducted during M3 – M4 of the project's duration.

4.1 Framework of the market analysis of all ICAERUS industrial cases

4.1.1 Multi-purpose drone applications represented in ICAERUS

Multi-purpose drone applications are represented in this project with five well defined industrial cases under two industries – precision agriculture and aerial supply chain or rural logistics. Generally, the applied drones are multirotor ones – a VTOL drone, a Quadcopter, and an Octocopter in all UCs. They are equipped with sensors, thermal and hyperspectral cameras, and the technological analysis of our UCs is presented in WP3 ICAERUS Use Cases and Demonstration Activities, as the focus of this section is only on the market evaluations of current and future potential. Table 9 shows the market segments represented in the project's use cases.

Table 9 Different market segments represented in ICAERUS

	Crop health assessment	Crop spraying	Livestock monitoring	Land & forestry monitoring	Rural delivery of goods
UC1	x				
UC2	x	x			
UC3			x		
UC4				x	
UC5					x

The specifics for each use case show their potential for market penetration:

- ✓ **UC1**: represents a very good commercial case of crop monitoring and vineyards disease detection in large terrains of vineyards in Catalonia (Tarragona), where there is a clear shift towards both more high-quality wine products and organic wine production among the local customers. Developing a sustainable business model for UC1 could expand the market to other regions of Spain, and to neighbouring countries (Portugal, France) too.
- ✓ **UC2**: represents an optimisation process in precision agriculture, where the usage of drone spraying could increase crop yields and initially such tests were done in Japan. UC2 will utilise drone services in the region of Attika (Greece) to explore all benefits of automatic pesticides spraying, collecting data, and assessing the economic indicators of crop production. The success of UC2 and its potential business model could turn the agricultural sector into a technology-driven industry in a country where traditionally the agriculture has had a large share of the GDP.
- ✓ **UC3**: has a large scope and aims to utilise drone monitoring of land, farming terrains and livestock. The first three use cases have similar traits and explore the potential of drone services in the agricultural sector. The experimental farms in French provinces of Alps utilise drones to optimise the process of livestock monitoring during times of grazing and resting. UC3 has the potential to expand to Scotland where beef cattle, goats, buffaloes, and horses are in large numbers, as well as grassland terrains are huge, and thus, drone services can be efficient. This UC is interesting not only because of its scalability, but also its implicit potential of growth through the creation of future value-added services by third parties that could re-shape the model and create new opportunities.

- ✓ **UC4**: offers business solutions (B2B) to land-owners and state agencies in charge of forest protection and biodiversity in Lithuania. It can utilise drone services in hot spots where natural disasters - fire, snow wind, water logging, drought and wild animal digging in forestry regions – are much more likely to happen. Its business model could expand to the Scandinavia on a basis of public-private partnerships.
- ✓ **UC5**: offers a B2C solution aiming to provide an overall improvement of the supply chain in goods, small packages, and medical products. UC5 has great opportunities of commercialisation and is open to the services it can offer to various customer groups for social purposes (isolated villages, mountain residences, small towns) in the Balkans. It starts with a demo in North Macedonia, but with high chances of customisation, covering several neighbouring countries, it could potentially develop a few business models such as DAAS, value added services and data exploitation.

4.1.2 Framework

The framework contains the market and stakeholders' analysis of each use case as the methodology follows the same steps in all UCs, and naturally some differences are observed due to the different nature of the demand and supply side of the UCs' own markets. The deliverable D1.1 includes the following parts per use case, which are separated into two chapters:

A/ An overview of the current and potential market, showing the specific project's use case market landscape and market segment definition (market demand and supply in each case). The sole focus of chapter 4 is to present extensively the market research analysis of each UC.

B/ Stakeholders network analysis will be presented in chapter 5, and it includes:

- Identification of stakeholders' interest and characteristics, selecting the specific stakeholders from each group and extracting information through surveys and interviews
- Each stakeholder will be defined by:
  - Stakeholder name
  - Stakeholder group
  - Stakeholder definition
  - Role
  - Interests /Objectives
  - Needs
  - Cost structure
  - Revenue model
  - Outputs and Inputs

All background information was collected by the UC Leaders in M2 – M3 of the project's duration.

- Assessment of stakeholders considering their importance and classification into primary, secondary, and tertiary group
- Mapping and characterising relations and dependences between stakeholders, creating a visual colourful image of them as a value flow map.

The objectives of this step are to: 1) identify the highest value-producing interactions between the most important stakeholders at each case; 2) map value flows identifying interactions and major relationships between actors, which will be presented by diagrams designed on OmniGraffle 7.0, a specialised software product.

4.2 Use Case 1: Crop monitoring in Spain

The overall scope of this industrial case is to create a set of transversal solutions to manage, monitor, and interact within grapevines of vineyard crops with the objective of increasing productivity and efficiency, reducing the use of chemical pesticides, encouraging and introducing bio solutions, and incrementing the quality of crops. Robotics will be implemented to identify causes and provide treatments at individual plant levels, minimising the effort to keep crops in good health, and hence, maximise crop production and revenues. To accomplish these objectives, the solutions will be based on the adoption of unmanned aerial vehicle (UAV) for image analytics process, and a crop management dashboard to monitor and assess field data and operational field strategies.

4.2.1 Definition

This sub-section describes existing status, size and growth prospects of the vine and wine markets within the use case region as well as describing its segments. Whilst assessing demand and drivers for products and services within the sector, it then uses this as a basis to assess the broader trends towards its digitisation and the emergent markets of crop monitoring and the adoption of UAVs.

Regional viticulture industry, segments and drivers

Baix camp represents one of the 7 regional divisions of Catalonia and contains two of the major wine producing areas of Catalonia. The 'Priorat' region and the 'Penedes' regions, recognised internationally as regions to produce quality wines, the wine sector in Catalonia, as well as in Spain, accounts for an important fraction of the agriculture and food industry of the country. Its relevance is multifunctional and lies in its contribution to the economy, the social identity, and the landscape. In Catalonia, there are 12 Protected Designations of Origin (PDO), including the PDO Cava5. The Catalan PDOs represent more than 90% of the grape-growing surface[64], which exhibit specialised production for quality wine.

The establishment of the higher 'Quality Designation of Origin' (DOQ) accreditation for the Priorat region is in part due to the strong support of regional administrations and farmers unions and innovative and broad ranging investment strategies in the area. This is important when discussing the emergent digitisation of labelling and monitoring strategies undertaken below. The rebounding market from pre-pandemic period estimates the European wine market size as expected to grow from USD 50.94 Billion in 2020 at a CAGR of 3.8% and reach USD 65 Billion by 2025[65]. According to the market review, the European market will retain the global majority market share at 48%[66].

In 2010, Spain produced more than 35 million hectolitres of wine[67]. Accounting for nearly 10% of wine production in Spain, Catalonia accounts for more than 3.4 million hectolitres with a proportion that percentage is increasing slightly in recent years[68]. As for more regional markets the household wine consumption in Catalonia decreased from 21.86 litres per capita in 2000 to only 12.42 litres in 2012[69], and now this trend is well-defined (see Fig.11). However, during the same period, the consumption of quality wine increased by 10.7%. This data shows how consumers are experiencing a change of habits by increasing their demand for higher-quality wine while decreasing their consumption of other wine products, specifically from the table wines segment.

[64] IDESCAT, (2007), Catalan Institute of Statistics, Farm structure survey

[65] OMR Global, (2020): European Wine Market Size, Share & Trends Analysis Report by Type (Still Wine, Sparkling Wine, Dessert Wine, and Fortified Wine), by Distribution Channel (Online and Offline), Forecast Period 2019-2025 https://www.omrglobal.com/industry-reports/european-wine-market

[66] Fortune Business Insights, 2022

[67] OIV, (2011). International organization of vine and wine. World Viti-viniculture Situation. Annual statistics.

[68] DAAM, (2010). Department of Agriculture, Farming, Fishing and Food in Catalonia. Production statistics.

[69] MAPAMA, (2013) Spanish Ministry of Agriculture, Fisheries, Food and Environment. Food consumption statistics

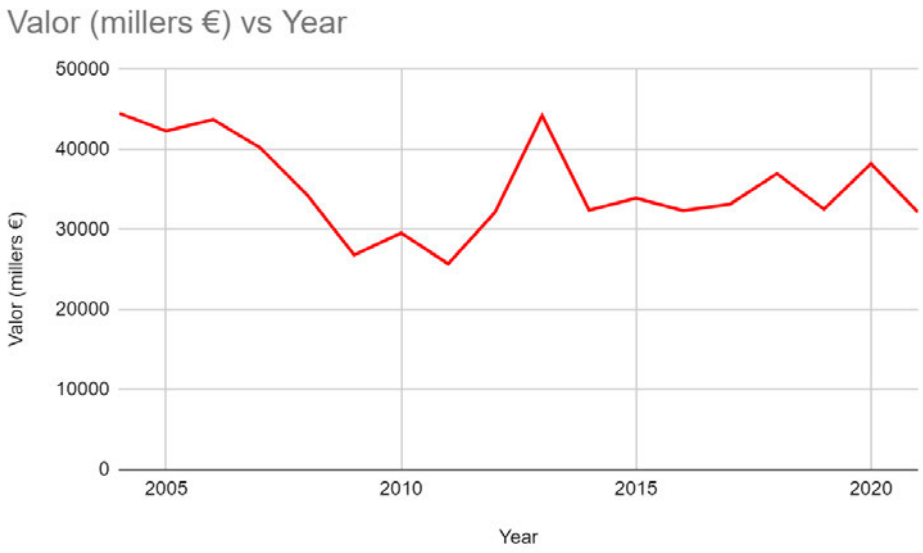

Figure 10 National wine consumption in Catalonia

The Priorat region favours the production of white and red wine segments whilst the Penedes is primarily concerned with the production of sparkling wines. There is a notable trend towards higher consumption of white sparkling wine segment in Europe and Asian Markets[70]. Furthermore, the market share of the Catalan PDO wines in retailer channels and in the HORECA sector in Catalonia is low. Catalan PDO wines represent 27.7% of the total quality wine consumption in Catalonia. Thus, although consumers are shifting their preferences to high-quality wines, the demand for quality Catalan wines in Catalonia is low, and their main competitors are (some) Spanish quality wines, such as “La Rioja". The economic drivers for the growth in the Viticulture market are widely recognised to be a) socialisation in pubs and restaurants with alcohol consumption and b) the expansion of e-commerce platforms.

Correspondingly the numbers of farms dedicated to Viticulture in the region matches the growth in demand over longer periods of time. An example of being that of the Priorat region where the land area hosted up to 5000 hectares of vineyards prior to the Phylloxera plague of the 1980’s when the number of farms dedicated to viticulture dropped to 700 hectares. A key player in the European wine market and region is the ‘Familia Torres’ who launched an expansion of their wine ranges in Priorat. In the first seven months of 2022, Spain exported 1,204.3 million litres of wine (-11.6%), worth 1,700.1 million euros (+4%), which represents 157.9 million litres less, but 63.6 million euros more than in the first seven months of 2021[71]. Indicating overall growth and a move towards higher quality products as well as organic production[72].

Emerging trends towards organic agriculture, digitalisation and labelling

According to Catalan media sources, the region has seen an exponential growth in proportion of vineyards dedicated to organic wines[73]. The drivers of this are due to a heightened climate change awareness amongst both consumers and producers, as well as strategic alignment with United Nations Sustainable development and European policies (CAP). Producers are therefore driven to the adaptation of improved farming methods and to the certification of quality and standards for their products. In evidence of this, in the year 2000, there were 400 hectares of organic vineyards in Catalonia as a whole, this has now grown

[70] Fortune Business Insights, 2022
[71] Fortune Business Insights, 2022
[72] OEMV - Exportaciones Española’s de vino - Julio 2022. (2022, September 22). Retrieved September 30, 2022, from https://www.oemv.es/exportaciones-espanolas-de-vino-julio-2022
[73] Catalonia’s organic wines are growing exponentially. (n.d.). Retrieved September 30, 2022, from https://www.catalannews.com/business/item/catalonia-s-organic-wines-are-growing-exponentially

by 2021 to 23,000 hectares of organic wine production, a growth of 50 times[74] (see Fig.12&13). In particular, the Penedès region continues to be one of the leading wine regions in terms of organic production and in the Priorat region the 'Mas Martinet' vineyard is widely recognised for pioneering methods of organic vine cultivation.

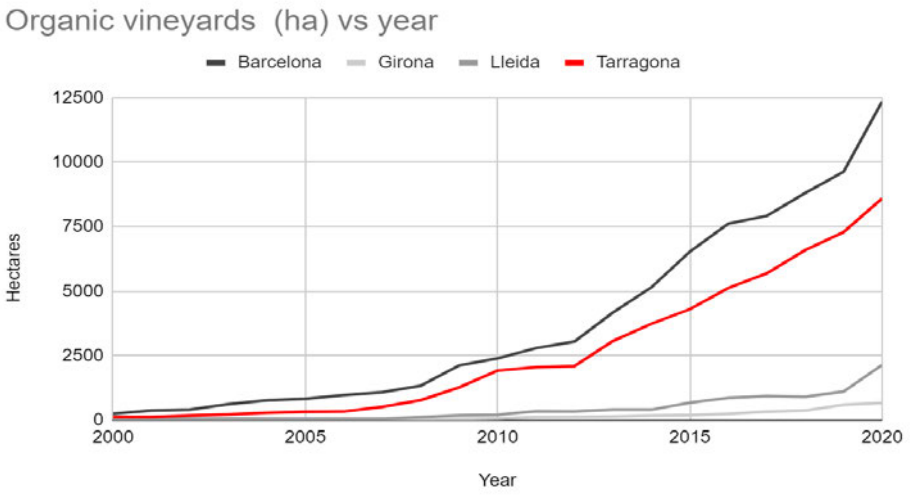

Figure 11 Hectares organic vineyards by province

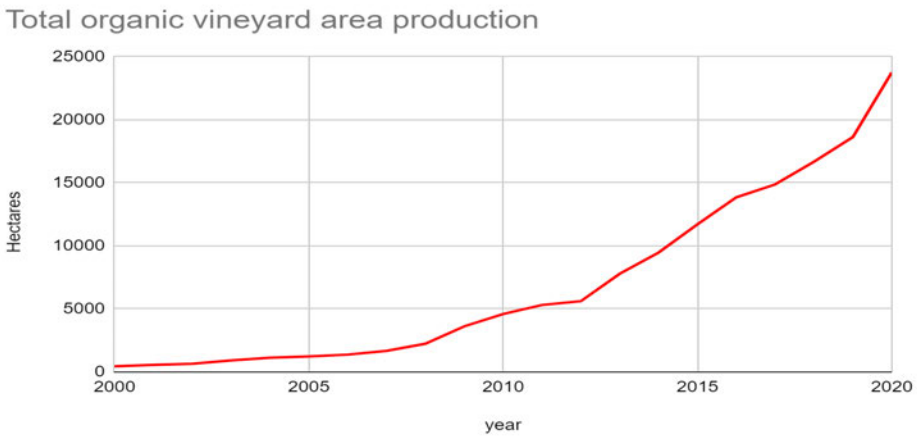

Figure 12 Total hectares organic vineyards in Spain

The trend towards organic agriculture and quality certification is accompanied by a need of viable certification data. Organic farmers also require more accurate crop monitoring and prediction methods and access to reliable environmental and climate prediction data as the risk of climate induced crop failures is well noted amongst vintners and policy makers[75]. Accurate climate prediction data methods are actively being sort by farmers, the market supporting that is described further in the following sections. Tied to data procurement and crop monitoring markets is the need for attaining a mark of quality and accreditation. The importance of the DOCs / PDO status has already been demonstrated and these quality labels are recognised as a strong contributing factor to the success of the regional wine products in international markets. Innovation in future accreditation systems, such as digital accreditations and labels, are accompanied with strict monitoring and control by various authorities.

Monitoring the consumer/citizen's experience and using this information to optimise management of the entire value chain will be essential to close the cycle. For example, the Eurecat pilot project

[74] INCAVI, (2008) Catalan Vine and Wine Institute. Market annual report from NIELSEN Data

[75] INCAVI, (2008)

INTERACCIONA[76] has developed smart labels which are produced using printed electronics containing quality and temperature sensors. The circuit receives energy when a mobile device with NFC[77] technology is placed close to it, and it monitors liquids packed in transparent containers. The solution helps link the entire agri-food value chain, from the farm to the table, optimises resource use according to demand, increases customer satisfaction, improves traceability, and is a step towards dynamic quality management. The OPENVINO group are also developing smart labelling and consumer driven quality labels based around the deployment of crop monitoring data using blockchain[78]. Emergent methods of smart labelling compliments the existing growth of sales through e-commerce platforms, and is also a driver for crop monitoring markets, IoT deployments and data procurement for organic farming certification.

4.2.2 Market Analysis

4.2.2.1 Analysis of current and potential market

Current trends in the development and adoption of advent technologies, such as IoT and AI are at the bottom of a significant transformation of the agricultural industry worldwide, driving crop-management techniques towards increasing productivity and profitability. These technologies include smart-sensing capabilities as well as increasing ubiquitous connectivity, coming to aid the retrieval of needed insight of in-field information such as crop vigour, weather conditions and soil composition. When combined in a system, this data-driven information is helpful to the efficiency of resource management and the reduction of crop losses. This powerful combination of advantages is heavily adopted by farmers in the form of end-to-end crop monitoring product-service applications capable of enhancing crop quality and productivity.

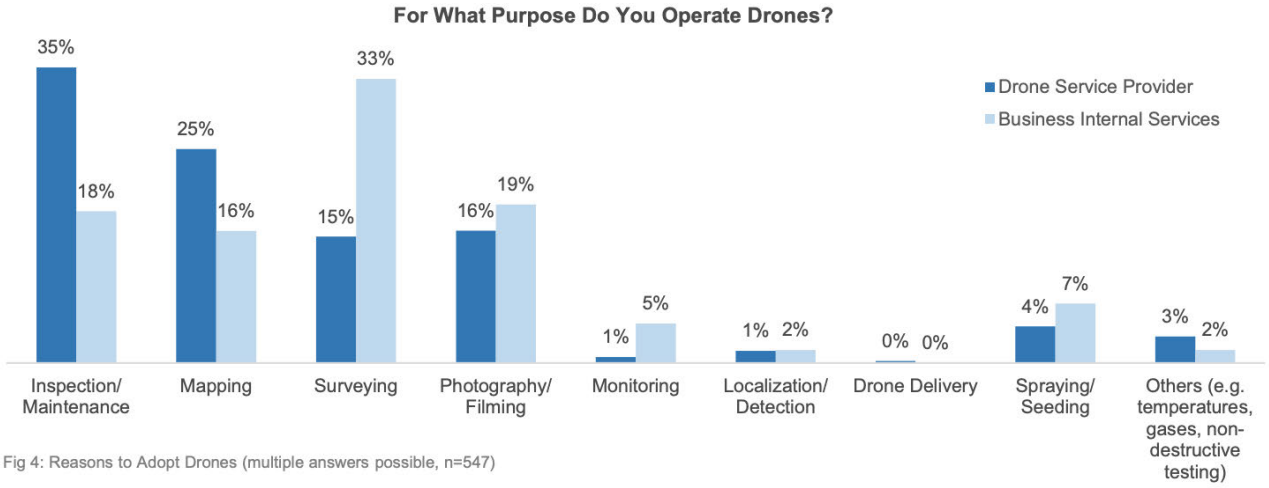

Fig 4: Reasons to Adopt Drones (multiple answers possible, n=547)

Figure 13 Drone Industry Barometer, 2021

In addition to this set of technological capabilities, geo-positioning and field-mapping for land use is also accelerating market growth in parallel with increasing concerns about food security and safety (see Fig.14, source: Droneii.com).

During the period in consideration the market size of precision crop farming is expected to grow from approximately one billion to 2.35 billion U.S. dollars in 2023. The size of all other application verticals in the smart farming market is likewise expected to grow. The entire smart farming market in Europe is

[76] Eurecat 2016

[77] Near Field Communication (NFC) is a set of short-range wireless technologies, typically requiring a distance of 4cm or less to initiate a connection. NFC allows you to share small payloads of data between an NFC tag and an Android-powered device, or between two Android-powered devices

[78] Open Vino. (n.d.). Retrieved September 30, 2022, from https://openvino.org

expected to increase in size from $3.076 billion to approximately $7.2 billion[79]. Revenue from the Internet of Things (IoT) market in Europe increased in 2021 to around 4.8 billion U.S. dollars, up from around 3.3 billion dollars in 2020. The Statista Technology Market Outlook estimates that this growth will continue and by 2022 surpass five billion dollars in annual revenue across Europe[80] with the largest markets – United Kingdom, France, Germany, and Spain (see Fig. 15).

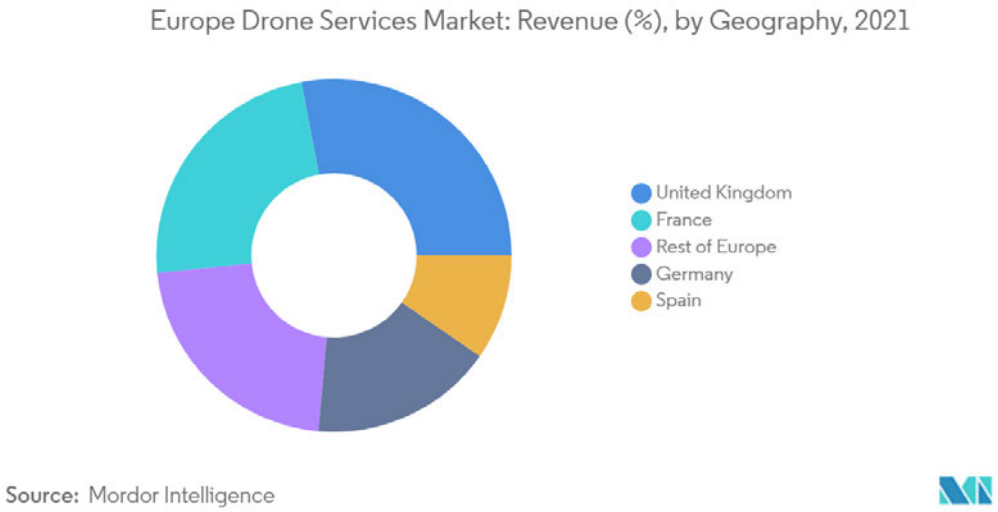

Figure 14 Drone services markets in precision crop farming, 2021

The Crop Monitoring Market is valued at $1.81 Billion in 2019 and is projected to reach $5.42 Billion by 2027, growing at a CAGR of 14.59% from 2020 to 2030[81]. The key driving factors for the growth of the crop monitoring market are the rising adoption of IoT and AI-based devices for crop monitoring and the use of advanced sensors. The major players are Trimble, Topcon Corporation, Yara International, The Climate Corporation, CropX Technologies, Cropio, Earth Observing System, Precision Hawk, AgLeader and Taranis. This market is segmented into the basis of technology, farm type, and geography.

4.2.2.2 Segmented analysis definition of market demand and supply

In recent years, due to fast rising population, poor farming techniques, increased insect damage and loss of usable land agricultural resources, the businesses have been experiencing extreme supply side shocks. The demand of the market appears to be improving due to the better offered quality of food production around the world, the installed robotic farm surveillance systems, the generated automatic process controls and the automated advice for the farms events[82]. This UC focuses on the crop monitoring techniques which gradually become very relevant in vineyards across the European Union. The EU is the world leader in wine production and represents 50% of the world vineyard area with 3.7 million hectares[83].

[79] Statista. (2021b, October 19). Size of the smart farming market in Europe 2018-2023, by application vertical. Retrieved September 30, 2022, from https://www.statista.com/statistics/956934/smart-farming-market-size-europe-application-vertical/

[80] Statista. (2022, January 13). Revenue from Internet of Things in Europe 2016-2026. Retrieved September 30, 2022, from https://www.statista.com/forecasts/1283723/revenue-from-internet-of-things-in-europe

[81] Verified Market Research 2022

[82] Bhatt, Prakruti, Sanat Sarangi, and Srinivasu Pappula, (2019), 'Unsupervised Image Segmentation Using Convolutional Neural Networks for Automated Crop Monitoring': In Proceedings of the 8th International Conference on Pattern Recognition Applications and Methods, 887–93. Prague, Czech Republic: SCITEPRESS - Science and Technology Publications. https://doi.org/10.5220/0007687508870893

[83] López-García, P., Intrigliolo, D., Moreno, M. A., Martínez-Moreno, A., Ortega, J. F., Pérez-Álvarez, E. P., & Ballesteros, R. (2022). Machine learning-based processing of multispectral and RGB UAV imagery for the multitemporal monitoring of Vineyard Water Status. Agronomy, 12(9), 2122. https://doi.org/10.3390/agronomy12092122

Additionally, it's important to note the growing interest in precision agriculture research techniques in recent years. Among these methods, UAV applications for crop monitoring and spraying constitute 23% and 37%, respectively, of the most prevalent applications in this field[84]. A significant portion of the effort expended to meet near-real time requirements has focused on combining machine and deep learning techniques[85].

The capabilities of inferring plant vigour from RGB, Multi-spectral and Hyper-spectral Images, have combined with the autonomous navigation techniques utilising GPS, UWB (Ultra-Wide Band) and computer vision to deliver a powerful tool capable of scaling in-field data collection at relatively low cost in production and management. According to a study of the drone sector[86], the presence of safety and privacy regulation does not interject adoption in agricultural applications. Privacy concerns are absent from farmland surveillance and monitoring, characterised as well as a low-risk flight zone for the scarce presence of human personnel.

Current and potential demand

Statista's research department reports that the global commercial drone market is projected to reach the size of around $58.4 billion in 2026. The market is expected to grow at a compound annual growth rate of over 16% between 2021 - 2026. A recent study shows that the highest estimated growth in the next years will occur in the commercial segment[87]. More companies in different industries will be in demand for drones to carry on monitoring activities, mapping, and surveying[88]. However, the work conducted by the EPI-AGRI focus group on precision farming concluded that most farmers need clearer quantifications of the potential benefits of precision farming before considering adoption[89]. Potential demand of farmers with small fields and/or a small number of animals can be met with work done on assessing situations, areas, field sizes and conditions where precision farming would be profitable.

Focusing on our project's specific case, the main target users and potential customers for this UC1 are the farmers and vineyard owners who are now, more than ever, investing in new technologies for the innovation in the agricultural environment. Some of the key parameters that they must evaluate to understand the external environment are the *quantity and quality of yield*, the *vineyard area* and the *wine production*. For this reason, farmers aim to equip themselves with the necessary technology.

Subsequently, the current and potential demand can be well described by the needs for:

1) plant monitoring and irrigation automation
2) early pest and disease detection via leaves condition classification
3) data farming where vineyard owners could sell the data of their vineyards and create a new source of income
4) yield calculation and fruit detection.

Mas Martinet is the initial place for UC1, located in Crta. Falset a Gratallops, Km 6, 43730 Falset, Tarragona, Spain, European Union. The potential and scalability of Tarragona is about 6235 ha (2022) and around 2.289 vineyards (2010) (see Table 10).

[84] Ghazali, M. H. M., Azmin, A., & Rahiman, W. (2022). Drone implementation in precision agriculture—A survey. International Journal of Emerging Technology and Advanced Engineering, 12(4), 67-77.

[85] Weiss, M., Jacob, F., & Duveiller, G. (2020). Remote sensing for agricultural applications: A meta-review. Remote sensing of environment, 236, 111402.

[86] De-Miguel-Molina, Blanca & Segarra-Oña, Marival. (2018). The Drone Sector in Europe. 10.1007/978-3-319-71087-7_2.

[87] De-Miguel-Molina, et el., (2018)

[88] Narkus-Kramer M., (2017), Future demand and benefits for small unmanned aerial systems (UAS) package delivery. In: 17th AIAA aviation technology, integration, and operations conference, AIAA AVIATION Forum (AIAA 2017-4103)

[89] EIP-AGRI FOCUS GROUP PRECISION FARMING - FINAL REPORT NOVEMBER 2015 https://ec.europa.eu/eip/agriculture/ accessed on the 20 September 2022

Demand side

Table 10 UC1 details about the demand side

Demand (farmers and vineyard owners)	Numeric answers	Explain if necessary
Land-size of Falset, Tarragona	6235 ha	
Cropped land and vineyards as a % of total land in: (1) Tarragona (2) Catalonia	 14.77% 3.40%	
Organic vineyards: (1) Tarragona (1) Catalonia	x 23 000 ha	
How many times farms need to spray, irrigate, or detect diseases per year?	12 – 15 times	Variable (depends on forecasts of how likely it is that diseases and pests will occur in the year in question)
Number of farm holders and vineyard owners in Tarragona	4508*	* Estimation of the researchers
Total number of employees in the farms/ vineyards in Tarragona: Youngsters Aging population	17108 x x	
Number of admin staff in the farms in Tarragona	In the range: 1500 – 2000*	*Estimation of the researchers
Number of agricultural employees in Tarragona	In the range: 70 000 – 80 000*	*Estimation of the researchers
Number of drone companies dedicated to agriculture	6	

Aside from reducing cost and fruit waste, the combination of all technical capabilities provided by drone servicing can in fact lead to an increase in both quality and transparency of production for farmers which impacts directly upon the bottle's label, and thus, the market value and reach of their products.

Current and potential supply

The stakeholders for this UC1 can be differentiated in various categories, but the ones that are of interest are as follows:

- Software and data operators providing data analytics and decision support systems for the farmers, for example: AGRAWDATA, OPENVINO, AEROCLUB REUS
- Agrarian schools from Amposta, Gandesa, Mas Bove, Les Borges Blanque which provide skilled workforce to enter the labour market
- Other companies relevant for our UC1 are Parrot Drone SAS, DJI, AeroVironment, Inc., AgEagle Aerial Systems, Inc., DRAGONFLY UAS which are UAV manufacturers. In addition, there are several companies that provide software development for UAVs.

Supply side

Table 11 UC1 details about the supply side

Supply side of UC1 (drone industry)	Numeric answers	Explain if necessary
Number of drone companies in Catalonia	67	
Number of drones in Spain	In the range: 50 000 – 100 000*	* *Estimation of the researchers*
Number of licenced pilots in Spain	50836	
Number of drone service providers in Tarragona	6*	* *Estimation of the researchers*
Number of marketing companies to facilitate drone awareness campaigns in Tarragona	2*	* *Estimation of the researchers*

Demand and supply relationship

In this case, the supply curve is elastic (in black), and the demand curve is inelastic (in blue, see Fig. 16) with q^o the optimal number of drone services (the equilibrium number on a yearly average basis). The demand curve is inelastic, because farmers have a fixed number of managed hectares that are cropped or planted, and as a result they can utilise drone services (spraying, irrigating, monitoring, pest detecting) as a fixed number of applications. Both curves cross in the positive areas at price equal to p, which is above zero. In this UC, the demand generates the supply, so the revenues are strictly determined by the farmers' needs. If the drone service providers decide to increase the supply to more than q^o and offer more rounds of drone services per year, they will not be able to improve their revenues without a substantial increase in the demand. The demand curve must shift further on the right (the orange curve, see Fig. 16), which means an increase in the amount of land that is fertilised and cropped.

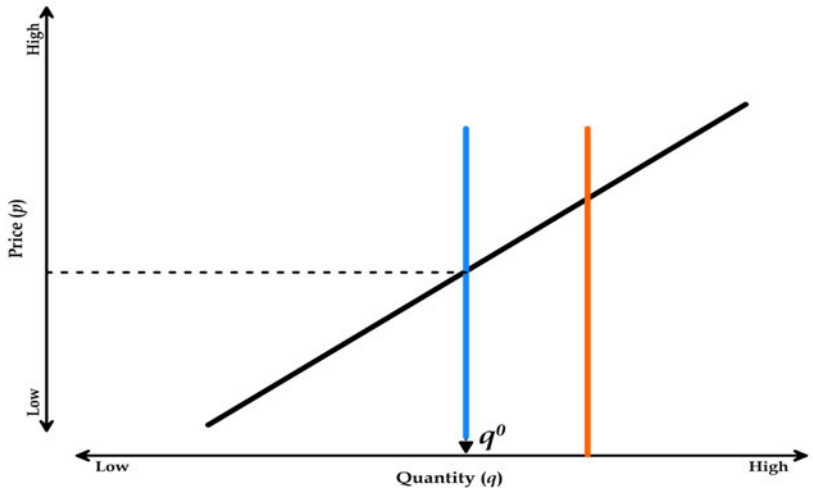

Figure 15 Demand and supply curves

4.2.2.3 Segmentations of users

The main target market in this research is based on the interpolation of identifiability, substantiality, accessibility, responsiveness, stability and actionability between vineyards/farm owners and crop monitoring by drones[90].

[90] Johnson, T. E., Danner, L., & Bastian, S. E. P. (2017). Consumer Segmentation Methods for the Wine Market. Reference Module in Food Science. https://doi.org/10.1016/b978-0-08-100596-5.21419-4

For UC1, we can comprehend how to use the information from cultural, geographic and socio-economic variables. It can be identified how consistent would be for the objectives and competencies to improve the vineyards market sector. Crop monitoring by drones has a remarkable opportunity and potential to support current and future vineyards owners, in hand with environmental agencies and agricultural educators. These opportunities would be achieved by sensing and digitising yields for assessment and improve practices on vineyards management and agricultural endeavours.

In addition, in UC1, the buying power of customers is essential for having a steady demand in Catalonia, although products of Tarragona vineyards are also exported around the world. In this section, we will look at the customer groups of the Spanish population as they demand wine, crops and fruits produced by the local farmers. Naturally, the demand for drone services from the farm holders or vineyard owners is pre-determined by the demand for food and wine by customers in the region.

"Callcredit" Information Group in the United Kingdom used to produce CAMEO Tables[91] that covered countries of Europe, and internationally, providing detail information that allows consumers to be classified consistently across markets. The company was acquired by TransUnion (*https://www.transunion.co.uk*) in 2018, and still produces these reference tables. Segmentations are done on demographics and social factors. In addition, they produce a single global classification and specify 25 different consumer types based on two key factors – life stage and affluence (income). The reference tables for Spain (South Europe) provide a more dynamic picture of the local population. The tables are based on data from the latest Spanish Census at Census Tract level. It has been designed at a small area level. The applied variables are:

- Presence of adults aged over 60; and presence of children
- Household size; Occupation; House size; Housing costs
- Income Focus and Education

Table 12 Customer segments - Spain

Key Group	Description
Group 1	Affluent urban neighbourhoods
Group 2	Wealthy households nearing & enjoying retirement
Group 3	Affluent family neighbourhoods
Group 4	Comfortable home-owning neighbourhoods
Group 5	Comfortable households nearing & enjoying retirement
Group 6	Comfortable mixed tenure households
Group 7	Less affluent mixed households
Group 8	Less affluent mature households
Group 9	Poorer family neighbourhoods
Group 10	Poorer mature rural communities

To identify Customer Groups and their needs usually one can differentiate by a range of factors such as:

1) Differentiated by income.
2) Differentiated by age.
3) Differentiated by sex (male or female).

[91] See at: www.callcredit.co.uk or www.transunion.co.uk/product/cameo

4) Differentiated by household groups, ethnic groups or urban/rural population.

One way to describe customer groups is by generation or age. There are huge gaps between generations, their thinking, their belief, habits and even their language.

The other way is to have detailed target groups – the first six groups (see Table 13) have income levels of above nation average, which means a higher propensity to buy and move, and with a presence of children above nation average which creates the foundations for a potential increase of many markets in the future. As there are also foreign students in Spain coming from other EU-member states, the growth potential for the local markets appears positive as on top of foreign flows of youngsters, there is about 65% of the total population that live with means above average. The last four groups are characterised by income levels below nation average and the presence of children is around average or below, in total these four groups constitute about 35% of the local population. Their propensity to commute is limited, so their children could be more open to the rural life and self-making careers in the agricultural fields. The last group represents the ageing rural communities, which are less than 6% of the population in Spain with income far below average and a low propensity to consume.

Table 13 Spanish customer target groups

Key group (% of total)	Description	Presence of children	Income Levels 100=average
Group 1 9.15%	Affluent urban neighbourhoods	Very high, 0-9 years old	About 130
Group 2 12.03%	Wealthy households nearing & enjoying retirement	Below average, 0-9 years old	About 126
Group 3 9.19%	Affluent family neighbourhoods	Above average, mixed	About 118
Group 4 4.13%	Comfortable home-owning neighbourhoods	High, 5 – 14 years old	About 113
Group 5 14.82%	Comfortable households nearing & enjoying retirement	High, 5 – 14 years old	About 105
Group 6 15.13%	Comfortable mixed tenure households	Average, 0-9 years old	About 101
Total above average: 65%	From Gr. 1 to Gr. 6	Above statistical mean	101 - 130
Group 7 10.44%	Less affluent mixed households	Average, mixed	About 97
Group 8 9.69%	Less affluent mature households	Average, mixed	About 91
Group 9 10.05%	Poorer family neighbourhoods	Average, mixed	About 80
Group 10 5.38%	Poorer mature rural communities	Below average, mixed	About 50
Total below average: 35%	From Gr. 7 to Gr. 10	Below statistical mean	50 – 97

Summarising the customer target groups and their needs from all examples, it appears that dividing the local population into groups only on demographics would not provide a complete understanding of what really the preferences are, as clearly the urban and rural population have very different priorities. Sometimes age, gender and religion do not really make huge differences between people's preferences for food & wine. The ageing population, per se, may not be a problem for agricultural markets and viticulture products, as the baby boomers are affluent, retired with a good level of savings and adaptable, and although they owe their private houses, they still choose to spend time together with the families, having meals and wine. The residents of the rural areas are more unreliable as customers of the food & wine markets as they make their own productions and the ageing population in the villages is not the most approachable customer target group, so the division urban vs. rural provides much more valuable information for the firms and public authorities than merely the age/gender groups of the local population.

In conclusion, the methodology applied in this UC1 is based on the reference tables for Spain since the most important factors would be the presence of children, their age group and income levels as a potential increase of forthcoming youngsters to the local markets for raw food, meat, cooked meals and drinks, but also as potential workforce entering the tech-driven sectors. In UC1, the target market is the private and public owners of vineyards segmented by region, age (generation, demographic customer group), affluency and size of the business. In addition, state agencies can be customers of the drone services offered for crop protection as well as agricultural educators.

4.3 Use Case 2: Drone spraying in Greece

The application of plant protection products (PPPs), especially spraying, is a key aspect of agricultural production of all open-field crops, including vegetables, orchards, vineyards, and arable crops. The term spraying drone refers to any manually or automatically operated drone capable of applying agrochemicals at the desired rate close to the tree canopy (usually < 5m). The aim of this industrial case – Drone Spraying Use Case (UC2) – is to test and evaluate spray configurations for optimal drone spray applications under field conditions. Its experimental design focuses on both evaluating the spray quality (i.e., application, canopy penetration, and drift) achieved by different operational configurations (i.e., spray height, speed, nozzle flow, and liquid application rates) for spray drones, as well as comparing them to existing conventional spray equipment, such as conventional terrestrial boom and mist sprayers.

4.3.1 Definition

This sub-section makes an overview of the existing trends in the agricultural sprayers market and discusses the potential for aerial spraying in the European agricultural industry to keep it sustainable, productive and profitable. Now the European agricultural stakeholders call for an update of the Sustainable Use of Pesticides Directive (SUD) and to allow the use of drones for aerial spraying of pesticides. In their opinion, this can help farmers reduce pesticide use in line with the ambitions of the EU's flagship policy, the Farm to Fork strategy and sets an EU-wide target to reduce the use and risks of all chemical pesticides by 50% by 2030. The Farm to Fork Strategy, which is at the core of the Green Deal, and the Biodiversity Strategy put agriculture at the centre of the European Commission's concerted efforts to address climate and environmental challenges and put European society and economy on a more sustainable path to achieve the United Nations 2030 Agenda for Sustainable Development. One promising solution is the use of drones for the targeted application of PPPs. Spraying drones offer an environmentally friendly and sustainable alternative to conventional spraying methods and significantly reduce the use and negative impacts of pesticides and other agrochemicals.

The main objectives of the UC2 are the following:

- Evaluate drone spraying settings and operations
- Identify optimal spraying parameters and create a methodological guide for optimal drone spraying applications
- Testing and evaluating the application approaches
- Investigation of socio-economic/environmental impacts

- Development of business and management models
- Identifying risks and developing mitigation strategies

High-tech pesticides control

One of the biggest growth areas that traders expect is high-tech pest control. About a third of dealers offer VRT pesticide applications now, but more than half say they will do so in 3 years. About a quarter of dealers say they use a drone for some pesticide apps now, but nearly half say they will do so in 3 years[92].

The European Green Deal since 2009 with EU legislation -PPPs regulations and the Sustainable Use Directive (SUD)- on agricultural pharmaceuticals: Environmental and Food Safety Issues, aims to reduce the risks and impacts of pesticide use on human health and the environment, promote the use of Integrated Pest Management (IPM) and identify alternative approaches or techniques. As a result, the risks to human health and the environment from the use of PPPs have decreased. However, the quantities of pesticides and fertilisers sold and used have remained relatively constant, reflecting the changing profile of PPP use. Between 2011 and 2020, pesticide sales in the EU remained relatively stable (Fig. 17), with total annual sales fluctuating by ± 6% around the 350 000 tonnes level, reaching 346 000 tonnes in 2020. It should be noted that in this reference period < 1 % of the total sales volume were confidential values and therefore could not be considered[93].

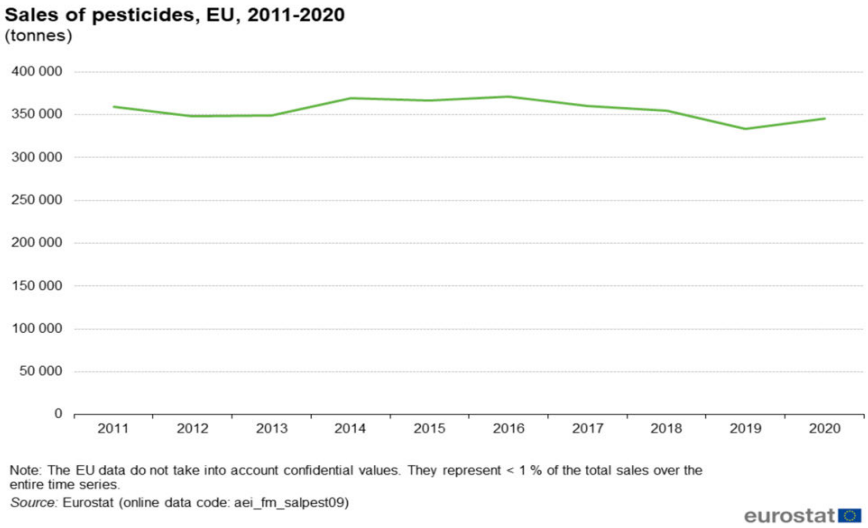

Figure 16 Sales of pesticides, EU, 2011-2020 (tonnes)

A CEMA report presents the European agricultural machinery industry and Modern agricultural machinery and solutions for sustainable agriculture[94]. In 2017, European production of crop protection equipment increased by 14% compared to 2016. The production of trailed and mounted sprayers increased by 11%.

The global agricultural sprayer market was estimated to be around USD 1.8 billion in 2020, accounting for nearly 1.6% of the total agricultural equipment market. Agricultural sprayer revenue is expected to grow at a healthy CAGR of 6% to reach US$ 3.2 billion by 2031 (Fig. 18).

According to Fact. MR, a provider of market research and competitive intelligence, the global market for agricultural spraying systems is estimated at USD 1.8 billion in 2020. Companies in the agricultural sprayer industry have introduced highly accurate and convenient agricultural sprayers to help farmers increase the efficiency and profitability of their farming practices. Agricultural sprayer pump technology has evolved

[92] Precision Survey: As Ag Economy Shifts, So Does Technology Use By Retailers – CropLife.com, 2022
[93] Agri-environmental Indicator - Consumption of Pesticides - Statistics Explained, n.d.- Eurostat.com, 2022
[94] European Agricultural Machinery Industry, CEMA, 2019

significantly as the need for improved efficiency, accuracy and productivity in agricultural spraying grows. The development of novel agrochemicals that can be sprayed on crops with agricultural sprayers, the growing demand for advanced sprayers and the increasing sales of battery-powered agricultural sprayers are driving the market growth. The demand for modern sprayers is increasing as farmers are becoming more knowledgeable about how to protect their crops from pests. Sustainable application of pesticides by agricultural sprayers increases the value of crops, thus driving the market growth. Rising demand for aerial sprayers, increasing adoption of self-propelled sprayers, and increasing adoption of solar agricultural sprayers will drive the market growth at a CAGR of 6% from 2021 to 2031[95].

New technologies, precision methods and techniques such as the use of drones in PPP application and/or irrigation can further support the goals of the New Green Deal and enhance the Farm to Fork and Biodiversity strategies to reduce the use and risk of chemical pesticides by 50% by 2030. One promising solution is the use of drones for the targeted application of pesticides. Agricultural spraying drones have been tested in Europe and worldwide for years.

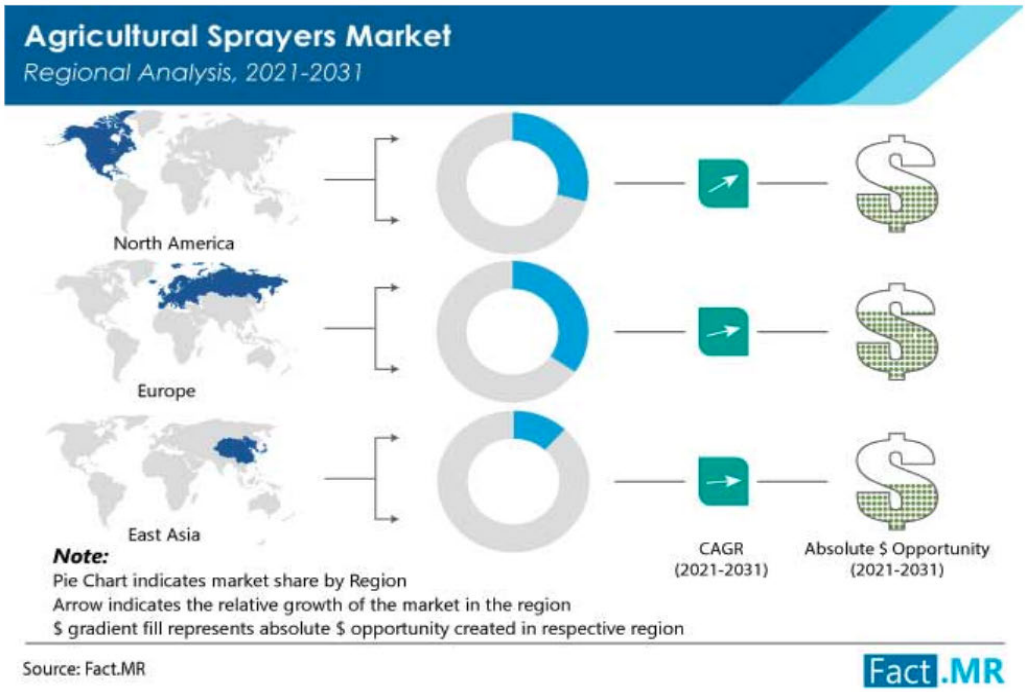

Figure 17 Agricultural sprayers market, 2021 – 2031

Preliminary results suggest that drones could provide farmers with a precise tool to further reduce pesticide use and increase safety for both the environment and users, in line with Green Deal priorities, according to the Farmers' Union COPA-COGECA. The federation stressed in a letter sent earlier this year that drones "appear to be an extremely valuable tool for precision farming", highlighting that this is particularly true for vineyards and orchards on steep slopes where the use of conventional technologies is "difficult or impossible". However, the possibilities of drones are currently not fully exploited due to restrictive regulations. The SUD sets the legal framework for testing the use of this technology. Although the provisions of SUD, drafted back in 2009, do not explicitly mention the use of drones for pesticide application, Article 9 prohibits the application of pesticides by aerial spraying unless an exemption is granted in special circumstances[96].

[95] Agricultural Sprayers Market Report – Fact.MR, 2021
[96] EU Farmers: Unlock Potential of Agricultural Drones or Risk Falling Behind – EURACTIV.com, 2020; Kovács, 2022

Although aerial spraying of pesticides is banned and spraying drones are not yet officially used, a new framework for PPP use with drones, where information and awareness is available, training for responsible purchase and use, inspections and certification of materials and equipment, handling and monitoring with efficacy and evaluation reports are available, will be the next big, perhaps hurtful, but necessary step to reach the 2030 target. This need for a shift in technology profile (precision investment) is in line with price inflation in agricultural products and inputs in the cost of growing crops. If the cost and availability of labour, pesticides, fertilisers and other inputs, and crop prices are rising faster than the cost of electronics and controls to manage it all, then investment and the use of drones to protect seeds and crops is justified[97].

4.3.2 Market Analysis

4.3.2.1 Analysis of current and potential market

Agricultural spraying drones have been tested in Europe and worldwide for years. They are already being used successfully in North, Central and South America, as well as in the Asia-Pacific region, including China, giving farmers a precise tool to further reduce pesticide use and increase safety for both the environment and users. Although this is in line with the priorities of the Green Deal, drones are not currently being fully explored for use in crop protection/spraying due to restrictive regulations in Europe. In practice, this means that no forms of aerial spraying, manned or not, are allowed at SUD. However, it is acknowledged that a derogation from the ban is possible "if it offers clear advantages in terms of reduced impact on human health and the environment compared to other spraying methods". This has been used by some European countries such as Switzerland, where the authorities have granted a three-year permit to the Swiss Agricultural Institute to study aerial spraying by drones in vineyards[98]. Apart from the few test permits granted so far at national level, Germany and some Eastern European countries use drones for crop protection and spraying with local approval. In the UK, the HSE also processes permits for aerial spraying, considering different legislations[99].

The European drone market is forecast to grow at a CAGR of 21.9% and reach a market value of US$55.2 billion by 2032, resulting in an absolute dollar opportunity worth US$47.6 billion during the forecast years 2022-2032[100]. The European agricultural drone market was worth USD 2.37 billion in 2021 and is estimated to grow at a CAGR of 28.58% to reach USD 4.29 billion by 2026[101]. The specific use case of crop spraying, looking at global data (Alvarado, 2021), accounts for about 30% of the total market activity of drones in agriculture. Assuming that current legislation is adjusted accordingly, the spray drone market is expected to reach more than $1.5 billion by 2026 and $2 billion by 2030.

4.3.2.2 Segmented analysis definition of market demand and supply

The drone industry and the market are shaped by trends. Due to these forces, companies are facing a unique consumer behaviour that is evolving from a need-based to a planetary, personalised and connected ecosystem. The spray drone market UC is evolving globally due to environmental changes and pressures (climate, water and input resources, intensification methods), socio-demographic factors (urbanisation, ageing workforce), consumer values and trade developments (services and sharing systems that reduce risks and supply chain cycles), and innovation and technology developments (need for productivity and capacity, potential for precision and sustainable agriculture). On the other hand, the sector UC is still in a young stage of development with first steps towards standardisation, limited availability of technical experts and gaps in a common framework between governments and administrations.

[97] Precision Survey: As Ag Economy Shifts, So Does Technology Use by Retailers – CropLife.com, 2022
[98] EU Farmers: Unlock Potential of Agricultural Drones or Risk Falling Behind – EURACTIV.com, 2020
[99] Aerial Spraying Permitting Arrangements, 2022; Reger et al., 2018
[100] Europe Drones Market Analysis – Fact.MR, 2022
[101] Europe Agricultural Drones Market Size and Growth Forecast Report – Market Data Forecast, 2022; Agricultural Drone Industry Insight Report – DRONEHRP, 2021

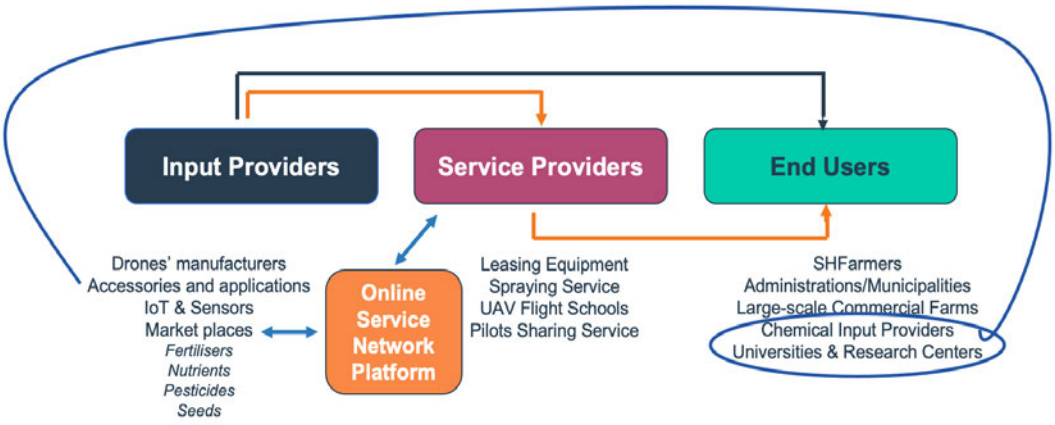

Figure 18 Looking at the drone value chain, we can see a number of potential business models for the UC

Current and potential demand

Users primarily include farmers who may consider alternative tools and technologies to reduce the amount of intensive labour required. By using spray drones, either directly themselves or through intermediaries, farmers can quickly and efficiently manage crop protection in fragmented farms or impassable areas, save time and optimise and regulate inputs such as pesticides, herbicides and insecticides. Details of the different models for drone use are defined in the supply section. The demand for spraying drones for SHF and large farms is expected to increase in the future (see Table 14). The benefits of precision agriculture have already been realised and the sharing model (drone service providers and platforms) is continuously improving the affordability and accessibility of the technology.

Demand side

Table 14 UC2 details about the demand side

Demand side of UC2 (crop farmers, landowners)	Numeric answers	Explain if necessary
Total cultivated area in Greece Increase (+), 2019/20 Decrease (-), 2019/20 No change (0)	Total harvested area 7,413,060 ha (2019) 7,456,250 ha (2020)	Most recent data published by Elstat (the Hellenic Statistical Authority)
% of total cultivated area in: Peloponnese Greece	 15.6 % 56.5 %	
How often do farms have to spray per year	2 - 4	Depending on the crop type
No. of farm holders Peloponnese Greece	 88,366 684,250	
Total number of people employed on farms: Peloponnese Greece	 88,410 684,900	Young & Older population 14-24 2,511 24-34 21,469 35-44 80,655 45-54 151,186 55-64 179,946 65+ 248,483
No. of administrative employees on farms		Unknown
No. of drones used on farms		Unknown

Current and potential supply

Most drones for agricultural purposes in Europe are manufactured in Asia (China, Korea, Japan) and in Europe (Germany, France, UK) and the US. Their acquisition costs are not very affordable, and the market is dominated by international brands. Many of the manufacturers move downstream in the chain and offer services, either in the form of Platform as a Service (PaaS) with apps and connectivity systems, or they get directly involved in the service itself with appropriate hardware and trained personnel. Trimble, for example, can offer a variety of spraying accessories integrated with software systems and algorithms that effectively manage the flow and application of inputs. Or TTA offers a one-stop shop with drones that integrates R&D, manufacturing, training and testing, pilot certifications and all services related to drones, including spraying activities[102].

In the framework of the Greek Digital Transformation Strategy for 2020-2025, drone technology is proposed for various cases in agriculture, e.g., for improving the living conditions of animals by facilitating pasture management and spraying soil activators, and for remote monitoring of forests by detecting

[102] Drone Accessories Market Analysis by Accessories – Fact.MR, 2022

possible fire outbreaks[103]. However, drones are not yet adopted by Greek agricultural stakeholders (e.g., farmers, livestock breeders, cooperatives, and institutions). There is a positive attitude of Greek farmers towards the use of drones in their cultivation activities. Although they consider drones as a useful tool to facilitate their daily agricultural work and the majority have observed them in practice, they lack knowledge about their use and capabilities (more national statistics, see in Table 15).

Supply side

Table 15 UC2 details about the supply side

Supply side of UC2 (drone industry)	Numeric answers	Explain if necessary
Number of drones available in Greece	In the range: 10,000-15,000	Estimation number based on the National Mission Planning Platform (dagr.hcaa.gr)
By type, Greece, %: Fixed wing Rotary Hybrid	6.66% 91.66% 1.68%	Estimation
Ownership of drones: Private Public Shared ownership	80% 20%	Estimation
Expected increase in drone fleet used in precision agriculture		Unknown
Number of licenced pilots in the region (South Greece)	1000	Estimation
Number of drone service providers	10	Estimation
Number of local drone platforms	5	Estimation

There are three common models for end users to access and operate agricultural drones for crop protection – the on-farm operator model, the leasing service provider model, and the platform operator model. Given global trends, the platform operator model is expected to grow at the highest rates in both the short and long term.

Demand and supply relationship

To illustrate both curves in a diagram, the simplest case is taken into consideration – the supply curve is elastic (in black), and the demand curve is inelastic (in blue, see Fig. 20) with q^o the optimal number of drone spraying (the equilibrium number on an annual average basis).

[103] Hellenic Ministry of Digital Governance, 2021

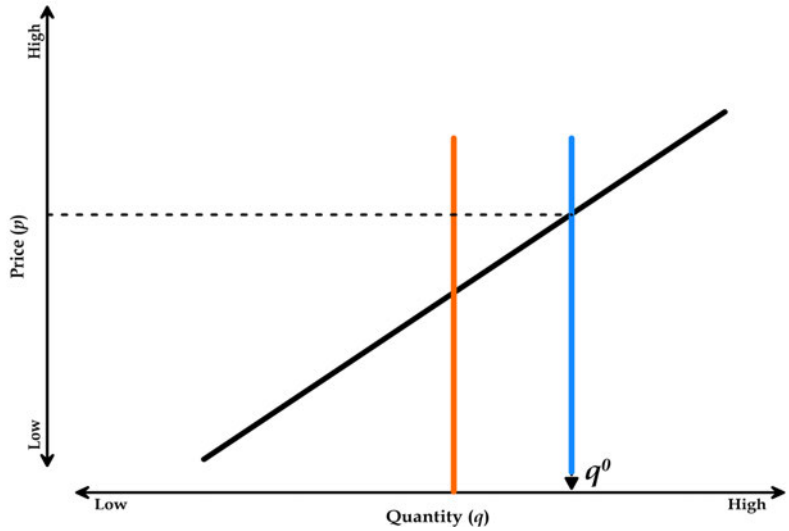

Figure 19 Demand and supply curves

The demand curve is inelastic because farmers have a fixed number of fertilised and managed hectares and can therefore take up a fixed number of drone applications. When services are paid for, the two curves cross at a price of p that is positive and above zero. In this UC demand generates supply, so revenue is strictly determined by farmers' needs. Even if drone service providers increase supply to more than q^o and offer more rounds of drone spraying, they cannot drive up their revenues without demand increasing significantly (the entire demand curve must shift further to the right). If the demand curve shifts to the left (the orange curve in Fig. 20), the drone service providers will be forced to reduce the supplied quantity of applications and accept lower prices for their service.

4.3.2.3 Segmentations of users

Market segmentations are carried out according to various principles: One is demographic segmentation, which is a study of the people who make up a particular market for a product or service. The most important attributes are age, gender, income, education, family size, ethnicity and religion – they are important for every company and authority. As a rule, it is essential for any organisation to understand the dynamics of an ever-changing market to organise its plans and expenditure and stay ahead of the competition. To this end, organisations always collect micro-data from various official sources or use census data from the latest editions. For example, national statistical offices provide a wide range of public data necessary for classifying the population.

Demographic segmentation usually involves dividing the population by generation and examining the characteristics of each generation, which provides local businesses and authorities with the information they need. Thus, the population in Europe and the US is divided into five groups as shown in the following table[104]:

Table 16 Demographic segments – Europe / US

Groups by generation	Generational characteristics
Group 1: Baby-boomers Generation (1945-1965)	This generation did not grow up with the new technology, and therefore, is not tech-driven
Group 2: Generation X (1966-1981)	This generation is self-aware and not entirely shaped by technology

[104] Meghana N.M., (2016) "Demographic strategy of Market Segmentation", Indian Journal of Applied Research, Vol. 6, Issue 5

Group 3: Generation Y (1982-2001)	This generation is totally shaped by technology and like customization
Group 4: Generation Z (2002-onwards)	This is a high-tech generation with the abundant utilisation of apps and selfies
Group 5: Teenagers, 14-19 years old living in large cities	These are the youngsters characterised by high disposable income and technology-driven lifestyles

Source: Meghana (2016)

User needs by generation

Group 1: Baby boomer generation

The baby boomers have always shown a tendency to reject traditional values and are in favour of using communication devices. The urban population of this generation is adapting and using the means of mobile technology.

Group 2: Generation X

Generation X is very difficult to market because it is characterised by a strong sense of self-confidence and has never allowed itself to be pigeonholed. There are many subcultures and eras within this group, which differ in their habits and inclinations, and which prefer their own private property.

Group 3: Generation Y

Generation Y is completely influenced by technology. Several characteristics mark them (Sladek, 2014)[105]:

- They hate being sold anything;
- They are rewarded for participation and not for performance;
- They do not strive to acquire things;
- They can organise their friends for grassroots activism;
- They trust peers first and then parents;
- They actively research prices and read reviews before each purchase;
- They have a desire to make a difference;
- They want to do business with ethical, trustworthy organisations;
- Value individuality;
- They stay away from institutions but are closely networked with friends and willing to share.

Group 4: Generation Z

Generation Z like to volunteer and are aware of the importance of a good education. They are referred to as “the first real tribe of digital natives” or “screenagers”, 60% of them want to influence the world. They are predicted to be highly connected and live in an age of high-tech communication, technology-driven lifestyles and heavy social media use[106].

Group 5: Teenagers, 14-19 years old, living in big cities

With each successive generation, some groups or subgroups of the population had more disposable income. This was made available to some teenagers aged 14-19, especially in big cities such as Tokyo, New York and London, making them a special target group for businesses, private organisations and government agencies.

Different studies focus on different trends when it comes to how market segmentation should be done. For example, another literature study from the United States, “Planning for Demographic Diversity: The Case for Immigrants and Public Transit”, divides the local population into three groups as it captures trends between immigrants and non-immigrants (Blumenberg & Evans, 2010).

[105] S. Sladek, (2014), “Knowing Y: Engage the next generation now”, US

[106] Natalie Waterworth, Talented Heads, Digital Marketing Agency, London’s Tech City

Table 17 Demographic segments of the US

Demographic Group	Characteristics
Group 1: Native born vs. Foreign born	The distinction refers to the place of origin of each customer
Group 2: Ethnic background	The main distinction is White, Asian and Hispanic
Group 3: Native born vs. Settled immigrants vs. Recent immigrants	The distinction refers to the time of settlement

Source: Blumenberg & Evans (2010)

Some suggest that a combination of demographic, behavioural and psychographic segmentation should produce the best solutions. For example, the online survey tool from AYTM, an "in-tech" (Insights Technology) company, allows brands to create customised pre-qualification questions to target specific respondent behaviours[107]. This is in addition to 2,016 house brands that include a variety of demographic, psychographic and behavioural criteria. For example, a financial company that previously could only target respondents based on demographic criteria such as age and income can use the online survey tool to create custom behavioural tags such as "actively saving for retirement" or "worried about saving enough money for retirement" In the case of drone spraying, farmers' behaviour could be tagged with "environmentally friendly" or "tech savvy" in addition to the age and income characteristics.

According to the Digital Optimizer Survey and some critical voices on the use of demographic segmentation of a given market, segmentation by age, gender and income still delivers the best results, especially for email campaigns. Some marketers are using the data generated by social media and other insightful techniques to build a networking infrastructure[108]. More and more companies are deploying programmes on social media by integrating it with traditional email campaigns to reach the ageing population and young people at the same time. Marketers say the most effective tactic has been to communicate the same message in emails and on Twitter. A very small percentage of marketers focus only on mobile optimisation.

In our UC2, the market for drones is segmented according to their intended use: spraying drones fall under the commercial segment. Following the business models already mentioned, the user segments mainly comprise a younger generation compared to the ageing workforce on farms and fields. "Back to the sky, face the ground" has kept many young people away from rural areas. However, the introduction of drones is making agriculture a tech-savvy sector by providing farmers with smart agricultural technology and new systems and practices.

New and appropriate employment opportunities are being created for rural youth who are becoming self-reliant in agriculture, bringing with them new concepts and lifestyles of the digital age, e.g., as drone operators and trainers. The use of technologies such as agricultural drones is one way to alleviate the labour shortage in agriculture, transform rural areas from a low value-added sector into a growing economic pillar and improve the layers of the economic growth. Therefore, the approach taken in this subsection considered the importance for any business to understand the structure of their markets, what

[107] See more at: www.aytm.com
[108] See more at: www.caci.com

the local customers demand or require, and in our UC, the pilot deployment will take place in the crop fields of Peloponnese outside of Athens, Greece. To sum it up the segmentation in UC2, can be done by:

- Business model – leasing services vs. ownership of drones vs. platform operators
- Farmers business production
- Farmers' age /generation/ and education
- Farmers' income and size of business

The Greek UAV sector is relatively new, yet very dynamic. All stakeholders involved have expressed very clear expectations of the project and its development and are aware of the benefits of achieving the set goals and the potential for change they may bring. In addition, engaged agri-food stakeholders at both national and European level have expressed strong interest in the project's activities. This is a positive indicator, considering the general demographic composition of Greece and of farmers as well as the general mistrust of new technologies that characterises the older age groups that dominate the sector. At the same time, there is still much room for improvement. Outside of the regulatory framework and legislation, the lack of adequate documentation of the drone market and statistics on drone use in Greece became apparent during the preparation of this report.

4.4 Use Case 3: Livestock monitoring in South of France

The scope of this industrial use case is to evaluate the risks and the interests to use drones for monitoring cattle and sheep in grassland systems whether drones are piloted by farmers themselves or a drone service provider. Drones will be used as an "eye-in-the-sky" supporting farmers and sheepherders with visual information. Indeed, from the drones' images, livestock farmers can collect much information that they are collecting with a close visual check of the herd – number of animals, position of the animals, access to water, health assessment, and welfare levels. Building on existing and "off-the-shelves" drone technologies, the UAVs will be evaluated in two complementary pilot farms representing 2 species and 2 types of grasslands: the first farm with a beef cattle herd in pastures low-lands, and the second farm with a sheep flock in mountain rangeland.

4.4.1 Definition

The UC3 market should be investigated in complementarity with the markets of UC1 and UC2, because a livestock farmer is most of the time producing crops and plants too, and drones can be used as a multi-purpose vehicle. In general, grassland-based livestock systems have many benefits: environmental services with high biodiversity and carbon sequestration, economic benefits with a low-cost production of forages for cattle and valorisation of areas that cannot be used for crop production. Grazing animals also meet the society demands of having animals outside and having more "nature" in the food production systems. However, for farmers to make animals graze involves strenuous monitoring.

The UC will tackle 3 main challenges regarding the use of drones in grassland-based livestock systems: 1) the limited knowledge about the usage of drones in grasslands for monitoring animals; 2) the limited knowledge of the socio-economic impact of using drones; 3) provide cost-effective solutions.

Two scenarios will be investigated to provide answers to those challenges:

1. **Monitoring beef cattle in "bocage" grasslands**
2. **Monitoring sheep flocks in mountain rangelands**

That will allow us to evaluate the risk and the interest of using drones in a variety of configurations: animals (beef cattle or sheep), landscapes (mountain rangelands or prairies), farming systems, nature of the pilot (farmers, drone service providers) and to measure their social, economic, and environmental impacts on a variety of tasks. These results about drone use cases and impacts will be largely communicated with demonstrations and a variety of communications channels to fill this important lack of knowledge regarding both impact and regulations.

Drone for monitoring livestock

Very little studies focused specifically on the "drone for monitoring livestock" because most of the time it is a small segment of "the drone for agriculture applications" market, however, a recent specific market report provides us with some information. The global "drone for monitoring livestock" market is currently estimated to USD 2.95 billion and is expected to reach USD 19.58 billion by 2029 (Fig. 21), compound annual growth rate (CAGR) of 31%[109]. This optimistic market analysis is tempered with a global drone for agriculture applications market which valued the global drone for the whole agriculture applications market to USD 0.88 billion in 2020 and estimated to USD 5.89 billion by 2030 (Fig. 21) with a CAGR of 22.4%[110].

[109] Data Bridge, 2022
[110] Allied Market Research, 2021

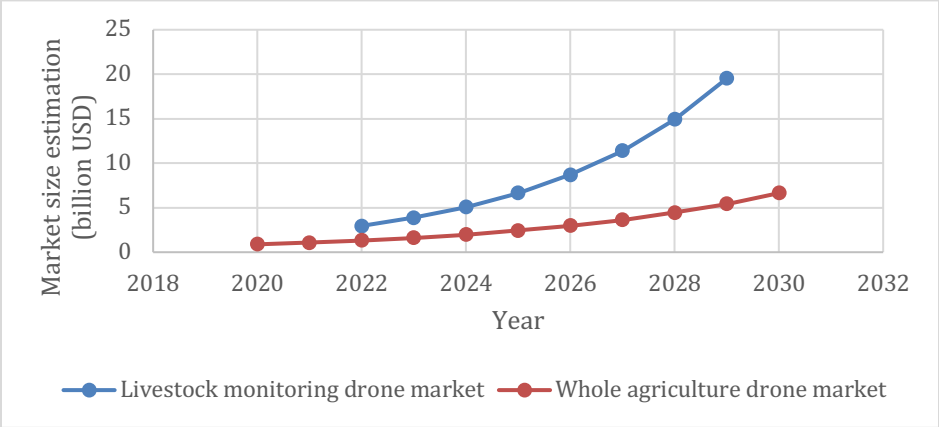

Figure 20 Market size estimations

Market size estimations (adapted from Allied Market Research 2021 and Data Bridge 2022). The blue line represents the estimation by Data Bridge (2022) for the size of the global "drone for livestock monitoring" market. The red line represents the estimation by Allied Market Research (2021) for the size of the global "drone for the whole agriculture applications" market.

Due to this lack of information, **we can approach the market size with other indirect indicators** that are difficult to translate in USD. Starting global with the area where the market is, the grasslands, van den Pol et al. (2019) noticed that permanent and temporary grasslands cover 61 million ha including 17 million of rangelands across the EU-28, which represents 40% of the EU agricultural area. Those grasslands are managed by 3.6 million livestock farmers, which represents about 33% of all European farm holders[111]. Those livestock farmers are monitoring on those grasslands about 196 million heads of livestock which represent 59% of the total livestock in livestock unit (LSU). Most of the grasslands are in EU-15 (Fig. 22), especially in Ireland, United Kingdom, and Slovenia from central Europe.

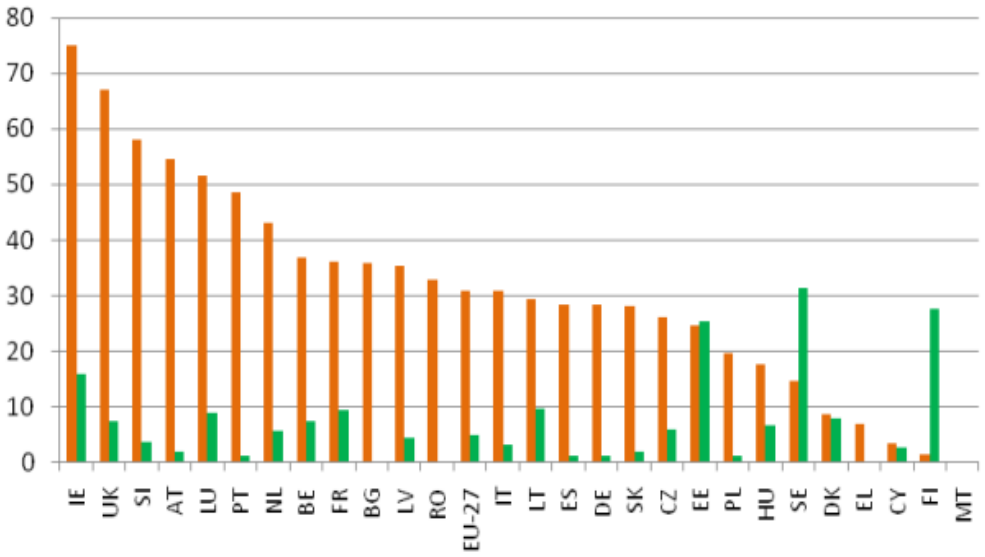

Figure 21 Part of the UAA (%) that is permanent grasslands (orange) or temporary grasslands (green) by country

All this livestock is not entirely applicable to our UC's market. Even if the use of drones for monitoring livestock and thus the market can be applied to various species: cattle, sheep, goats, buffalos, horses etc., because the dairy cow is already "the most connected animal in the world", the market seems very small in this production chain due to high competition regarding digital solutions for monitoring the animals and

[111] VAN DEN POL, A., BASTIAANSEN-AANTJES, L., BOGUE, F., O'DONOVAN, M., & HUYGHE, C. (2019). GRASSLAND USE IN EUROPE: A SYLLABUS FOR YOUNG FARMERS. INNO4GRASS. AVAILABLE AT: HTTPS://EDEPOT.WUR.NL/533384; EUROSTAT EU-28

a lower need to support monitoring (dairy cows stayed close to the barn and farmers for daily milking), although dairy cows represent 31% of grazing animals in EU-27 in LSU[112].
Goats are most of the time in the same segment as sheep, as small ruminants. In EU-27 in LSU (Pol et al., 2019):

- beef cattle represent 51% of grazing animals
- small ruminants represent 14% of the grazing animals
- other animals including buffalos and horses represent around 6%.

That's why the market analysis will focus on beef cattle and small ruminants in grasslands-based farming systems. Those two main markets represent our two pilot farms that support the use case.

4.4.2 Market Analysis

4.4.2.1 Analysis of current and potential market

If we zoom on France and more recent figures – grasslands represent 41% of the national UAA[113] and grazing animals represent 14.6 million of LSU, including dairy cows and horses that are outside of our market. In 2019, the grasslands dedicated to beef cattle – 3 915 000 heads – was managed by 81 000 farm holders[114] and those dedicated to sheep – 7 705 000 heads – was managed by 31 000 farm holders[115]. Mountain regions gather most of the sheep and beef cattle production.

On those grasslands-based farmers, all are not interested in drone technologies. Maclaren et al. (2022) survey farmers on their needs and expectations regarding new technologies in the European project SmaRT[116]. 271 European small ruminants' farmers answer to this question "Assuming you could get any of the following systems for free, how much would you like to use them?", regarding drones the answers were on the scale 1-5 (1: I would not like, 5: I would like very much):

- 5 (I would like very much): N=79
- 4: N=46
- 3: N=45
- 2: N=37
- 1 (I would not like): N= 64

Despite the economic model and limited knowledge of drone's impact for monitoring livestock, a significant part of the small ruminant farmers is open to using drones. In the same survey, the adoption rate of drones was 4.5% in small ruminant farmers and stakeholders (N=330).

Drones for monitoring cattle is an emerging market with a current low adoption rate that has chances to increase due to the importance of grasslands-based livestock farming systems in Europe. It is essential to notice the maximum size of the market will be reduced or stagnated at this level for the next few years and no growth of animal production is expected in Europe. Some products are even expected to decline[117].

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[112] I.E.

[113] Idele Statistics, 2022 Les chiffres clés des prairies et des parcours. Available at: *https://idele.fr/detail-article/les-chiffres-cles-des-prairies-et-parcours-en-france*

[114] Idele Statistics, 2021a Les chiffres clés du GEB - Bovins 2021. Available at: *https://idele.fr/detail-article/les-chiffres-cles-du-geb-bovins-2021*

[115] Idele Statistics, 2021b Les chiffres clés du GEB - Bovins 2021. Available at: *https://idele.fr/detail-article/les-chiffres-cles-du-geb-ovins-2021*

[116] McLaren, A., Depuille, L., Katzman, N., Bar Shamai, A., Halachmi, I., Grøva, L., Keady, T.W.J., McClearn, B., Giovanetti, V., Piirsalu, P., Nagy, O., Gautier, J.-M., Kenyon, F. and Morgan-Davies, C. (2022). Attitudes of European small ruminant farmers towards new digital technologies. In: 73rd Annual Meeting of the European Federation of Animal Science. 5-9 September 2022, Porto

[117] Dumont, B., Dupraz, P., Aubin, J., Benoit, M., Bouamramechemache, Z., Chatellier, V., Delaby, L., Delfosse, C., Dourmad, J.Y., Duru, M., Frappier, L., Friant-perrot, M., Gaigné C., Girard A., Guichet J.L., Havlik, P., Hostiou, N., Huguenin-Elie, O., Klumpp, K., Langlais, A., Lemauviel-Lavenant, S., le Perchec, S., Lepiller, O., Méda, B., Ryschawy, J., Sabatier, R., Veissier, I., Verrier, E., Vollet, D., Savini, I., Hercule, J., Donnars, C. (2016) : rôles, impacts et services issus des élevages en Europe. Synthèse de l'expertise scientifique collective, INRA (France), 126 p.

The trend of the demand is multifactorial and hard to predict:

- the part of UAA dedicated to UAA will stagnate in France and in Europe (Idele, 2022),
- beef cattle production slightly decreased all over Europe, -2.6% of heads between 2016 and 2021 in EU-27[118],
- sheep production decreased by -5.5% of heads between 2011 and 2021, and the main European sheep producers experienced a huge variability[119]: -18.7% in Spain, -26.6% in Greece, -14.8% in Italy, +23.5% in Romania, +27.8% Ireland.

By the same token, optimisation is increasing with more animals to be monitored by farm holders, and thus, a bigger need for supporting the monitoring through drones or other digital solutions. Some external parameters that will impact the size of the market in the next years are:

- European strategies to mitigate greenhouse gas emissions from ruminants especially on the beef production as policy innovation
- Adaptation of rangelands farming systems to predation especially for the sheep production
- Evolution of the market demand in animal products as an external macroeconomic shock

4.4.2.2 Segmented analysis definition of market demand and supply

The next paragraphs will present a few market characteristics that are available on the demand and supply sides by attempting to define which part of grasslands-based livestock farmers could be interested in drones' applications. Aside of this, the potential creation of value-added services could open a brand-new scenario which will be relevant for the supply-side even though the demand-side does not vary too much or may even go into a shrinking phase if there is a significant decline in the demand for agricultural products. The additional creation of services may be discovered if all three use cases – UC1, UC2 and UC3 – are explored in a combination as a conglomerate of services with the extraction of much data from the whole value-chain that can lead to new offerings to the farm holders and livestock owners not only in France but in Scotland, Ireland, and the rest of Europe. This will be a cost saving option for the farmers.

Current and potential demand

Demand for drone services in this market segment comes from the need to optimise the farm processes and make them cost-efficient but also to provide some comfort to the employees and animals. The scope of UC3 allows the drones to fulfil other needs too and offer relevant digital solutions. Services for monitoring livestock farming can be seen as using drones as a farmer tool or using drones as services provided by a third party for punctual uses. This leads to observing two current business models that dominate in this agricultural segment, and they are differentiated into two sub-categories, which also describe the demand for drone services by farmers (more national statistics is presented in Table 18):

Drone as a farmer tool:

The adoption rate of drones as a farmer tool is low in Europe, 4.5% in small ruminant farmers[120] and might not be higher in beef cattle farmers. The potential users are the livestock farmers that need to improve the working dimensions of their monitoring. In such a use case, the drone is an eye in the sky that can move faster than the farmer and provide a wider point of view. Thus, the potential demand is from farmers that have animals grazing in areas that are large, difficult to access or masking the animal and can save a significant time or effort for monitoring their animals. For example, in France a farmer can remotely pilot a

[118] AGRESTE (2022A), SYNTHÈSE CONJONCTURELLE : PRODUCTION BOVINE EN 2021, MAI 2022, N°393. AVAILABLE AT: https://agreste.agriculture.gouv.fr/agreste-web/download/publication/publie/SynAbo22393/consyn393202205-Bovins.pdf

[119] AGRESTE (2022B), SYNTHÈSE CONJONCTURELLE : PRODUCTION OVINE EN 2021, MARS 2022, N°393. AVAILABLE AT: https://agreste.agriculture.gouv.fr/agreste-web/download/publication/publie/SynAbo22387/consyn387202203Ovins.pdf

[120] McLaren, et al., 2022

drone and have access to 3.14 km² (one flight area) of grasslands, where there are animals to count or monitor, etc.

For “drone as a farmer tool”, the external parameters that segment the demand are:

- Number of animals to monitor
- Number of skilled employees able to monitor animals or grasslands
- Difficulties/facilities to access good workforce
- Size of the area to monitor
  - Size of the flyable area in the area to monitor
  - Size of the farm inside
  - Number of “one flight area” needed to monitor the whole observed area
- Difficulties/Facilities to access animals
- Use of other digital solutions on the farm

Drone as a service (DAAS):

There are no data available to our knowledge regarding drones as a service adoption. The potential demand for drone as a service is huge. The most interested task than can be provided and that has already been provided (with no real date) by a drone service is the assessment of grasslands degradation due to wild animals such as wild boars, drought, fires, etc. Due to climate change, insurances are spreading around to secure the production of forages for livestock. When drought occurs, farmers must prove to insurance companies the degradation of their grasslands and drones seem very relevant for that task. The UC3 will do the inventory of all the punctual tasks that can be performed by a drone service provider and examine economic models.

For “drone as a service” for insurance audit, the external parameters that segment the demand are:

- Number of insurances subscribed by the farmer
- Risk of degradation of the grasslands

Demand side

Table 18 UC3 details about the demand side

Demand side of UC3 (farmers and livestock owners)	Numeric answers	Explain if necessary
Grasslands used for livestock in France	41% (about 12 million hectares)	% from the national UAA
Prairies in the region Auvergne-Rhone-Alpes, gathering most of the mountainy areas	2 million ha	
How many grazing animals? **Total** Beef cattle Sheep	Million heads 14 600 000 3 915 000 7 705 000	Data from 2019
Number of farm holders (total) - dedicated to beef cattle - dedicated to sheep	112 000 81 000 farm holders 31 000 farm holders	
Size of farms in 2021: - dedicated to beef cattle - 5-19 beef cows - 20-49 beef cows - 50-69 beef cows	 8% 25%	

- 70-99 beef cows - More than 100 cows - dedicated to sheep - 1-19 ewes - 20-99 ewes - 100-199 ewes - 200-499 ewes - 500-999 ewes - More than 1000 ewes	18% 21% 29% 12% 16% 20% 22% 21% 9%	
Total number of employees in the farms	> 200 000	Estimation
Number of admin and tech staff in the farms	< 50 000	Estimation
Age of beef cattle farm holders in 2021: - Less than 40 years old - 40-49 years old - 50 years old and more **Age of sheep farm holders in 2021:** - Less than 40 years old - 40-49 years old - 50 years old and more	24% 27% 49% 26% 31% 43%	Data from Idele research, 2022

Current and potential supply

The market analysis specific to livestock monitoring use the segmentation of the supply below[121]:

- Based on offerings, the drones for livestock management market are segmented into hardware, fixed wing, rotary wing, hybrid wing and software.
- Based on components (payloads), the drones for livestock management market are segmented into cameras, batteries, navigation systems and others.
- Based on applications, the drones for livestock management market are segmented into cattle farming, cattle herding, cattle monitoring, and farm security.

Regarding offering and components, because the need is mostly about “off-the-shelf” rotary wing and software to fly, there are many manufacturers that can supply drones. Many sellers can provide these commercial technologies. In France, only 2 companies, Flying Eye and Abot, provide regulations approval kits that are required to fly under national scenarios. Farmers also need an offering, regarding the training to acquire pilot skills and to be a certified pilot under local regulations (national statistics see in Table 19).

Regarding applications:

[121] Data Bridge (2022). Global Drones for Livestock Management Market - Industry Trends and Forecast to 2029. Available at: *https://www.databridgemarketresearch.com/reports/global-drones-for-livestock-management-market#*

- "Cattle farming" seems not specific and hard to specify without the full access of the market analysis
- "Cattle herding" can be done by drones piloted by farmers and thus need no more than what is specified above. For automatic cattle herding, farmers need specific software to manage the drones. At our knowledge no commercial solutions exist but some universities are working on proof of concepts such as the University of Kentucky.
- "Cattle Monitoring", farmers can be supported by drone image analysis software to counting animal or detect welfare issues and others. Sheep counter form is an example of such software.
- "Farm security" can be done by actors of the security market.

Supply side

Table 19 UC3 details about the supply side

Supply side of UC3 (drone industry)	Numeric answers	Explain if necessary
Number of professional drones registered in France - 2019 - 2020	 17 624 21 805	Data in this table is adapted from DSAC 2020, 2021
By type Fixed wing, Rotary, Hybrid		Official data not available
Number of organisation of drones in France: - 2019 - 2020	 9 864 11 203	
Expected growth in drone usage for livestock monitoring	30%	By 2029 (Global trends)
Number of drone pilot's licence delivered in France: - 2019 - 2020	 3 961 6 223	
Number of drone service providers in France		Data not available

Demand and supply relationship

UC3 is an extension of UC1 and UC2 markets, and the economic reasoning behind Fig. 23 is not that different from the reasoning of UC1 and UC2. The supply curve is elastic (in black), and the demand curve is also elastic (in blue) with q^o the optimal number of drone services (the equilibrium number on a yearly average basis). Oppositely to the previous two cases, the demand curve here is elastic, because farmers are more flexible with changing the number of animals that they take care of in the farms, and as a result they can take up a flexible number of drone applications.

With a charge for the services, both curves cross at price equal to p, which is positive. In this UC, the revenues of the drone service providers are again determined by the farmers' needs and willingness to introduce new technological solutions in their farms. However, the farmers' flexibility depends very much on the markets for food, meat, raw milk, and other dairy products. In recent years, the trend for reducing meat bought by customers, and replacing animal milk as well as dairy products with other bio and plant products has been established in Europe. This leads to a shift of the demand curve to the left (the orange line, see Fig. 23), which brings a reduction in the price and quantity produced by the farmers, and hence,

the price and demanded quantity of drone services (less than q^o). These are external shocks to the agricultural markets. Hence, farmers will not be very open to introducing new technology and making huge investments in agricultural businesses that might be on a declining trend. Perhaps they will be more willing to introduce drone fleets to only optimise their already established farming business.

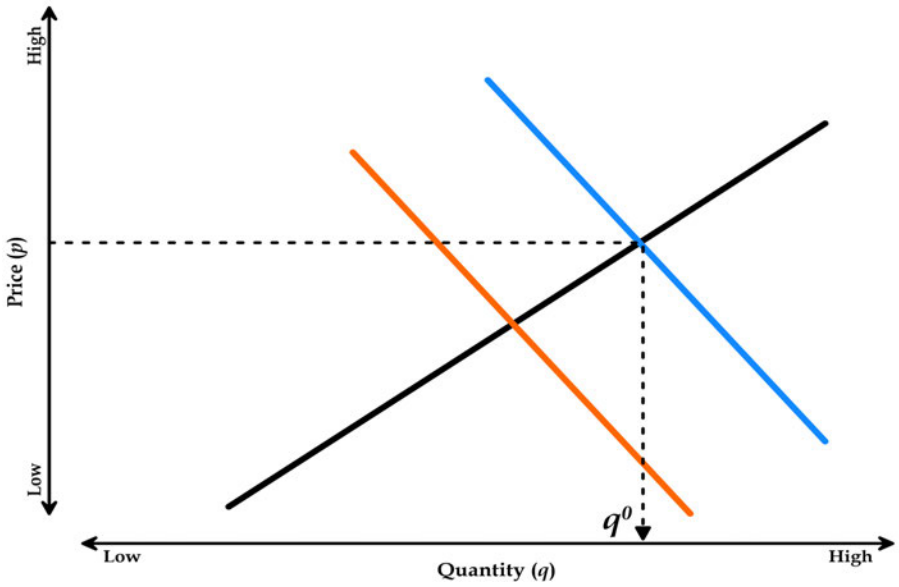

Figure 22 Demand and supply curves

4.4.2.3 Segmentations of users

In general, any customer segmentation analysis is planned to help provide a broader understanding of the traits and attributes that define the different types of customers within a particular customer base. The analyses usually identify and separate any customer base into distinct groups with common characteristics to help the organisation gain a deeper understanding of the profile of each segment, as well as to uncover the significant similarities and differences between the behaviour and demographics of each segment. The result is usually expected to help inform business planning and marketing decisions to improve overall business performance of companies or improve the organisation of public services in a residential area.

Once the organisation is facilitated with the detailed segmentation research, they can create advertising and promotional plans, support product or service development and pricing initiatives. They can develop tailored customer contact practices that will improve the customers' experience and result in greater sales and profit from each segment. To improve the Customer Relationship Management and optimise such strategies, one must start with understanding their customer base. The value added of this research is quite high as the categorisation by group of the French population show how much details can be provided by customer segmentation analysis based only on demographic and social variables (see tables below). The more complex segmentation is delivered, the more insights can be distilled from the micro-data, which after some statistical analysis can offer more accurate customer targeting tools.

The CAMEO Tables[122] for France (South Europe) provide a dynamic picture of the local communities. They are based on data from the French census and micro-data. It has been designed at a small area level with an average 180 households per area. The applied variables are:

- Movers; Household Composition
- Property Tenure & Type
- Income Focus and Education.

[122] More details about these reference tables see in Market analysis of UC1

9 key groups have been identified:

Table 20 Customer segments – France

Key Group	Description
Group 1	Wealthy city society
Group 2	Prosperous professionals
Group 3	Executive families
Group 4	Middle class communities
Group 5	Commuter societies
Group 6	Comfortable families
Group 7	Settled provincial communities
Group 8	Less affluent neighbourhoods
Group 9	Struggling households

Source: Reference tables, France

User needs

Group 1: Wealthy City Society – these are executives and intellectual professionals with high educational degrees, home, and cars

Sub-categories: prosperous young city professionals; high-flying pre-family households; established executive families; ageing city socialites

Group 2: Prosperous Professional – these are executives, intellectuals, and intermediate occupations, with high educational degrees, apartments & cars

Sub-categories: transient city singles; cosmopolitan young families; affluent homeowning families

Group 3: Executive Families – these are executives, intellectuals, and intermediate occupations, with above the average educational degrees, apartments or houses and cars

Sub-categories: pre-family executive couples; big city suburban families; established rural resident

Group 4: Middle Class Communities – these are intermediate occupations with average educational degrees and mixed properties (apartment or house)

Sub-categories: young career builders; new suburban settlers; suburban pensioners

Group 5: Commuter Societies – these are agriculture employed, artisans, merchants, and entrepreneurs with below average educational degrees

Sub-categories: large country living families; settled rural residence; retired rural empty nesters

Group 6: Comfortable Families – these are agriculture employed or industrial workers, with below the average educational degrees, owning an old house

Sub-categories: pastoral families in big abodes; ageing agricultural households

Group 7: Settled Provincial Communities – these are agriculture employed or industrial workers, with below the average educational degrees, owning a mixed range of properties (house or apartment)

Sub-categories: large rural blue-collar families; rustic rural homeowners

Group 8: Less Affluent Neighbourhoods – these are predominantly retired with an average degree and a mixed range of properties (usually built pre-1975)

Sub-categories: inner city singles and couples; provincial blue-collar communities

Group 9: Struggling Households – these are agriculture employed, industrial workers or pensioners, with below the average educational degrees, owning a mixed range of properties (an old house or apartment)

Sub-categories: young social renters; rural retirees

The first four groups represent the city residents. If we take “prosperous young city professionals” from Group 2 under the age of 40, predominantly single, some are couples with children, and some are from

foreign origin. They have high educational attainment and prefer to walk or cycle. The urban population in France, no matter the age, is genuinely more willing to make use of the environmentally friendly walking and cycling.

The last five groups of the segmentation include also sub-categories of rural population. These are residents from Group 5 “Commuter societies” till Group 9 “Struggling households”. They are usually agriculturally employed, industrial workers or retired residents. Ageing agricultural households from Gr. 6 dominate rural areas with retired members. As a customer base the following two sub-groups are of interest to our use case – “settled rural residents” and “large country living families” from Gr. 5, which are developing agricultural businesses. Representatives of these sub-categories are younger, self-sustaining themselves and their families with the farming. They might be more flexible and tech-savvy in comparison to the ageing farmers. Less approachable sub-groups are the “rustic rural homeowners” from Gr.7 and “rural retirees” from Gr. 9, which are predominantly retired but still doing some farming to support their low pensions.

For the purposes of our UC3 and in addition of the analysis above, the farmers might be segmented by:

- Business model – Drone as tool vs Drone as service
- Farming business production – sheep, beef cattle, goat
- Farmers’ age – younger farmers might have a bigger appeal for drones since they are tech-driven
- Farms’ regions – regions with an important part of the UAA dedicated to grasslands in South France

Concluding, this UC3 begins in two experimental farms in the French provinces of Alps, where the initial demos will take place to explore the opportunities of drone technology in livestock monitoring while the animals are grazing or resting. Theoretically, it has the great potential to expand its coverage and enter the markets of Ireland or Scotland where beef, cattle, goats, and other animals are in large quantities. Additionally, the natural grassland terrains are massive, which helps the farmers scale-up their activities and use the drone applications more efficiently.

4.5 Use Case 4: Forestry and biodiversity in Lithuania

Unmanned Aerial Vehicles (UAVs) are becoming an essential tool in forestry research and monitoring thanks to their capacity to cover high spatial resolutions and provide a high temporal-frequency analysis for the required level of detail. They can be used for early fire detection and control[123], monitoring active forest fire and supporting firefighting teams on duty[124], forest insect pest and disease monitoring[125], as well as classify species, quantify spatial gaps[126]. UAVs are low-cost, easy-to-use remotely operated vehicles that can carry a varied array of sensors such as LiDAR, multispectral, hyperspectral and RGB cameras. Technologies such as deep learning (DL) can reproduce expert observations on every single tree in hundreds or thousands of hectares. At the same time, a very high spatial resolution ensures that the features used by algorithms relate to real-life objects of a few centimetres, allowing thus, for example, to work with even the texture of leaves and have already become an affordable, cost-efficient tool to quickly map a targeted area for many emerging applications in the arena of Ecological Monitoring and Biodiversity Conservation. This use case (UC4) investigates the mentioned opportunities in forestry and biodiversity.

4.5.1 Definition

While essential for the health and wellbeing of all Europeans, as well as economies and societies, forests and other wooded land face increasing strain. Climate change continuously affects European forests by strengthening the extreme weather events, aggravating the previously hidden vulnerabilities such as pests, pollution and diseases, forest fire regimes (increasing the extent and intensity of forest fires). In response to the severing situation of forests, the EU has introduced a new EU forest strategy for 2030 that entails the focus on strategic forest monitoring, reporting and data collection, even throughout better remote sensing. It would allow to better capture the state of our forests, as well as step up the efforts to protect and restore forest biodiversity and with that ensure forest resilience[127].

Climate change is increasing the severity and frequency of the extreme natural phenomena on forests in Lithuania as well. From the overall of 2,200.2 thousand ha (forest land in Lithuania), abiotic natural factors damaged 2,883 ha (0.13%) of trees and plantations in 2021, with most harm caused by snow, wind, and drought. In addition, the warming climate inflicts the aggressiveness of harmful insects and diseases in forests. In 2021, the damage caused by insects, pathogens, animals, and abiotic factors affected 8,469 ha of state-owned forests in Lithuania[128]. Additionally, forest fires cause significant harm and economic loss. In 2020, 157 forest fires occurred and damaged 64 ha of forest (33 ha in state forests and 31 ha in private forests), with the total damage estimated to be €31,900[129]. Also, drought identification could potentially contribute to the monitoring and assessment of forest fires risk (according to 2021 data, 6,4 ha damaged)[130].

Finally, several issues related to the spreading wild boar's population are problematic in the context of Lithuania. The spreading wild boar population is severely destroying large areas of fertile land. In addition, the outbreaks of African swine fever (ASF) (a highly contagious viral disease in domestic and wild pigs and wild boars) in recent years cause significant economic losses. In Lithuania alone, the losses caused

[123] Kinaneva, Diyana, et al. (2019), Early forest fire detection using drones and artificial intelligence, 2019 42nd International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO)
[124] Simões, D., et al., (2020), Forest fire monitoring through a network of aerial drones and sensors, 2020 IEEE International Conference on Pervasive computing and communications workshop

[125] Duarte, A., et al., (2022), Recent advances in forest insect pests and diseases monitoring using UAV-based data: a systematic review, Forests 2022, 13, 911. https://doi.org/10.3390/f13060911
[126] Torresan, C., et al., (2017), Forestry applications of UAVs in Europe: a review, International Journal of Remote sensing, 38.8-10: 2427-2447.
[127] European Commission, 2021: New EU Forest strategy for 2030
[128] State forest service, 2021: State of forest overview, http://www.amvmt.lt/index.php/leidiniai/valstybine-misku-apskaita/2020-01-01
[129] JRC (2021), Forest Fires in Europe, Middle East and North Africa 2020
[130] JRC (2021), Forest Fires in Europe, Middle East and North Africa 2020

by African swine fever in the livestock sector are estimated at around €50 million. In Lithuania, cases of ASF are still recorded in the wild. According to the State food and veterinary services, the virus was detected in almost 400 wild boars in 2021 and four in January this year. There is still a risk of transmitting viruses from the forest to the pig-holding area[131].

Addressing the challenges Lithuanian forest ecosystems face, the proposal focuses on three main areas:

1. UAV-based forest tree health monitoring and risk assessment.
2. UAV-based wildfire risk monitoring.
3. UAV-based wildlife (specifically wild boars) monitoring.

Dominant tree species in Lithuania

This industrial Use Case's business solutions solely target forests and wooded land, and the focus of this sub-section is to present more statistical data about Lithuanian forests, which are in North-eastern Europe. Forests and wooded land cover more than 43.5% of the **European Union**'s land area and are essential to the health and well-being of all Europeans. Currently, there are around 16 million private and public forest owners in Europe. About 60% of the forest area is privately owned and 40% is publicly owned[132]. The numbers, however, differ greatly from one country to another due to different historical, legal, and social circumstances that should be considered in logistics[133].

In Lithuania, where the UC4 will take place, forests cover **33.7%** of the country's territory, and as much as half of it (923.8 thousand ha) is privately owned. According to the State Forest Service (SFS), Lithuania's forest cover increases every year, with around 8,500 ha of state forests being restored and an additional 500 ha of new forests being planted each year. Pine forests cover the largest area in Lithuania – 710,300 ha (Fig. 24). Their area has decreased by 1,200 ha over 17 years[134]. As of 2021, the overall value of Lithuanian forests was assessed to be close to EUR 5 billion. According to the State Forest Enterprise, a government resolution sets the rates of return for state-owned enterprises, the owners of forests. According to the State Forest Enterprise, the target one-year average normalised rate of return was set at EUR 40.5 million, which amounted to EUR 55.3 million in 2018 and EUR 35.8 million in 2019 (down due to the fall in the price of timber)[135].

Increasing the protection and restoration of forest biodiversity and biodiversity-friendly forest management practices are essential to increase forest resilience and improve forest adaptation. It is also a tremendous economic opportunity if forest owners and managers are adequately supported during the transition period. According to the World Economic Forum, by 2030, forest protection, restoration and sustainable forest management would create EUR 190 billion worth of business opportunities and 16 million jobs globally[136].

[131] Ministry of Environment of the Republic of Lithuania, (2019), Analysis of the Lithuanian economic sectors in regard to the goals and objectives of the national climate change management policy strategy.
[132] European Commission, 2021
[133] EFI, 2021: Knowledge to action report, https://efi.int/sites/default/files/files/publication-bank/2021/K2A%20-%20Forest%20Question%202.pdf
[134] State Forest Service, 2021
[135] https://branginu.lt/naujienos/misko-pasas
[136] World Economic Forum, 2020

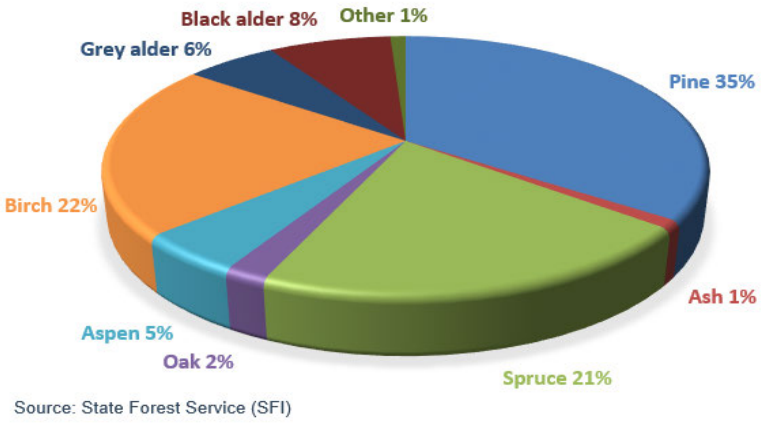

Figure 23 Forest strands area by dominant tree species, 2021

4.5.2 Market Analysis

4.5.2.1 Analysis of current and potential market

The applications of UAVs are expanding in different domains of the European economy despite the lack of common rules, and the use of UAVs in forestry is forecasted to increase, possibly leading to a regular utilisation for small-scale monitoring purposes in Europe when recent technologies (i.e., hyperspectral imagery and lidar) and methodological approaches will be consolidated. It is likely that the demand for UAV-based forest monitoring will further increase with the overall tendency to foster monitoring of health of forests and protection of forest biodiversity (species, habitats) both at the European and national levels[137] and increased responsibilities of public authorities such as Lithuania state forest services, and State service for protected areas.

In terms of the current state of global monitoring or inspection by drone, its market was evaluated at US$ 3.9 Bn in 2021. It is estimated to advance at a CAGR of 24.1% from 2022 to 2031 and reach a value of US$ 33.8 Bn by the end of 2031[138]. As for the type of the monitoring (inspection) drone, the rotary wing segment dominated the global inspection drone market with 62.5% share in 2021. The segment is expected to advance at a CAGR of 24.7% until 2031. Scale-up possibilities and potential market demand for forest monitoring using UAV, IoT, AI and satellite data combination solution:

- Insect pests (different type of forest)
- Infectious diseases of trees (different type of forest)
- Soil CO2 emission due the damage by wild boar depredation
- Damage from abiotic factors (different type of forest):
  - Fires and Drought
  - Snow and Frost
  - Water logging and Wind
- Wood logging monitoring
- The pathological condition measuring and assessment
- Forest biomass and soil carbon measuring and GHG balance assessments
- Other wild animals monitoring
- Agroforestry monitoring.

4.5.2.2 Segmented analysis definition of market demand and supply

The innovation of the proposed solutions to private and public actors in the Lithuanian ecosystems is the provision of real-time data to state-owned agencies that can analyse, explore, and plan the subsequent

[137] National Audit Office of Lithuania, (2022), Protection of forest resources in Lithuania
[138] Transparency Market Research

actions to protect forests and wooded land; propose treatment to various diseases of trees; and prevent damage from abiotic factors.

Current and potential demand

Corresponding to the three main streams of the service defined in this use case, the current and potential demand comes primarily from public authorities responsible for forest management, wildfire prevention, and food and veterinary security in the country. In the case of Lithuania, the primary target institutions are:

(1) Environmental Protection Department under the Ministry of Environment,

(2) Lithuanian state forest services (SFS),

(3) National Paying Agency (NPA),

(4) State Food and Veterinary Services (SFVS).

The state-of-the-art forest monitoring by using drones will impact and help to reduce, for instance, the amount of costs per hectare of Natura 2000 territory for the protection / monitoring / management / maintenance, which now amounts to 10.47 EUR/ha per year[139]. Since one of the proposed strands of services address the need for wildfire monitoring, public institutions responsible for fire prevention, detection and extinguish could be the primary beneficiaries of such service. These are Lithuanian Fire and Rescue Department as well as municipalities. The service could be of relevance to authorities operating the forests that are more likely to catch fire[140].

Further market demand may come indirectly from the following customer groups:

- Private forest owners represented by Lithuanian Forest and Landowners Association. The sole benefit for them will be to reduce risk of wildfires in their own terrains.
- Wood-based industry – the potential benefit for them is to reduce risk of wildfires; also monitoring of the tree health could help mitigate the risk of potential economic loss, which in turn benefits the whole nation, as in 2018, the industry constituted a share of 4.7% in the GDP.
- Producers of non-wood forest products – the likely benefit for them is to reduce risk of wildfires, and potential losses caused by migrating boars as well as timely inspection of forest health.
- Fuel and energy companies – the likely benefit for them is to reduce risk of wildfires and adjust their production quantity. In accordance with the national energy strategy, it is planned that renewables **(**incl. biomass**)** will consist 45% of total electricity and 90% of total heating produced; wind energy – 55%, solar energy – 25%, energy from biomass – 9% of electricity by 2030.

And the last group of beneficiaries, which may have potential benefits of the surged demand in drone services, and thus, facilitating such an increase are as follows:

- Technology developers and service providers – their benefit could be because of a greater need for monitoring services and equipment (drones). It would additionally create jobs in rural areas and reduce economic exclusion.
- Research organisations and individual researchers – their benefit mainly comes from improved evidence and data base related to tree health, wildfire risk, wildlife populations.
- Aviation authority – their benefit lays in the possibility to improve and accelerate the implementation of new regulatory rules.

As our services could be adapted and transferred to forests in other European countries, public sector institutions responsible for forest management in the respective countries could be considered the

[139] BGI Consulting, 2020

[140] https://civsauga.lt/pavojus/misko-gaisras/

potential customers, particularly the Scandinavian countries like Finland and Sweden where the forest terrains are in large quantities. More details about the demand side of UC4 are presented in Table 21.

Demand side

Table 21 UC4 details about the demand side

Demand side of UC4 (state-owned agencies and private owners)	Numeric answers	Explain if necessary
State forest Private forest Increase (+), 2021/22 Decrease (-), 2021/22 No change (0)	1,114,000 ha (+3,000 ha) 929,000 ha (+5,400 ha)	Data for 2021
Forest by type as a % of total land in Lithuania (%) Pine forest Others	In 2022, 10.9% (709,211 ha) 20.8% (1,355,416 ha)	
Number of private forest owners in Lithuania	255 400	Data for 2020
Number of state forest owners; Number of state agencies in charge of forest protection	1. State Forest Service 2. Municipalities 3. Ministry of National Defence 4. Ministry of the Interior 5. Ministry of Transport and Communications	1. State agency 2. Three ministries 3. All municipalities
Total number of employees in the state agency	149	State Forest Service (2022)

Current and potential supply

The supply of forest monitoring services has increased for the last years. Global initiatives that allow tracking forests and monitoring changes occur, for example, Global Forest Watch[141]. The cases of forest monitoring services using UAV provided by private companies across Europe have risen too. For example, HiView[142] offers high-resolution maps that delineates the forest area and observe it. Deep Forestry[143] provides services of scanning trees and labelling the terrain – tree location, species, height, diameter, trunk volume, trunk curvature, and terrain type. Additionally, engineers with drone equipment offer UAV services to detect diseases and pests in forests. The publicly available information, however, does not allow identification of either the parameters of the offered services, or the costs. The above-mentioned examples have been practically tested on only a few pilot cases, but it is difficult to track their further developments. Therefore, the potential for market implementation of such services remains very high.

As for the provision of forest monitoring using UAVs in Lithuania, evidence is scarce (see Table 22). At the time of writing, national public authorities with forest management responsibilities do not use drones to carry out monitoring. Relevant services offered by the private sector (SMEs, start-ups) are mostly limited to technically providing the required UAV-system and software equipment without any further market analysis, such examples are Geomanai, GeoNovus, GPSpartneris, Agrodronas, Promaksa, Dronai Pro.

141 https://www.globalforestwatch.org/
142 https://www.hiview.nl/
143 https://deepforestry.com/

Supply side

Table 22 UC4 details about the supply side

Supply side of UC4 (drone industry)	Numeric answers	Explain if necessary
Number of drones available: Total (in Lithuania)	No registered drones in the certificate category	No requirement to register a drone in the open and special categories in Lithuania
By type: Fixed wing, Rotary, Hybrid	n/a	Aggregated data not available
Ownership of drones: Private, Public Shared ownership	n/a	Aggregated data not available
Expected increase in drone fleet used in forestry & biodiversity	24%	Global trends
Number of licenced pilots in the region of Lithuania	2729	Officially registered remote pilots with certification
Number of drone service providers in Lithuania	> 10	According to the Lithuanian company register portal (https://rekvizitai.vz.lt/en/), there are just a few drone services providers directly related with land and forest monitoring.
Number of marketing companies to facilitate drone awareness campaigns in the region	> 5	DIHs: *https://www.agrifood.lt/en/* Drone association: *https://www.dronea.lt/en/about-us* *http://www.lbona.lt/lbona-veikla* Others: *https://lic.lt/en/lithuanian-innovation-center/;* https://vitp.lt/en/services/ *https://ssmtp.lt/en/innovation-support-services/*

Demand and supply relationship

In this UC4, we can demonstrate both curves on a diagram by taking a simple case into consideration – the supply curve is elastic (in black) and the demand curve is inelastic (in blue, see Fig. 25) with q^o the optimal number of drone applications such as monitoring or wild animal detection (the equilibrium number on a yearly average basis). In more detail, the demand curve is inelastic, because land and forest terrains are fixed to a certain number of hectares, and as a result the owners can take up a fixed quantity of drone applications. There is usually a charge for the services, and thus, both curves cross at price equal to ***p***, which is positive.

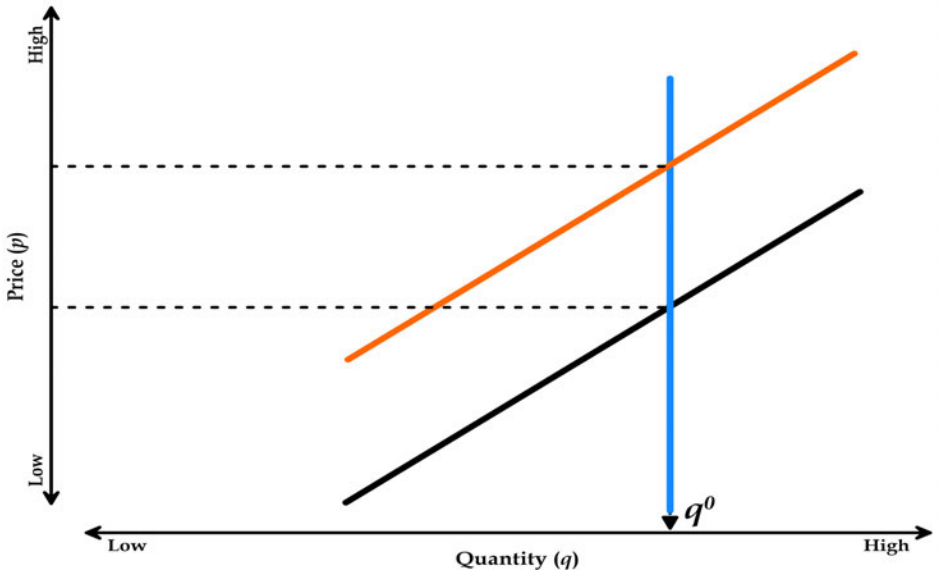

Figure 24 Demand and supply curves

Similar to the other cases, the drone operators' revenues are strictly determined by the needs of the forest owners and landowners, or the land holders. Even if the drone service providers increase the supply to more than q^o and offer more rounds of drone forest monitoring, they will not be able to drive up their revenues without a substantial shift in the demand. What drone operators may be able to achieve is to offer a package of new side services together with the old established ones in a combination to apply the principles of price discrimination, and thus increase prices, while offering the same quantity of applications, which means to shift up the supply curve (the orange line, see Fig. 25).

4.5.2.3 Segmentations of users

Demographic segmentation might be based on the assumption that *the place* where an individual lives can indicate the kind of purchasing power that they or their family possess. This theoretical assumption was used in the United Kingdom to make up the ACORN system – A Classification of Residential Neighbourhood. This methodology segregated the residential neighbourhoods in the UK and the homes that are located there. It draws the data straight out of the 10-year census results that the Office of National Statistics provides publicly[144]. This system is widely used to ascertain the buying power of different homes in different boroughs and councils of the United Kingdom. Businesses use such residential data before creating their production and selling plans. Also, public authorities implement this data in their decisions for proceeding with local policies.

Segregation of the local market based on the people's income and place of living has proved to be the most profitable for some private or public ventures. The buying power of customers is essential for having a steady demand in any local area. Some organisations are based on low-cost pricing models, and they target customers with low and average income, while others approach the high and middle-income groups.

[144] See more at: www.ons.gov.uk

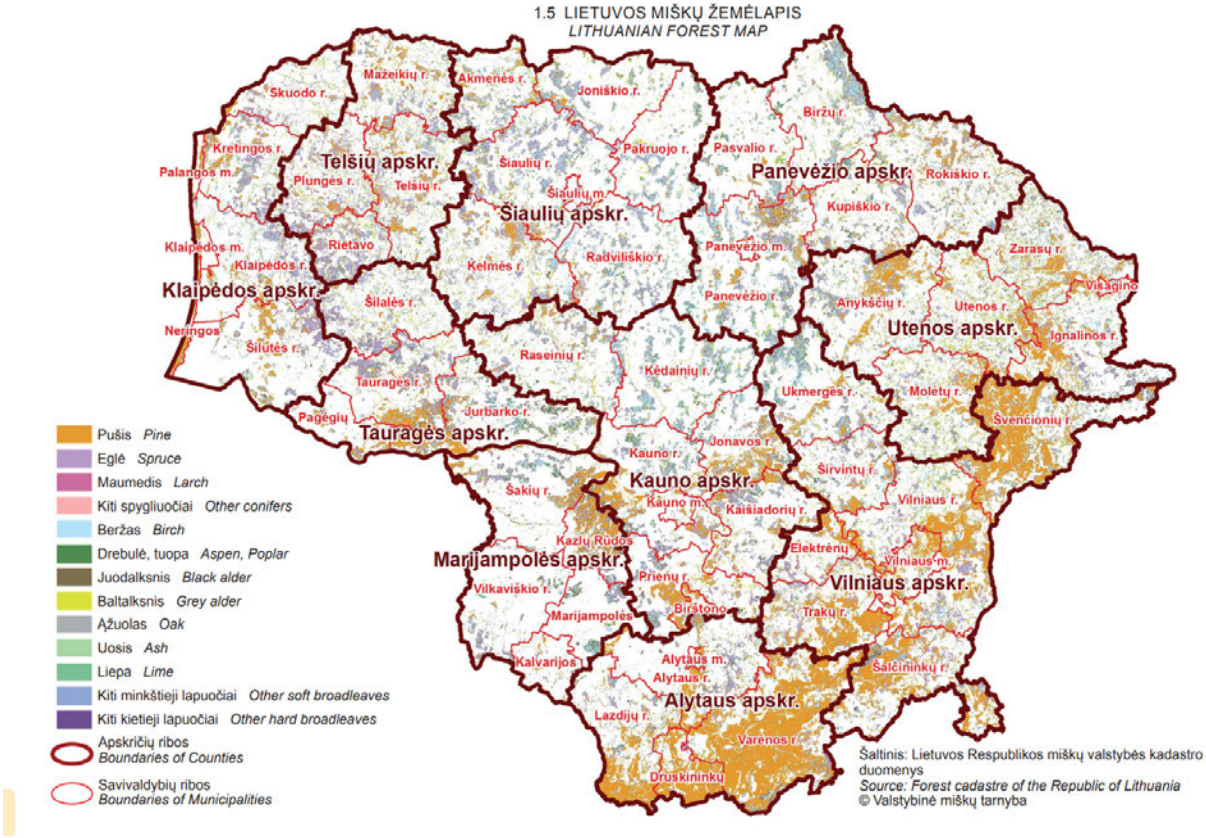

Figure 25 Lithuanian forest map

Similar to the UK methodology of the ACORN system developed in the past, the territory of Lithuania could be segmented into forest areas and non-forest areas with hotspots where fires, wind, water logging and drought as natural phenomena are much more possible to happen and make damages. These will be non-urban areas and they could be marked where the private and public forest & landowners live in addition to the level of affluency in such established rural residences (Fig. 26).

The monitoring of the forest area can be done by single tree, forest stand or the whole landscape. Figure 27 shows the remote sensing by: a) scale and spatial resolution; and b) scale and costs per square meter. Within the overlap area in the top graph, UAVs often have a significant cost advantage over crewed aircraft and are faster and more frequently deployable. Multirotor drones are easier to handle compared to fixed wing aircraft but are only suitable for relatively small areas[145].

For optimum results, the combination of UAVs will be performed in our UC4:

- **for tree health and fire risk monitoring – a multi-rotor drone**
- **and for wildlife monitoring – a fixed-wing drone**

[145] Source: https://www.mdpi.com/2072-4292/14/13/3205/pdf?version=1656928766

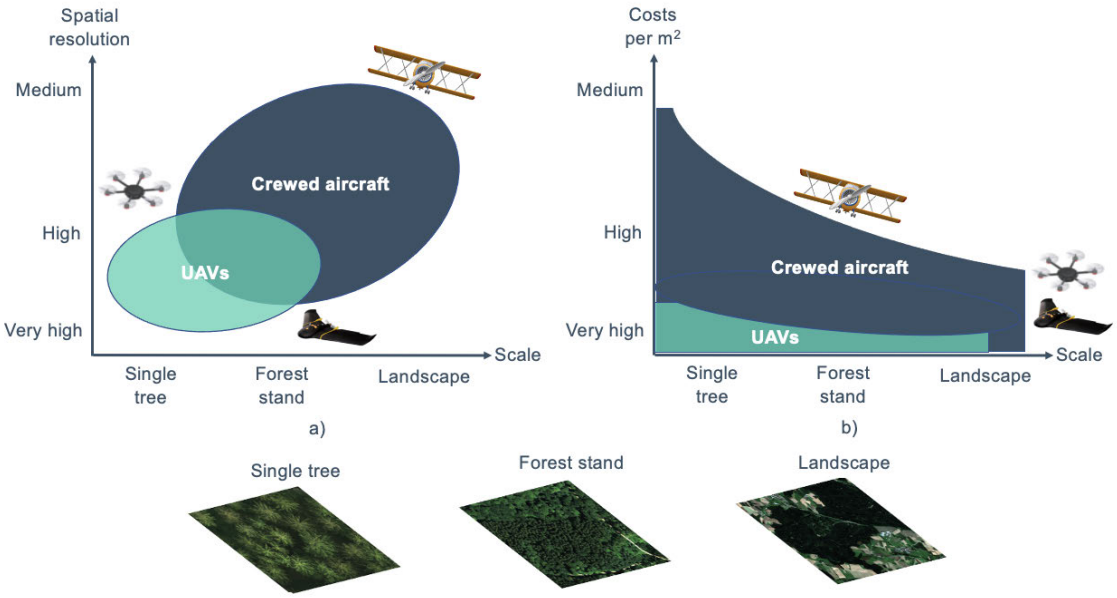

Figure 26 UAVs advantages for remote sensing of forests

In UC4 the main target market is the private and state-owned forest owners and landowners, which prefer the usage of cost-efficient technology, and could be further segmented by business model of utilised drone services. Therefore, the target customers of the UC4 services provided in forest and biodiversity monitoring will be:

I. Public sector:

- Environmental Protection Department under the Ministry of Environment, responsible for the monitoring of state of art of forests, their usage, restoration, seeding and protection.
- State Food and Veterinary Services (SFVS)
- Lithuania state forest services (SFS)
- National Paying Agency (NPA)
- Lithuanian Fire and Rescue Department
- Municipalities (local authorities).

II. Private sector:

- Private forest owners (Lithuanian Forest and Landowners Association verify statistical data, define, monitor, calculate harvest area)
- Wood-based industry
- Producers of non-wood forest products.

III. Indirectly targeted groups:

- Technology developers and service providers
- Research organisations and individual researchers
- Aviation authority.

4.6 Use Case 5: Rural logistics in North Macedonia

The main target of this industrial Use Case (UC5) is to design, develop and deploy an innovative drone-delivery fleet management system that will operate as an alternative fast response system for delivering small parcels of importance (e.g., medical supplies, documentation, etc.) in remote, isolated or rural areas in Europe. Such a system is aiming to ameliorate the living standards of the inhabitants in inaccessible regions, ensuring the secure transportation of important supplies on time. The proposed system will integrate state-of-the-art technologies for automated drone fleet navigation, as well as the utilisation of three drone types depending on the delivery parcel size, weight, and the required travel distance. Furthermore, there will be an effort to implement and probably establish drones as a service (DAAS) with the configuration of different models and the definition of appropriate principles for its efficient performance.

4.6.1 Definition

This UC5 is the only use case outside of the agricultural domain and its focus is on the aerial supply chain, which companies worldwide investigate the conditions to minimise the costs by using drones for "the last mile" of their value chain. The application of drones for the supply chain management and logistics has gained in popularity over the recent years due to several significant advantages they offer, such as the autonomous operation, flying capabilities and mobility, decrease of delivery times and costs, congestion relief in densely populated urban areas and the increase of environmental sustainability[146]. Particularly, the use of drone-based logistics is potentially very interesting for city suburbs, small villages, the countryside and generally all areas where the number of parcels to be delivered is low and the delivery destinations are spatially dispersed[147]. In fact, even mathematical programming models were deployed in recent years to obtain the optimal routing and scheduling of drones, including a scheme in which a drone works in collaboration with a traditional delivery truck for distribution of products[148]. Thus, companies associated with the supply of this market branch tend to incorporate drones to enhance their responsiveness and efficiency[149]. Moreover, the rapid technological development on various hardware and software aspects of drones' operation and manipulation allowed them to be a realistic option even for passenger use and transportation[150], as well as to support humanitarian assignments. Therefore, it is evident that the size of the drone logistics market is extensive, addressing to a diversity of target groups.

In general, the drone logistics and transportation market is divided to several segments, based on:
1) the application – commercial vs. military;
2) the offered solution:
    - warehousing, shipping, infrastructure, software;
3) the drone type:
    - freight for cargo or delivery, passengers, ambulance for medical supplies;
4) the region – North America, Europe, Asia.

The segment that has the largest share of the drone logistics and transportations market is freight for cargo or delivery with an expected CAGR of 54.6% during the period 2022 to 2030. Focusing on Europe, the market amount is roughly evaluated to USD 8 million in 2018, although is expected to grow rapidly with a

[146] Rejeb A., Rejeb K., Simske S. and Treiblmaier H. (2021), "Drones for supply chain management and logistics: a review and research agenda", *International Journal of Logistics Research and Applications*
[147] Benarbia T., Kyamakya K. (2022), "A literature review of drone-based package delivery logistics systems and their implementation feasibility, *Sustainability,* 14, 360
[148] Murray C.C., Chu A. G. (2015), "The flying sidekick traveling salesman problem: Optimization of drone-assisted parcel delivery", *Transportation Research Part C: Emerging Technologies, 54*
[149] Sah B., Gupta R. and Bani-Hani D. (2020), "Analysis of barriers to implement drone logistics", *International Journal of Logistics Research and Applications*
[150] Shavarani S. M., Golabi M. and Izbirak G. (2019), "A capacitated bijective location problem with uniformly distributed demands in the UAV-Supported delivery operation. *International Transactions in Operational Research*

CAGR of 61% over 2027 to account for USD 510.87 million approximately, during the forecast period[151]. An analysis of current and potential drone logistics market demand and supply is briefly discussed below.

4.6.2 Market Analysis

4.6.2.1 Analysis of current and potential market

Although now this UC5 is still in a pilot phase and many start-ups around the world explore the opportunities of developing drone services for "the last mile" of the supply chain, the potential for market growth is enormous. Generally, the predominance of drone logistics and transportation market analysis reports envision a dramatic growth of the market revenue, due to the gradually increasing demand in drone-based applications and services for the materialization of the complex social and economic activities in modern societies.

The global drone logistics and transportation market amount is currently estimated to USD 11.20 billion in 2022 and is expected to reach USD 29.06 billion by 2027, representing a compound annual growth rate (CAGR) of 21.01% during this period[152]. Similar results have been obtained for a slightly extended period, ranging from 2020 to 2030, as illustrated in the chart[153] (Fig. 28) from the industry research, which evaluates the current value to be USD 12,74 billion in 2022, and this number to be more than doubled in 2026. Thus, during the duration of this project, the drone logistics market is expected to be doubled.

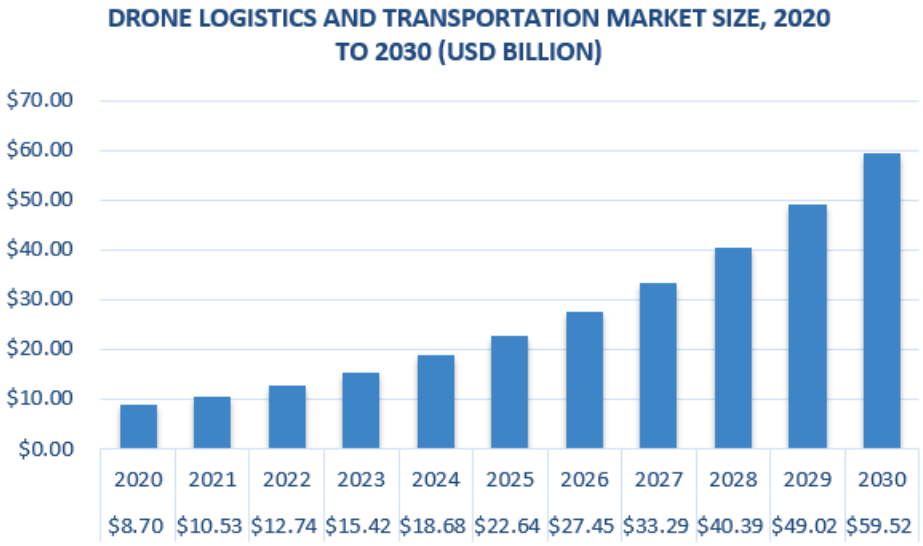

Figure 27 Estimated size of global drone logistics and transportation market, 2020 - 2030

4.6.2.2 Segmented analysis definition of market demand and supply

UC5 has great opportunities of commercialisation with tremendous market potential for growth in Europe and is open to the services it can offer to various customer segments including the ones for social purposes such as delivery to elderly people in isolated villages, mountain residences, or small towns in the Balkans.

The abovementioned size and segmentation of the drone logistics and transportation market reveals its prospects to support numerous industries and businesses aiming to provide their products and services to a variety of users with different requirements. The demand of the market emerges from three main needs of the users.

[151] Research and Markets, (2019), "Europe Drone Logistics & Transportation Market to 2027 - Regional Analysis and Forecasts by Type, Application and End-user", *Report*

[152] MarketsandMarkets, (2020), "Drone Logistics and Transportation Market by Solution (Warehousing, Shipping, Infrastructure, Software), Sector (Commercial, Military), Drone (Freight Drones, Passenger Drones, Ambulance Drones), and Region – Global Forecast to 2027, https://secure.livechatinc.com

[153] Precedence Research, 2020

- Firstly, the necessity of humanitarian logistics utilisation, which is vital for preparing and responding to disasters or complex emergencies by transporting valuable lightweight payloads (e.g., pharmaceuticals) to rural and inaccessible regions[154].
- Secondly, the global growth of e-commerce market inevitably led to the development of time and cost efficiency delivery service to fulfill the exponential increase of users' tendency to buy goods.
- Finally, the preference from most consumers to obtain the merchandise via the convenient service of the last-mile delivery. A general overview of the current and potential demand and supply of the drone logistics and transportation market is discussed in the following subparagraphs.

Current and potential demand

The target users of the drone logistics and transportation market products and services cover a wide range of customers, essentially embracing a diversity of industries, companies and individuals. For instance, healthcare facilities are expected to retain a significant proportion of the market demand, mainly for medical supplies and aid operations in case of emergencies, as well as to pharmaceuticals transportation in isolated areas. In addition, the e-commercial trading, which is extremely widespread nowadays, elevates the demand in fast, accurate and last-mile delivery of products among the customers. It is intriguing that the e-commerce market involves customers with varying age and profession, inhabiting to different countries and locations around the globe. This fact implies the vast potentiality of the drone logistics and transportation market demand and the impact on the world economy.

Furthermore, the rise of the demand for drone logistics and transportation services, could be beneficial to local populations and communities in various aspects. For example, citizens in remote areas, which are usually considered as practically inaccessible with conventional vehicles due to poorly constructed road networks, will be able to acquire several important supplies (medicines, documents, etc.) fast, with reduced cost and minimum effort. Moreover, the decrease of carbon emitting vehicles for logistics and transportations, positively contributes to maintain low pollution levels to the environment. Within UC5 of the ICAERUS project, we focus on the drone logistics and transportation market demand inside an area covering mainly the Balkan region (North Greece, South Bulgaria, North Macedonia, Albania, South Serbia). For the purposes of this market report, we look at the details of only three countries – North Greece, North Macedonia and Bulgaria.

Figure 28 UC5 potential drone logistics and transportation market

[154] Emery J. R., (2016), "The Possibilities and Pitfalls of Humanitarian Drones", *Ethics and International Affairs*, 30 (2):153–165. Altay N., Heaslip G., Kovács G., Spens K., Tatham P. and Vaillancourt A. (2018), "Innovation in humanitarian supply chains: A systematic review", *CIRANO, https://econpapers.repec.org/paper/circirwor/2018s-03.htm*

A map of the area of interest is presented in Figure 29, while Information about the demand side of UC5, including mainly local consumers and small firms, are presented in Table 23.

Demand side

Table 23 UC5 details about the demand side

Demand side of UC5	Numeric answers	Explain if necessary
Flat territory to be covered by drone services for logistics and transportation purposes	North Greece: 20% Bulgaria: 31% North Macedonia: 20%	The figures refer to the percentage of low-altitude areas in relation to the total area of the country. Source : https://en.wikipedia.org/
Share of urban population	Greece: 80% North Greece: 65% Bulgaria: 76% North Macedonia: 58%	Source : https://www.statista.com/
How many countries to be covered?	3	Greece, Bulgaria North Macedonia
Number of towns with a population < 10.000 residents	North Greece: 860 Bulgaria: 606 North Macedonia: 12	Population range is from 10,000 to 1,000 citizens
Approximate number of villages	North Greece: 5000 Bulgaria: 4380 North Macedonia: 1750	Population range is from 1,000 to 100 citizens
Population in this region	2.903.785 6.519.789 1.836.716 11.260.290	North Greece Bulgaria North Macedonia **Total**
Younger population (Age < 40)	1.254.705 2.515.000 887.000 4.656.705	North Greece Bulgaria North Macedonia **Total**
Ageing population (Age > 40)	1.649.080 4.004.789 949.716 6.603585	North Greece Bulgaria North Macedonia **Total**

What the statistics show is that the market size is of 11 million people in the described area as the ratio younger to ageing population is 41:59.

Current and potential supply

Drone logistics and transportation is being promoted and researched by a growing number of firms involved in different platforms of the market. For example, retail companies such as Amazon, Walmart, Alibaba, and others have tested drone delivery for years, some since 2005, as a possible alternative or

complement to traditional delivery[155]. More recently, Amazon[156] plans to use drones for 30 minutes deliveries directly to customers' residence, with the first drone-delivery customer becoming a reality. Furthermore, parcel and courier companies such as DHL, FeDex, UPS are investing on the development of drone logistics and transportation to gain better control of the last mile delivery performance (i.e., speed, reliability and cost), increasing the willingness of the customers to pay for the expedited shipping[157]. In addition, High-tech (Google, Facebook, Rakuten), Pharmaceutical (Matternet), Automotive (Mercedes-Benz, Audi) and Airline (EasyJet) companies are aiming to incorporate drones to manage the effective supply of their products and services to the customers[158]. Many start-up companies such as Skycart, Matternet[159] and FlyTrex[160] are also planning to offer drone delivery services.

Information about the supply side of UC5, including mainly drone industry actors, SMEs, and start-ups, are presented in Table 24. (***Note:*** *The set of information that follows is an approximate empirical assessment, as the relevant official data either do not exist or are not publicly available.)*

Supply side

Table 24 UC5 details about the supply side

Supply side of UC5	Greece (North Greece)	North Macedonia	Bulgaria
Number of drones available			
Total (in the region):	6000 (2200)	2070	4100
Increase (+), 2021/2022:	20%	15%	20%
Decrease (-), 2021/2022:	0%	0%	0%
No change (0):	0%	0%	0%
By type			
Fixed wing:	400 (150)	50	80
Rotary:	5500 (2000)	2000	4000
Hybrid:	100 (50)	20	20
Ownership of drones			
Private:	80%	90%	90%
Public:	20%	10%	10%
Shared ownership:	0%	0%	0%
Expected increase in drone fleet used in logistics & transportation	10%	10%	10%
Number of licenced pilots in the region of UC5	2000 (800)	100	1000

[155] Lee H. L., Chen Y., Gillai B., Rammohan S. (2016), "Technological disruption and innovation in last-mile delivery", Stanford Bus, 1-26

[156] Singireddy, R. S. R., Daim T. U. (2018), "Technology Roadmap: Drone Delivery – Amazon Prime Air", In T. Daim & C. L. EJ (Eds.), Infrastructure and Technology Management. Innovation, Technology, and Knowledge Management (387–412p), Cham, Switzerland, Springer

[157] Bouman P. N., Agatz N., Schmidt M. (2018), "Dynamic programming approaches for the traveling salesman problem with drone", Networks, 72 (4): 528-542

[158] Maharana S. (2017), "Commercial Drones", International Journal of Management and Applied Science, 5 (3): 96–101; Sibley J. (2017), "Speed, Distance and Adaptive Distribution – the Rise of the Logistics UAV", Logistics in War, August 7, https://logisticsinwar.com/2017/08/07/speed-distance-and-adaptive-distribution-the-rise-of-the-logistics-uav/.

[159] https://www.slideshare.net/Tracxn/tracxn-drones-startup-landscape

[160] http://www.flytrex.com/

Number of drone service providers	15 (3)	3	8
Number of local drone platforms	10 (4)	1	3
Number of marketing companies to facilitate drone awareness campaigns in the region of UC5	6 (3)	2	3

Demand and supply relationship

UC5 is the only case in our project representing the supply-chain market. To understand better the relation between demand and supply, we take a simplified case into consideration – the supply curve is elastic (black line), and the demand curve is elastic (blue line, see Fig. 30) with q^0 the optimal number of drone transport services (the equilibrium number on a yearly average basis).

In the previous cases, which represent the agricultural productions, the demand curve was inelastic due to the unique nature of the agricultural sector. In this case, both curves are elastic. Whenever there is a transport fee for the services, both curves cross at price equal to ***p***, which is positive. In this UC, the revenues of the drone service providers are determined by the needs of the local population for small package deliveries and humanitarian aids in cases of emergency, as well as firms' willingness to introduce new tech drone solutions in their "last-mile" of the supply chain. Naturally, the firms' flexibility depends very much on the regional markets of the Balkans for food, small packages below 2.5kg, pharmacy products and humanitarian aids deliveries. These markets must be well defined and explored to be able to approach local customers. And the demand can be expanded with additional countries in the region, which leads to a shift of the demand curve to the right (orange line, see Fig. 30) and brings an increase in the price and quantity that can be offered by drone service providers (more than q^0).

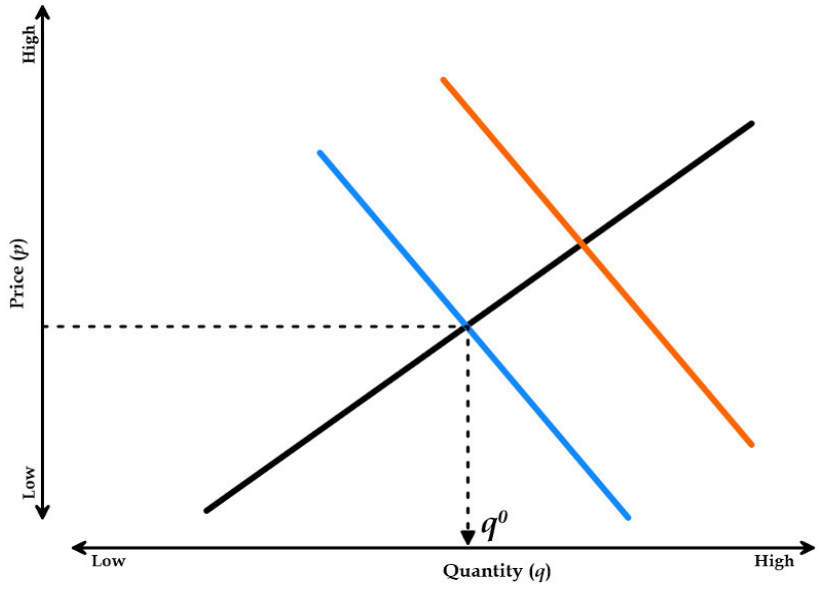

Figure 29 Demand and supply curves

4.6.2.3 Segmentations of users

A substantial amount of research has been carried out in the last years on the potential use of drones in the logistics and transportation market, principally in areas of their optimisation and adaptation in the supply chain. However, little is known about the potential market and economic viability of such services in Europe, especially how the drone-based deliveries could be sufficiently employed to benefit the citizens

or users. A recent analysis indicates that under the most technologically realistic scenario[161], up to 7% of EU citizens could get access to such services. When considering technological improvements scenarios, the share reaches 30%. Furthermore, their results suggest that due to the differences in population and land-use patterns in the different Member States, the potential drone coverage across Europe could be very heterogeneous, with the UK, Germany, Italy and France appearing as the most likely countries for the most efficient development and economically viable implementation[162]. Nevertheless, drone utilization in logistics and transportation is considered as a dominant option for last-mile, same-day, or instant deliveries at rural areas (typically with density smaller than 50.000 inhabitants), positively contributing to the need of a significant proportion of users in EU (30% approximately), since it is expected to grow in the near future[163].

The target market for UC5 are residential areas with dispersed population in mountain regions with a small number of inhabitants such as towns with less than 10.000 residents and villages with less than 1.000 people (see some examples in Table 25). Customer grouping can be done by generation, age, occupation and affluency. Usually, younger people from generation Y and Z are tech-savvy and shaped by social media. They accept easily new ideas and tech solutions. They can be targeted as potential customer group for the food and small package deliveries in various towns.

Ageing population from the "baby-boomers" generation, born between 1945 – 1965, that populate the UC5 region are a potential customer group for medical and pharmacy good deliveries directly to their houses in towns and villages. In addition, people from various occupations can be targeted too with specific drone delivery offers that are relevant for them.

Table 25 Examples of villages and towns within the area of interest for the UC5

Country	Village Name	Residents	Town Name	Residents
North Greece	Polymylos Profitis Toxotes	408 935 819	Argos Orestiko Didymoteicho Eleftheroupoli	7.473 9.263 5.555
Bulgaria	Bogdan (near Plovdiv) Bukovo (Blagoevgrad) Popovich (near Varna)	851 921 506	Bansko Dulovo Tryavna	8.562 6.568 9.569
North Macedonia	Beli Berikovo Lozovo	466 168 896	Kruševo Petrovec (municipality) Valandovo	5.211 8.298 4.402

Summing it up, UC5 begins with an initial demonstration in North Macedonia aiming to scale its market to three countries simultaneously and depending on the business model designed later in WP5 Ecosystem Building, Open Calls & Business and Governance Modelling, it has immense opportunities for market penetration of additional countries in the Balkans such as Albania, South of Serbia, or Romania. Once the use case is well-established, equipped with the proper capacity for expansion, it may have very good chances of scaling up its activities to the rest of the EU markets.

[161] Aurambout J.-P., Gkoumas K. and Ciuffo B. (2019), "Last mile delivery by drones: an estimation of viable market potential and access to citizens across European cities, *European Transport Research Review,* 11:30
[162] i.e.
[163] Joerss B. M., Neuhaus F. and Schroder J. (2016), "How customer demands are reshaping last-mile delivery", The McKinsey Quarterly, 17

Overall, for all UCs of ICAERUS project to increase the market share in their drone applications in agriculture and forestry, or logistics segments and take full advantage of drone technology, the market data should be analysed, compared and optimised to function as a benchmarking line in the investment and decision process.

5. Use Cases' Stakeholders Network Analysis

5.1 Framework of the stakeholders analysis of all ICAERUS industrial cases

Modern literature and research achievements have demonstrated an enormous progress in the fields of network formation, business ecosystem dynamics and networked processes to create value-added services and products. It is recognised that business ecosystems offer a broader perspective to explore emerging business structures and novel strategies to succeed with innovative technologies[164].

In ICAERUS, based on the business ecosystems research evidence and WP1 methodology, a four-stage process has been implemented to extract the needed parameters from the project's UCs networks:

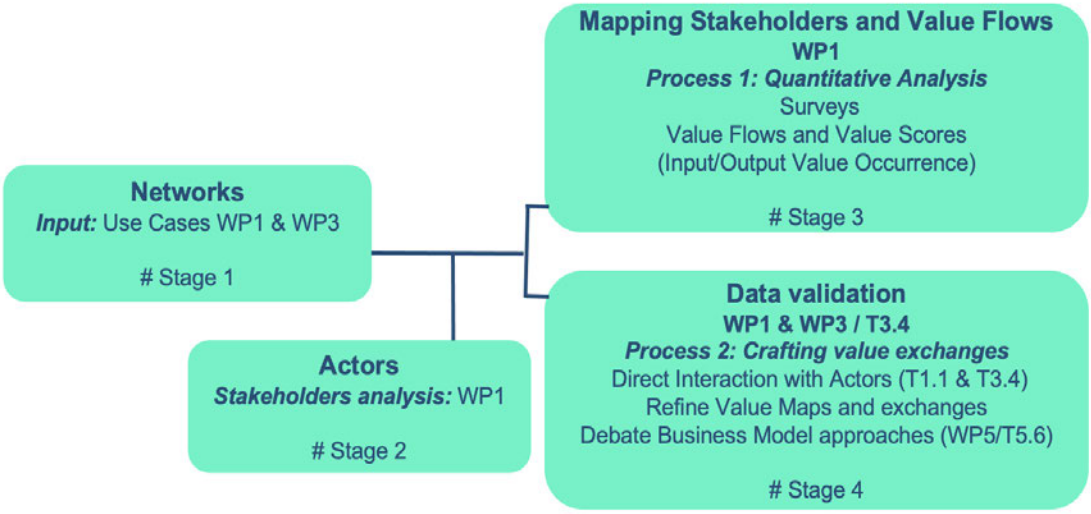

Figure 30 Methodological stages of the stakeholders network analysis

STAGES:

1) Networks – a baseline stakeholder map is identified by all UC leaders in M2 - M3 when the principal information about stakeholders was initially collected. This was advanced during the work in M6 – M8 of WP1;
2) Actors – stakeholder objectives, needs and inputs / outputs – these details were requested by all stakeholders of each network, primarily their roles, objectives and needs in an excel format to trace the inputs that each stakeholder receives from others (in M2 of WP1);
3) Mapping stakeholders and value flows – here is introduced the term *value flow* to outline the output of one stakeholder as an input to another. A training session with all UC leaders took place in M4 to elaborate on concepts, methodology and structures. In a way, the *flow* represents the delivery of *value* from one stakeholder to another;
4) Data validation – will be described in the final version of D1.1 in M42. The initial plan is presented in the methodology report of WP1, and briefly will be discussed below.

It can be also said that every value exchange should be supported by a well-defined mechanism or medium which enables the transaction involved. For instance, technology is used primarily as medium for enhancing relationships in space and time. Mechanisms that create knowledge value include technical know-how, exchanges of strategic information, plans and reports, policy development, collaborative design, and others, which flow around and support the value creation. Knowledge is conceived as a core resource. It is considered as the foundation of competitive advantage and economic growth and is

[164] Clarysse B., Wright M., Bruneel J., Mahajan A., (2014), "Creating value in ecosystems: Crossing the chasm between knowledge and business ecosystems", Research Policy 43 (2014) 1164 - 1176

recognised as the key source of wealth. Knowledge has components such as abstract or generalised knowledge and prescriptive knowledge which refers to techniques. According to this understanding, to define stakeholders in a network which is centred around specific service, the following elements should be performed:

- ✓ Identify core competences which include the fundamental knowledge and skills of an entity – these are considered as potential competitive advantage.
- ✓ Identify other entities that may benefit from these competences – these are considered as potential customers or end-users.
- ✓ Cultivate relationships that involve customers in a compelling value proposition to meet specific needs.
- ✓ Gauge marketplace feedback by analysing financial performance from value exchanges – following this process allows to learn how to improve the firm's performance and value offerings.

Thus T1.1 sets in motion a process to identify stakeholders and engage the described actors to reframe their preferences and develop their understanding of the value exchange, with the planned stakeholders' surveys[165] and collective workshops playing a crucial role. Therefore, we envision 5 collective workshops in total, each organised by the project partner responsible for each UC, specified by DoW. The workshops will thus take place at local level and will be oriented towards the demonstrations in T3.4/WP3, which provides an opportunity of demonstrating the strong interrelations between WP1 and WP3. For instance, the experimental phase of UC3 gives us a chance during ICAERUS events to illustrate to the French stakeholders how the drone technology can be implemented in their farming processes as part of WP3 and simultaneously discuss with them their preferences, needs and understanding of value creation as an integral part of WP1. More specifically, the interrelations between T1.1 and T3.4 entangles the project's demos with the direct interaction of consortium's partners and the local stakeholders.

The ICAERUS demos and associated workshops

Consortium partners will provide tailored information to participants on what the project aims to achieve and present the results of surveys from the previous steps. In the workshops, stakeholders will be involved in the evaluation of the value streams by approving the results of the surveys. A debate on the possible exchange of values will focus on aspects such as what values are created and how they are created.

NSWR will prepare a detailed plan for short workshops, aligned with the planned demonstrations in T3.4/WP3 Demonstration Activities (as part of T1.1 and D1.1 Final Version), setting out the following information after discussion with consortium partners:

- Scope and objectives
- Dates and duration
- Participants (local stakeholders expected to be present at the DEMOs).
- Format of the workshop (process model and structure, methods, and tools to achieve the objectives, material needed)
- Recording methods and languages
- Facilitators/team on site
- Logistics
- Follow-up activities and short reports on the workshop's results

Table 26 Collective Workshops

Workshops	**Responsible partner - Country**	**Provisional time period**

[165] Several surveys have been conducted as part of the stakeholder analysis (see Annex III)

UC1	Noumena & EI - Spain	M24 – M48
UC2	AUA & HCPA - Greece	M24 – M48
UC3	IDELE - France	M24 – M48
UC4	ART21 &AFL - Lithuania	M24 – M48
UC5	GS & AGFT - North Macedonia	M24 – M48

After all workshops have taken place, NSWR will finalise D1.1 in M42 (Dec. 2025). Between M18 and M42, the work done in WP3 and WP5 builds upon the results from T1.1 & T1.2, therefore D1.1 will provide vital inputs for specific tasks of these two WPs. Additionally, the outputs of surveys and interviews conducted in T1.1 (see §5.2) will be essential inputs for WP4 “Capacity Building & Value-added Services” that focuses on guiding, training, and creating novel skills.

5.1.1 Qualitative stakeholders network analysis

The qualitative analysis presents key aspects of the performed stakeholders network analysis lasted over a period of several months of collaborative work between the UC leaders, WP1 partners and the local stakeholders. It is a method that can help provide an in-depth understanding of the numerous stakeholders within any system, in our case – between 12 and 25 actors. It is very useful to shed light on the complex interactions between the stakeholders as well as their needs, expectations, and objectives. When one looks at the inputs and outputs of each stakeholder, this method allows us to visualise how value is created and delivered throughout the system. It also provides an indication of the level of connectedness that exists among the stakeholders, and what they really expect from the rest of the network.

The qualitative analysis involves the following steps:

1. Identifying stakeholders
2. Developing a stakeholder map
3. Describing stakeholder needs and objectives
4. Determining the interactions (value flows) between each stakeholder
5. Mapping value flows

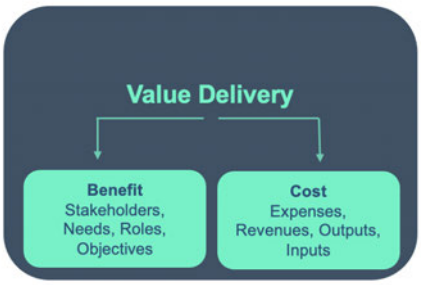

Figure 31 Framework for analysis of stakeholders

To summarise the five steps above, figure 32 presents the framework within which the stakeholders will be analysed in this document. The diagram decomposes any complexity and help us manage the methodology and model the UCs stakeholders. It is centred around the delivery of value to the stakeholders and beneficiaries of drone services in the local environment of a few EU-member states. Benefit is realised on the left side of the diagram, and it identifies beneficiary groups, their primary needs, and objectives. Any need is described by three attributes – level of satisfaction in fulfilment, level of regret if the need is unfulfilled, and the importance of a particular source. On the left side of the diagram, the cost is incurred – each stakeholder’s objectives can be linked to a set of expenses, inputs, human resources,

and other measurements that facilitate the achievement of any objective. Our focus will be on the delivery of benefit to the stakeholders.

Moreover, the proposed grouping is aligned with the stakeholder definition carried out in T1.1:

Definition of the network and its stakeholders

1. National government – the legislative, executive, and judicial branches of each member-state
2. European Commission – the legislative, executive, and judicial branches of the EU
3. International partners – organisations which are not part of the EU structure
4. Regulatory authorities – European Aviation Safety Agency; National or Civil Aviation Authority
5. Universities/research institutes – organisations responsible for research and innovations
6. Drone operators – performers of drone operations
7. Drone service providers – enablers of drone solutions
8. Drone software developers – developers of drone software
9. Manufacturers of drones – producers of drones (UAVs)
10. Public authorities – a level other than government, e.g., forest protection agents, infrastructure facilitators or transport managers
11. Users (focus on end-user needs) - different sectors such as agriculture, fisheries, forestry and biodiversity, mining and exploration, agriculture and livestock monitoring, logistics, transport, and utilities appear to be users of drone services
12. Specialised and social media – engaging end-users through a continuous analysis of their opinions

Figure 32 Science-related value flows

Having identified a distinctive number of groups for each use case in consultation with the UC leaders and key stakeholders, further specifications have been added such as roles, primary objectives, certain needs, and inputs received from some stakeholders or outputs going to others. More detailed explanation of the interaction among stakeholders is provided, for instance, what kind of scientific knowledge of drone technologies is shared between universities of any EU member-state and their national government or the European Commission; or what kind of drone applications are offered to public authorities by drone start-ups which provide drone services, and what public policy is facilitated by this. To illustrate such interactions, Figure 33 shows the science-related value flows. When all stakeholders interact on multiple levels, this creates a complex map of transactions or value flows.

5.1.1.1 Identification of stakeholders

The first step was to identify the stakeholders and stakeholder groups that were to be included in the analysis and characterise their objectives and needs. The use case leaders had two months at the beginning of the project (M1 – M2) to identify the relevant stakeholders. For all use cases of ICAERUS, the stakeholders were considered from the point of view of the network's core activity: UC1 – crop monitoring; UC2 – drone spraying; UC3 – livestock monitoring; UC4 – forest monitoring; UC5 – rural logistics. To proceed further, in general, stakeholders are defined as those who:

(**1**) have a direct or indirect involvement in the core activity
(**2**) receive direct or indirect benefits from the core activity
(**3**) possess a significant, legitimate interest in this core activity (regulators).

Table 27 Initial Lists of Stakeholders

UC1 List of Stakeholders	**UC2** List of Stakeholders	**UC3** List of Stakeholders	**UC4** List of Stakeholders	**UC5** List of Stakeholders
1.Institute of Agrifood Research & Technology (IRTA) 2.Department d'Agricultura, Ramaderia, Pesca i Alimentacio (DARP) 3.Centre for Research In Agricultural Genomics (CRAG) 4.UNIO de Paigesos Catalanes 5.AGRAWDATA 6.AGROXARXA 7.OPENVINO 8.FUNDACIO la PEDRERA 9.AEROCLUB REUS 10.MAS MARTINET 11.CREAF 12.INCANVI 13.Universitat Oberta de Catalunya (UOC) 14.Mas Doix 15.Alvario Palacios 16.Ferrer Bobet 17.Clos Erasmus/Clos Terasses 18.Clos Mogador 19.Spanish Air Safety Agency (AESA) 20.The Agricultural Mechanisation Unit (UMA) 21.Municipality Falset 22.Municipality of Villafranca 23.EASA 24.XIA 25.La Vanguardia	1. HCPA 2. CropLife Europe 3. AUA 4. Poliagroktima Gi Mas 5. Palivos Estate 6. Ucandrone 7. CAFFINI Sprayers Equipment 8. Agrotech (John Deere Hellas) 9. Hellenic Civil Aviation Authority (CAA) 10. Peloponnese Regional Authority (zone of NEMEA) 11. European Aviation Safety Agency (EASA) 12. UPL Hellas S.A. 13. K&N Efthymiadis Single Member S.A. 14. Bayer Hellas S.A. 15. Syngenta Hellas S.A. 16. Elanco Hellas S.A. 17. ICAERUS Partners 18. Educators	1. Idele 2. Jalogny Farm 3. Carmejane Farm 4. Livestock producers Groups 5. Carmejane School 6. Flying eye 7. Jalogny Municipality 8. La Chaffaut-Saint -Jurson 9. French National Aviation Authority 10. EASA 11. ICAERUS Partners 12. Educators 13. Government	1. State Food & Veterinary Services. (SFVS) 2. Lithuania State Forest Service (SFS) 3. National Paying. Agency (NPA). 4. Lithuania Forest. and Landowners. Association (FOAL) 5. GeoNovus, Ltd. 6. Vytautas Magnus University (VMU) 7. Lithuanian Research Centre for Agriculture and Forestry (RCAF) 8. ICAERUS Cons. 9. Vilnius Municipality 10. Transport Authority 11. EASA 12. Educators 13. Government	1. Make Telecom 2. MSF 3. Uni GD 4. UCM 5. Pharma_1Str 6. Pharma_2Oh 7. Pharma_3P 8. AG-Pharma_S 9. Ag-Pharma_K 10. Debarca M 11. Kavadarci M 12. Vevecani M 13. CAA 14. HCAA 15. Educators 16. ICAERUS 17. iDRONES 18. EASA 19. Government 20. FLYEE

In the stakeholders network each stakeholder is treated as a node with links to the rest of the network. Table 27 presents the initial lists of stakeholders for all our five use cases, which will be refined in due course of the work in WP1. Similarly, a description of all stakeholders is provided in several appendixes. Based on this information, initial maps of stakeholders were drawn too.

5.1.1.2 Stakeholders objectives, needs and inputs /outputs

The next step of the analysis is to gather information from the stakeholders to understand how each of them contributes to and derive value from the network. The initial mapping of stakeholders in each use case helps us understand the grouping and possible exchanges among them (see Fig. 34).

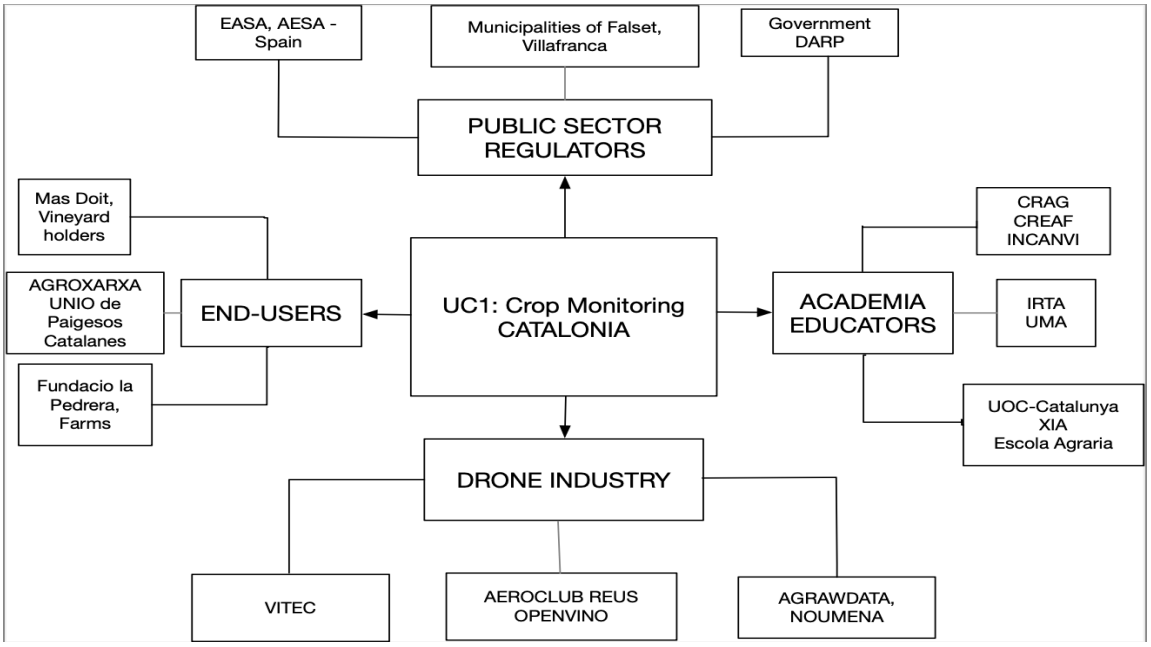

Figure 33 Qualitative mapping of stakeholders in UC1

The detailed names of all UC1 stakeholders are presented in Table 27 and the Fig. 34 aims to show the stakeholder grouping in a visible mode – **1)** national government of Spain; public authorities of Catalonia; regulatory bodies; **2)** universities and research institutes as well as educators; **3)** drone industry operators; and finally, **4)** the end-users – farms, vineyard holders and agricultural associations.

Similarly, the UC2 stakeholders are classified with the same groups as presented in Fig.34. The end-users are represented by the associations, farms, and family vineyards. There are many companies with research activities that are present in the Greek market, offering protection products and specialised fertilizers. They are listed in Table 27 and are considered as “plant protection industry R&D units and labs” in the same cluster with the universities and educators. In all our UCs, the municipalities play a regulatory role as they have responsibility to issue some of the licences necessary to the drone operators.

The stakeholder grouping of UC3, which is based in South of France, and owns the distinctive groups of: educators, R&D farms, and research institutes - IDELE; national government, regulators, and municipalities; drone industry – FLYING EYE; and the end-users such as family farm holders, Jalogny and Carmejane farms, and livestock producers’ groups. UC3 is in its experimental phase and will be supported by the ICAERUS consortium to build-up the necessary capacity to be able to emerge or even reach the “close-to-market” phase.

UC4 stakeholders are grouped similarly to the stakeholders in previous three use cases. The distinctive characteristic of UC4 is that the end-users represent the public sector in the name of state-owned agencies and the private sector – forest owners and landowners. The differentiation is necessary here since the public-private ownership of forest territory in Lithuania is 50:50, and the support of the consortium will be needed to define and expand this business case. Finally, the stakeholder grouping of UC5 and Table 27 names all stakeholders located in North Greece and North Macedonia. The end-users are represented by various pharmacies in different towns of North Macedonia and the medical humanitarian body “doctors without borders” the Greek office based in Thessaloniki.

5.1.2 Use Case 1 Network

To clearly see the interactions among stakeholders and whether they were satisfied with the inputs received from other stakeholders, we followed a template that concisely specify their role, objectives,

needs, inputs and outputs, costs, and revenues. The figures below (Fig. 35-38) describe four of the stakeholders of UC1 (randomly chosen from the pool of stakeholders), populated with the necessary information, collected by the UC Leader, Noumena and Ecological Interaction, by following the template. The profiles of the rest of UC1 stakeholders are included in Annex IV.

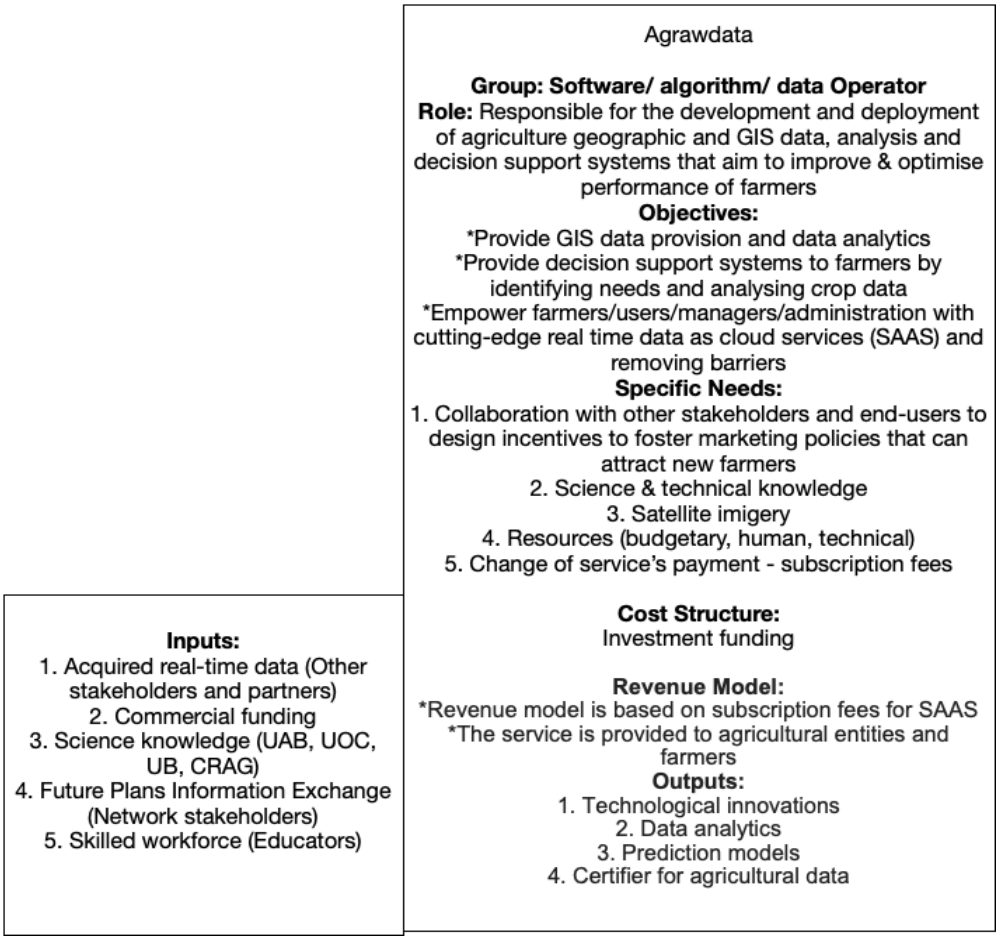

Figure 34 UC1 stakeholder description - Agrawdata

Some of the information in Fig.35 was provided directly by the stakeholder, other was initially collected from their websites or public documents. The consortium partner – Ecological Interaction – have kept the direct communication with the UC1 stakeholders. By talking directly to them ensured us that the interests of every stakeholder would be fully captured by the analysis. In this regard, the meaning of "specific needs" indicates the resources necessary by the stakeholder to achieve their objectives. The inputs fulfil one or another specific need, and they are usually provided by other stakeholders in the network. If we take a specific need of AGRAWDATA in UC1 as an example – to collaborate with other stakeholders and end-users to design incentives to foster marketing policies that can attract new farmers to their services – to do so they need real-time data, science knowledge, skilled workforce, commercial funding to operate and information about the plans of the network's partners. Similarly, fig. 36, 37 and 38 present the needs and objectives of the other stakeholders – OpenVino, Fundación la Pedrera, and the Government of Spain.

OpenVino

Group: Software/ algorithm/ data Operator
Role: Responsible for the development and deployment of vineyard data analytics with software and platform infrastructures that aim to improve & optimise performance of vineyard holders
Objectives:
*Provide vineyard data analytics and consultancy
*Provide services for digitalisation, tokenisation and cryptocurrencies for vineyard owners
*Empower farmers/users/managers/administration with cutting-edge software & platforms and remove barriers for investments in organic production
Specific Needs:
1. Collaboration with other stakeholders and end-users to design incentives to foster marketing policies that can attract new vineyard owners
2. Science & technical knowledge
3. Access to markets
4. Resources (budgetary, human, technical)
5. Policy integration and network cooperation

Cost Structure:
Private cost modeling

Revenue Model:
*Revenue model is based on paid services and consultations
*Providing regulatory support for standards
Outputs:
1. Technological innovations
2. Data analytics
3. Digital business models
4. Carbon-neutral certification (BioDigital Cert)

Inputs:
1. Acquired real-time data - sensor and field data (Network stakeholders)
2. Commercial funding
3. Science knowledge (UAB, UOC, UB, CRAG)
4. Future Plans Information Exchange (Network stakeholders)
5. Skilled workforce (Educators)

Figure 35 UC1 stakeholder description – OpenVino

GOVERNMENT

Group: City / Government of Spain

Role: This includes municipalities, city authorities, public administration, government agencies and central departments. It is responsible for the provision of policy-making and policy direction

Objectives:
*Provide oversight of public programmes/ agencies
*Appropriate funds to public programmes/ agencies
*Evaluation of activities with respect to UAV systems and their management
*Promote actions that will improve the quality of life in agricultural and rural areas
*Sustain political support for environmental UAV services
*Introduce fair and good legislation
Specific Needs:
1. Resources to implement objectives (budgetary)
2. Progress reports on activities
3. Data from government-funded programmes
4. Expert scientific, technical and policy advice
5. Knowledge of policy-direction of other public bodies, and inter-governmental agencies
6. General information (scientific, technical, social, etc.)
7. Political support (through voting)

Cost Structure:
Central budgeting or local budgeting
Revenue Model:
Public taxation
Outputs:
*Policy-making documentation and public funding

Inputs
1. Compliance with policy direction (EU and other government agencies)
2. Plans and reports of progress (Municipality, other Public Administration, Associations)
3. Science knowledge (UAB, UB, UOC, CRAG)
4. Public opinions (Community)
5. Informative & disseminative content (Social media, La Vanguardia)
6. Taxes (Community)

Figure 36 UC1 stakeholder description - Government

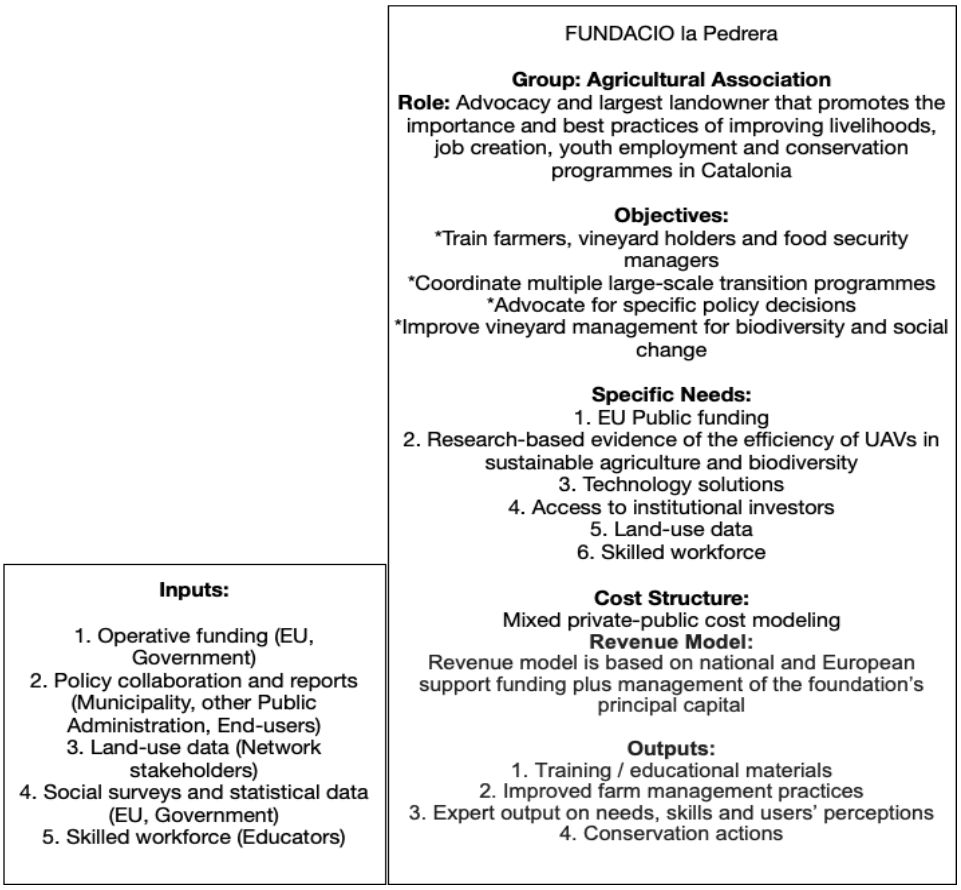

Figure 37 UC1 stakeholder description – Fundacio la Pedrera

Moreover, the *value flow* indicates the output of one stakeholder as the input to another, and Fig. 39-41 show the value flows into and out of three stakeholders. These figures also support the designed maps in Fig. 42-44. For instance, stakeholder "**Agrawdata"** receives commercial funding from clients and the network; acquired real-time data from the network; science knowledge from a few universities in Barcelona (University of Barcelona, Autonomous university of Barcelona and University of Catalonia) and the Centre for Research in Agricultural Genomics; plans' exchange with regulatory bodies; skilled workforce from the educators. Simultaneously, "Agrawdata" provides prediction models, technology solutions and data analytics to the end-users such as the farmers in Catalonia to improve their management and processes in the farming business; and certified agricultural data to Fundacio la Pedrera, which is an Agricultural Association. The value flows are shown in different colours for the sole reason of identifying them as flows of different types in the diagrams (see Fig. 39).

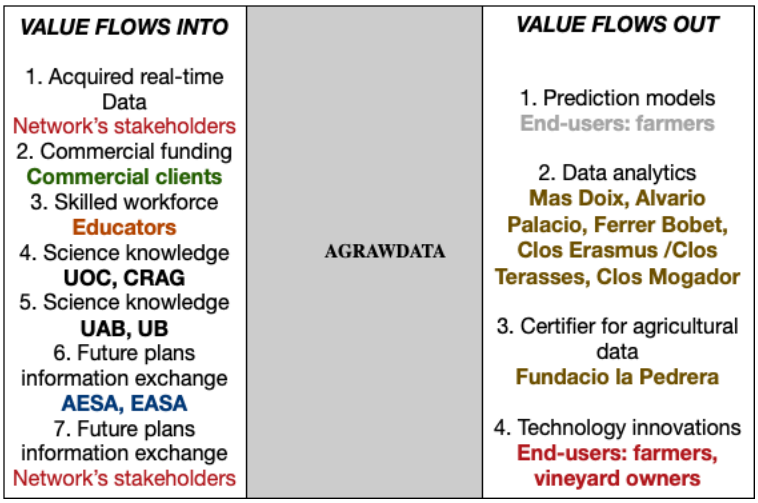

Figure 38 Value flows into and out of stakeholder: AGRAWDATA

Similarly, the other stakeholder "**OpenVino"** as an algorithm operator receives commercial funding from clients and consultations; acquired real-time data (sensor and field data) from the network; science knowledge from a few universities in Barcelona (University of Barcelona, Autonomous university of Barcelona and University of Catalonia); plans' information exchange from municipalities; skilled workforce from the educators. Simultaneously, "OpenVino" provides digital business models, technology innovations and data analytics to the end-users such as the vineyard owners and holders in Catalonia to optimise processes in the farming business; and carbon-neutral certification to the vineyards.

VALUE FLOWS INTO		***VALUE FLOWS OUT***
1. Acquired real-time Data (sensor data and field data) Network's stakeholders 2. Commercial funding **Commercial clients** 3. Skilled workforce **Educators** 5. Science knowledge **UAB, UB, UOC** 6. Future plans information exchange **Municipalities** 7. Future plans information exchange Network's stakeholders	**OpenVino**	1. Digital business models **End-users: vineyard owners and holders** 2. Data analytics **Fundacio la Pedrera, vineyard owners, farms** 3. Carbon-neutral certification **Mas Doix, Alvario Palacio, Ferrer Bobet, Clos Erasmus/ Clos Terasses, Clos Mogador** 4. Technology innovations **End-users: vineyards**

Figure 39 Value flows into and out of stakeholder: OpenVino

The last stakeholder on Fig. 41, **Fundacio la Pedrera**, receives EU or national funding for on-going large-scale projects; statistical data and data from social surveys from EU and national institutions; policy collaboration and reports of progress from municipalities, public administration, and the end-users; land-use data from the network; skilled workforce from educators. Simultaneously, the foundation provides training and educational materials as well as improved farm management practices to the end-users, an expert outcome on needs, skills and users' perceptions to municipalities, public administration, and end-users.

VALUE FLOWS INTO		***VALUE FLOWS OUT***
1. Operative funding EU, Government 2. Policy collaboration and reports **Municipality, other Public administration** 3. Policy collaboration and reports End users 4. Skilled workforce **Educators** 5. Land-use data **Network's stakeholders** 6. Social surveys and statistical data **EU, Government**	**FUNDACIO la Pedrera**	1. Training /educational materials **End-users** 2. Improved farm management practices **Mas Doix, Alvario Palacio, Ferrer Bobet, Clos Erasmus /Clos Terasses, Clos Mogador** 3. Conservation actions **End-users** 4. Expert output on needs, skills and users' perceptions **Municipality, Public Administration, End-users**

Figure 40 Value flows into and out of stakeholder: Fundacio la Pedrera

Repetitively, this process has been done for all stakeholders of UC1. Then as a next step, the value network model has been visually created by linking all value flows within one case. Different types of value flows are coloured in 1) red – knowledge & information; 2) blue – monetary; 3) green – policy flows; 4) light mocha – data, technology &services.

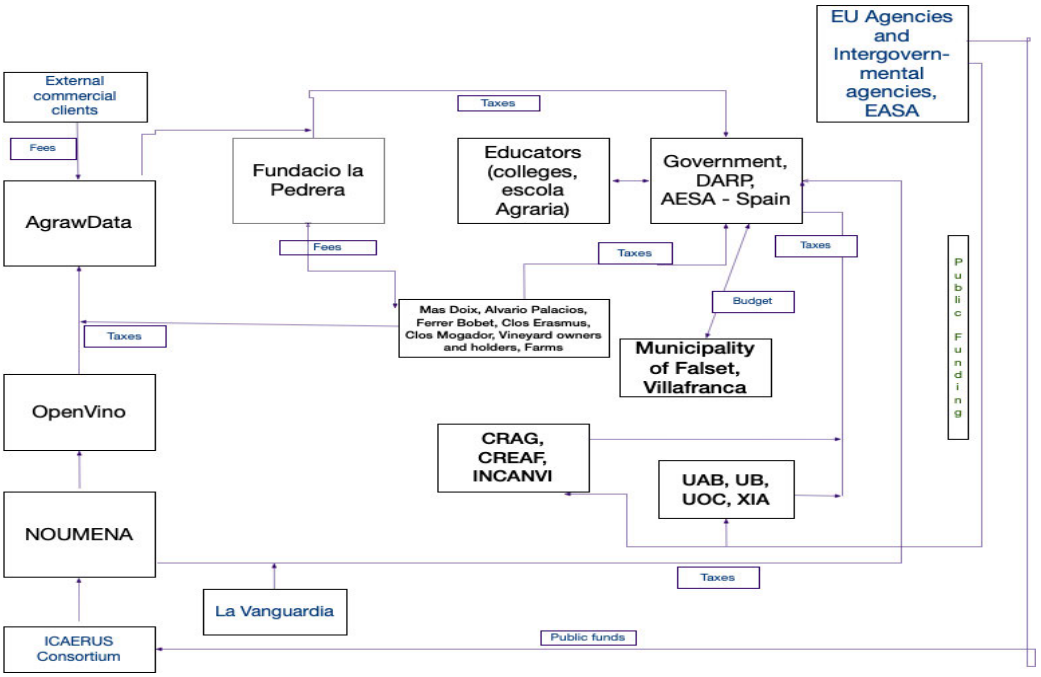

Figure 41 Monetary value flows in UC1 network

In Figure 42 above, the focus is on the monetary value flows and monetary exchanges, all coloured in blue among all initially identified stakeholders. There are three major types of interaction among the stakeholders: 1) funding 2) commercial fees and 3) taxes.

Cost sharing at this early stage of network creation is not observed between any of the stakeholders. The private stakeholders pay taxes that are collected for the government, and then public funds are allocated to educators, research organisations and partners involved in EU-funded projects as well as public institutions such as municipalities of Falset and Villafranca.

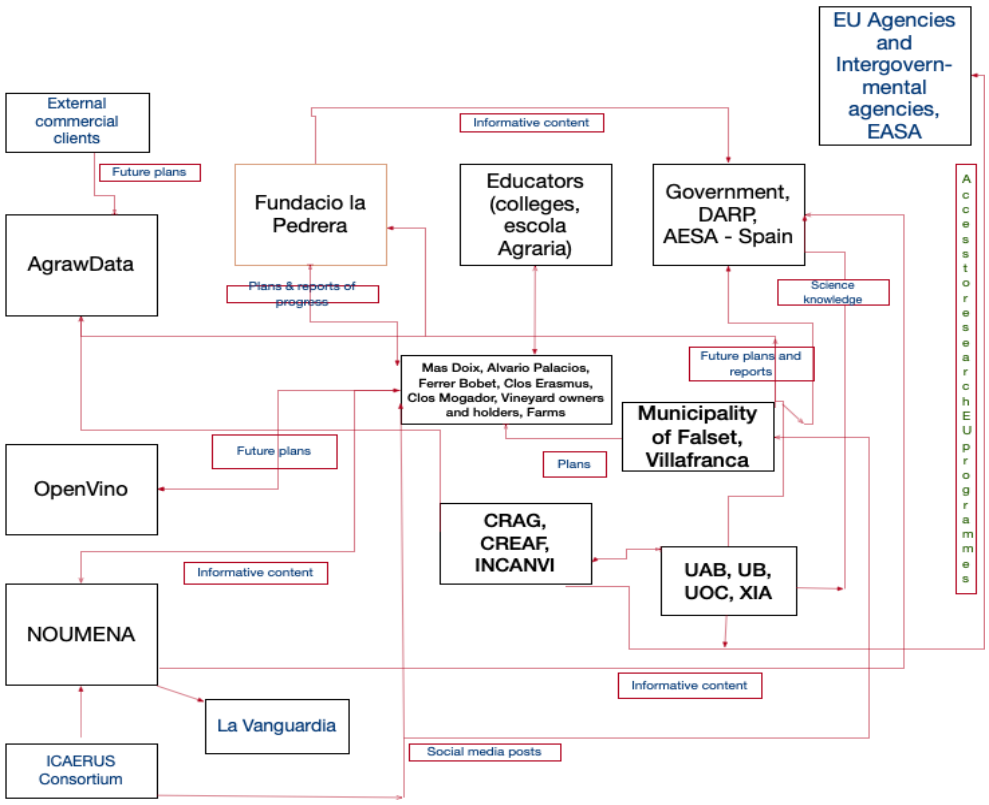

Figure 42 Knowledge & informative content value flows in UC1 network

In Figure 43, we solely look at the knowledge & informative content value flows that move between the stakeholders. **First**, there is an outflow of scientific and technical knowledge (drone-related) from the universities (UAB, UB, UOC) and research institutions (CRAG, CREAF, INCANVI) to the other stakeholders – mainly governmental departments, municipalities and the tech companies that provide data analytics and prediction models. **Second**, there is a separate circle of informative content that facilitates the exchange of information between various stakeholders. **Third**, an individual flow of "plans and reports" moves between the agricultural associations, farms and vineyard holders, family vineyard owners as well as a flow of social media posts and newspapers articles (La Vanguardia).

In Figure 44 below, more interactions are added, including the policy collaboration and engagement, data & drone services to the existing knowledge value flows which were presented in Fig.43. What is observable, two separate loops are identified:

1) Policy directions flow from the EU & Intergovernmental agencies to the national government of Spain, and then to the municipalities, agricultural associations (Fundacio la Pedrera) and the farms or vineyard holders; and
2) EU Drone strategy 2.0, regulations (EU Regulations 2019/945 and 947) and standards that flow to the drone industry, and in our UC1 to the ICAERUS consortium, which has a supportive role in the network.

In support of these value flow maps, the top specific needs for UC1 stakeholders are included here and illustrated on Fig. 43-44 as science knowledge, future plans, reports of progress and informative content:

Table 28 Prioritised needs of UC1 stakeholders

NEED	Stakeholder
1. Commercial funding	AGRAWDATA
2. Access to wider European policy shifts	AEROCLUB REUS
3. Access to wider markets	OpenVino, Mas Martinet Farm
4. Research-based evidence of the efficiency of UAVs in sustainable agriculture and biodiversity in Spain	Fundacio la PEDRERA
5. Science opinions and scientific publications	CRAG, UOC, UAB
6. Research-based evidence of efficient drone monitoring in the crop fields of Spain	IRTA
7. Public funding	DARP, Municipality Falset and Villafranca
8. Training and resources for modernisation	Farms (end-users)
9. Policy collaboration (engaging the end-users) and reports on EU best practices	AESA – Spain
10. Social media content, press releases, images, and videos	La Vanguardia

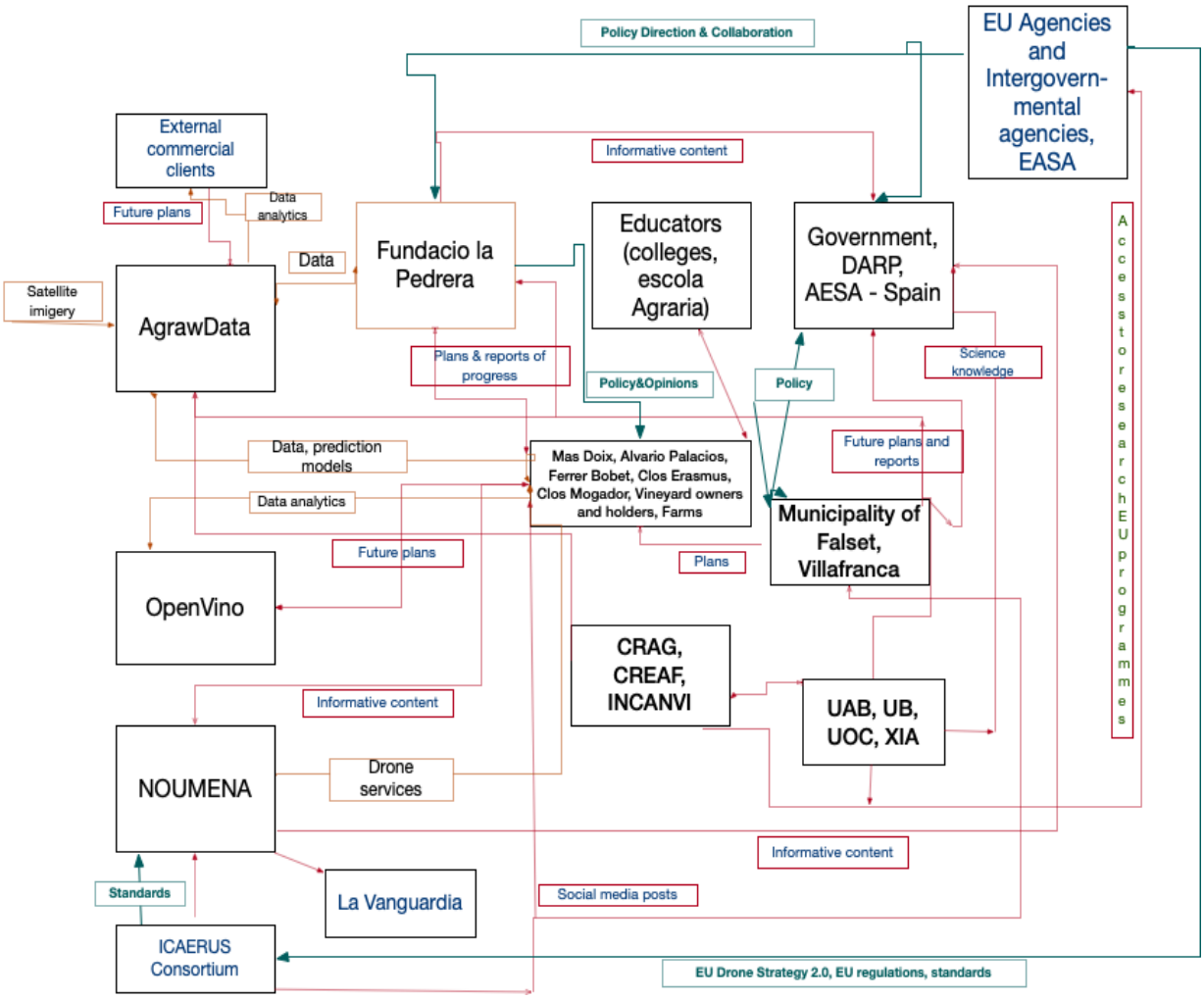

Figure 43 Knowledge & informative, policy & opinions, data, drone services value flows in UC1 network

Overall, this **UC1** network is very large and dynamic with data providers, drone service providers, regulators, and the government, as well as the end-users, which are large-scale vineyard holders and owners in Catalonia in total of 25 selected stakeholders. What the market research in chapter 4 demonstrated is that the established trends of increasing consumption of high-quality wine and organic grape production in Spain may become the basis for a growing demand of drone services in the area, particularly for vineyard plant protection and crop disease detection, or data analytics together with farm processes optimisation. Since the interactions and value flows will be additionally refined in due course of the project, it is likely that some of the maps may have to be adjusted, also new players may enter the network once the demos take place between M24 – M48, and there are more farms interested in the drone services. Therefore, this network is open to new entries and even replacement of stakeholders until it finds its balanced path of development. Moreover, the regulatory regime of the drone industry has gradually emerging and establishing clearer rules, technical standards, and EU regulations, which will additionally put more pressure on the drone operators to comply with and pay attention to safety models and risk assessment rules. The regulations will make a filtration of the drone actors as the new requirements will make business processes for the drone service providers more expensive. However, the maturity of the Spanish drone ecosystem will determine which drone actors will survive in this business environment. The UC5 is presented as a business-to-business case (B2B).

5.1.3 Use Case 2 Network

The figures below (Fig. 45-49) describe five of the stakeholders of UC2 (randomly chosen from the pool of stakeholders), populated with the necessary information, collected by the UC Leaders, Athens University of Agriculture, and the Hellenic Crop Protection Association, by following the template. These two organisations kept the direct communication with all stakeholders. The profiles of the rest of UC2 stakeholders are provided in Annex V.

UCANDRONE

Group: Drone Manufacturer
Role: a trading company of UAVs and GIS applications

Objectives:
*Manufacture and /or operate UAV systems
*Provide decision support systems to farmers by offering drone technology and geoinformatic solutions
*Empower farmers/users/managers/administration with cutting-edge technology

Specific Needs:
1. Knowledge on optimal and safe UAV spraying
2. Science & technical knowledge
3. Future plans information exchange
4. Resources (budgetary, technical)
5. Skilled workforce

Cost Structure:
Private cost modelling

Revenue Model:
*Private revenue stream

Outputs:
1. Technological innovations
2. Drone manufacturing
3. GIS Apps and solutions
4. Economic evidence of the efficient use of spraying drones in the commercial sector

Inputs:

1. Drone fleet (Network)
2. Commercial funding (External clients)
3. Science knowledge and algorithms (AUA)
4. Drone manufacturing processes (Network stakeholders)
5. Skilled workforce (Educators)

Figure 44 UC2 stakeholder description - UCANDRONE

Agrotech (John Deere Hellas)

Group: Agricultural Machinery Manufacturer
Role: Agricultural machinery and mechanical parts manufacturer (since 1984)

Objectives:
*Manufacture and operate agricultural machinery
*Retail of agricultural machinery
*Provide crop protection services

Specific Needs:
1. Knowledge on optimal and safe UAV spraying
2. Science & technical knowledge
3. Drone fleet
4. Manufacturing components
5. Skilled workforce
6. Investments

Cost Structure:
*Private cost modelling

Revenue Model:
*Private revenue stream

Outputs:
1. Machinery and components
2. Services - crop protection innovations
3. Economic evidence of the efficient use of spraying drones in the commercial sector

Inputs:

1. Commercial funding (External clients)
2. Science reports (AUA)
3. UAVs as a support tool for farmers (Network)
4. Skilled workforce (Educators)

Figure 45 UC2 stakeholder description - Agrotech

As already explained about the UC1 network, if we take a specific need of UCANDRONE in UC2 – to provide decision support systems to farmers by offering drone technology and geoinformatics solutions –

to do so they need science knowledge and algorithms, skilled workforce, commercial funding to operate and drone manufacturing processes.

Hellenic Crop Protection Association

Group: Agricultural Association
Role: Advocate the safe pesticide use, water protection and prevent usage of illegal pesticide products

Objectives:
*Train farmers, landowners
*Coordinate members to get their input
*Advocate for specific policy decisions
*Understand the impact of the Green Deal on the Greek agricultural sector

Specific Needs:
1. Members opinion (feedback)
2. Research-based evidence of the efficiency of spraying UAVs in sustainable agriculture in Europe
3. Future plans information exchange with members
4. Membership fees
5. Agri-science know-how
6. Skilled workforce

Cost Structure:
n/a
Revenue Model:
Revenue model is based on national and European support funding plus membership fees

Outputs:
1. Training materials
2. Guidelines for the safe use of crop protection products
3. Guidelines for the use of novel spraying equipment
4. Guidelines for plastic bottles recycling, water safety, public health and the environment
5. Awareness campaigns

Inputs:

1. Operative funding (Membership fees, EU projects)
2. Policy collaboration and reports (Municipality, other Public Administration, End-users)
3. Future plans exchange (Network stakeholders)
4. Scientific know-how (AUA)
5. Skilled workforce (Educators)

Figure 46 UC2 stakeholder description - HCPA

If we take Pavilos Estate as an end-user, one of their objectives is to “replace traditional terrestrial vehicles with UAVs” and a specific need is to apply “the drone spraying services” (Fig. 48). For them to achieve this objective and satisfy their needs, they will have to find:

1) operative funding,
2) knowledge from field trials on the optimal use of UAVs,
3) skilled workforce,
4) implement agricultural processes in their vineyard business, and
5) do policy collaboration with other stakeholders of the network.

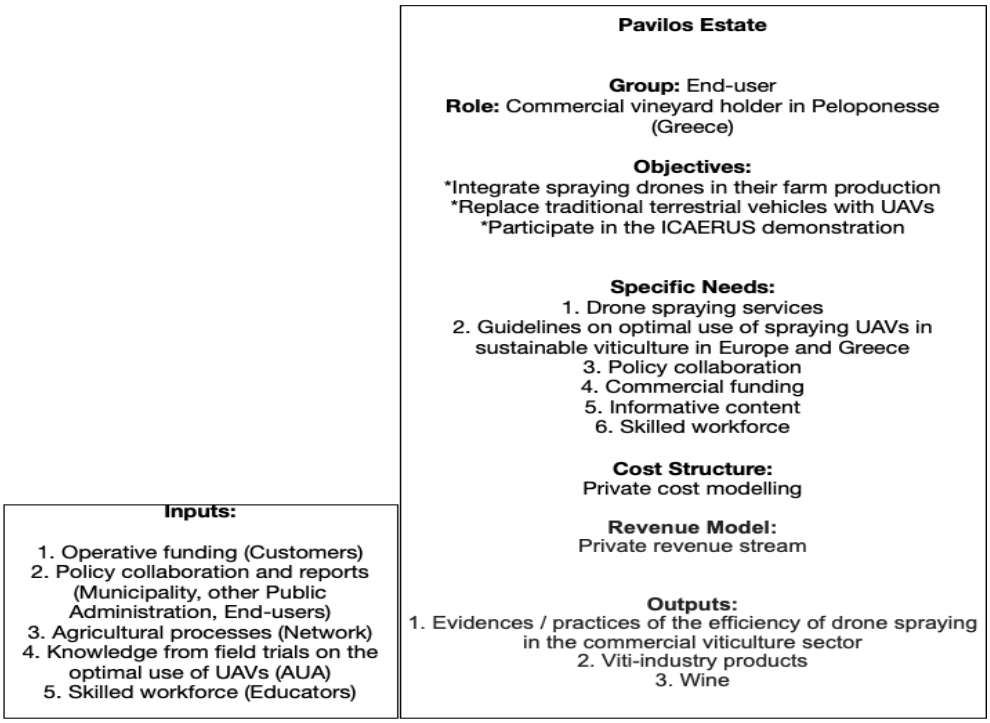

Figure 47 UC2 stakeholder description – Pavilos estate

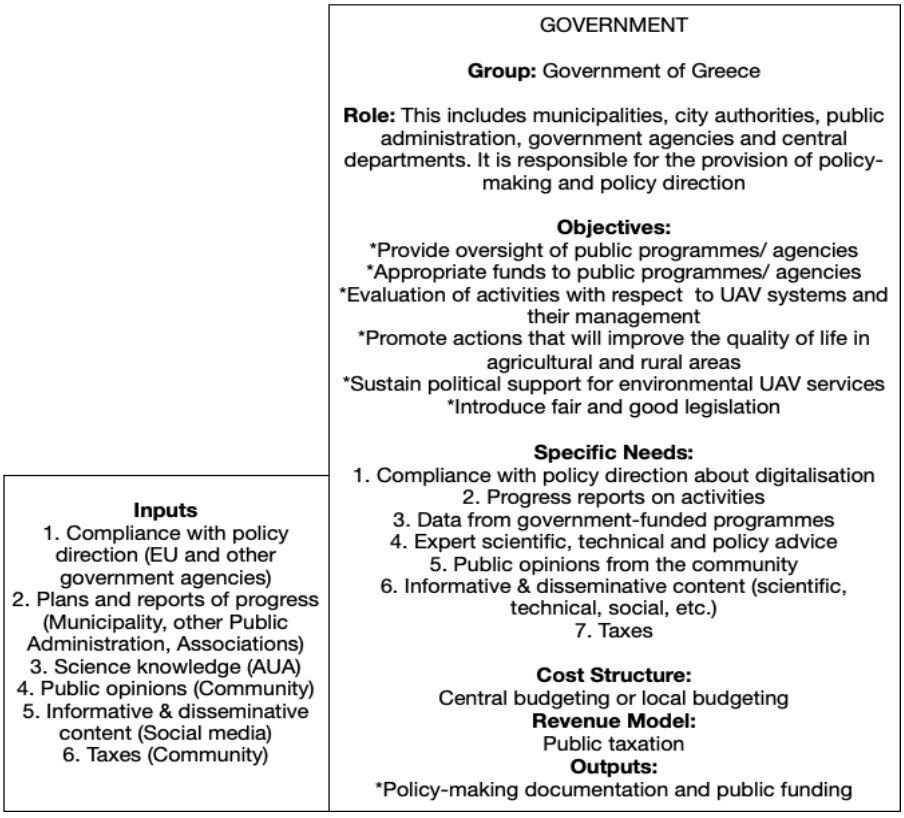

Figure 48 UC2 stakeholder description - Government

In more details, the *value flow* indicates the output of one stakeholder as the input to another, and Fig. 50-52 show the value flows into and out of three stakeholders. For instance, stakeholder "**UCANDRONE",** in Fig. 50**,** which is a well-established drone manufacturer in Attika (Greece) began its activities in 2015 in the field of unmanned aerial systems (UAS)[166], and offers research and design of fixed wings UAVs and

[166] Ucandrone is part of the Hellenic Aerospace Security & Defence Industries Group http://www.hasdig.com.gr

multicopters. It receives commercial funding from clients and customers (the firm offers in-store shopping and home delivery); science knowledge and algorithms from a university in UC2 network; drone manufacturing processes from the network's stakeholders; skilled workforce from the educators (engineering schools). Simultaneously, "Ucandrone" can provide drone manufacturing, technology solutions and GIS apps to the end-users to improve their processes in the farming business; and economic evidence of the efficient use of spraying drones to HCPA, the end-users and others. The value flows are shown in different colours for the sole reason of identifying them as flows of different types in the diagrams.

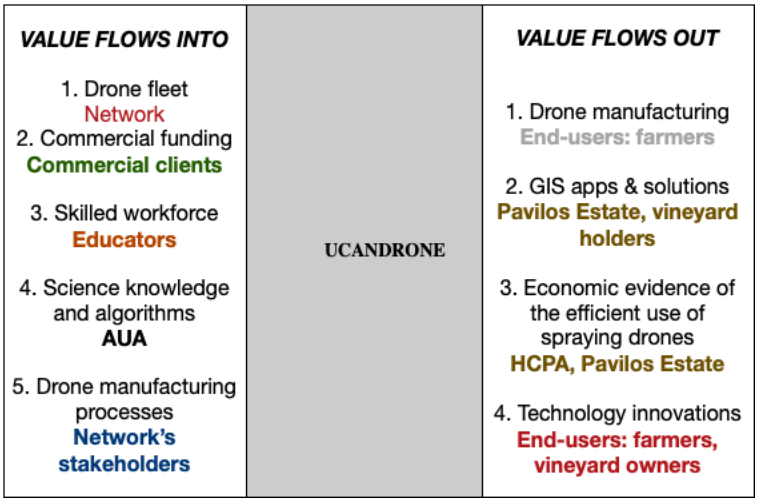

Figure 49 Value flows into and out of stakeholder: UCANDRONE

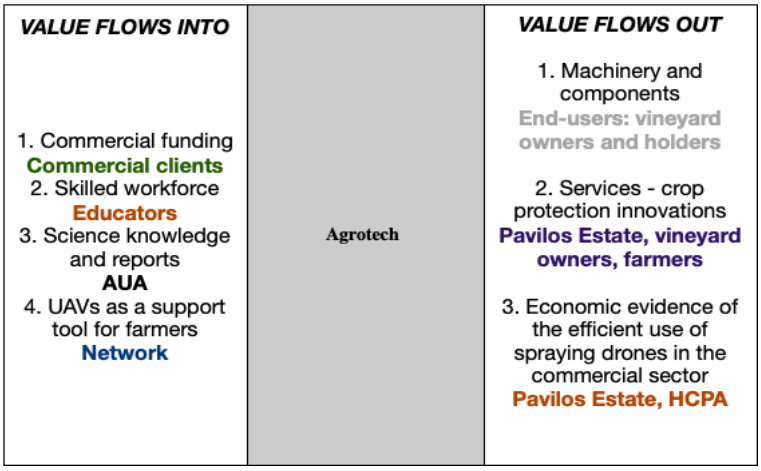

Figure 50 Value flows into and out of stakeholder: Agrotech

The other stakeholder "**Agrotech"** is a well-established producer since it began its manufacturing business in 1984 in Greece as a machinery manufacturer. It receives commercial funding from external clients and consumers; UAVs as a support tool for farmers from the network; science knowledge and scientific reports from a university in UC2 network; and skilled workforce from the educators. Simultaneously, "Agrotech" provides machinery and components to the end-users, services as crop protection innovations to the end-users such as the vineyard owners and holders in UC2 to optimise processes in the farming business, and economic evidence of the efficient use of spraying drones in the commercial sector.

Repetitively, this process has been done for all stakeholders of UC2. In Fig. 52 below one can see the value flows that go to the Hellenic Crop Protection Association (industry association) as well as the value flows going out as outputs. The HCPA is also part of the ICAERUS consortium and plays an essential role in UC2 network as an umbrella of the Greek farmers.

VALUE FLOWS INTO		VALUE FLOWS OUT
1. Operative funding EU, Membership fees 2. Policy collaboration and reports **Municipality, other Public administration** 3. Policy collaboration and reports End users 4. Skilled workforce **Educators** 5. Scientific know-how **AUA** 6. Future plans exchange **Network**	**HCPA**	1. Training /materials End-users 2. Guidelines for the safe use of crop protection products **Pavilos Estate, farms** 3. Guidelines for the use of novel spraying equipment **End-users: farms** 4. Guidelines for plastic bottles recycling, water safety, public health and the environment **Municipality, Public Administration, End-users** 5. Awareness Campaigns Community

Figure 51 Value flows into and out of stakeholder: HCPA

Then as a next step, the value network model has been visually created by linking all value flows within one case. Different types of value flows are coloured in 1) red – knowledge & information; 2) blue – monetary; 3) green – policy flows; 4) light mocha – data, technology &services. The same as in UC1, here are three maps that present different exchanges among the stakeholders. In Fig. 53 below, we begin with the analysis of the monetary transactions – taxes, public funds, and commercial fees. The public funds move from governmental institutions towards the public bodies, universities, municipalities (all in blue).

In Figure 54, we solely look at the knowledge & informative content value flows that move between the stakeholders. **First**, there is an outflow of scientific and technical knowledge (drone-related) from the universities (AUA) and research institutions to the other stakeholders – mainly governmental departments, municipalities and the drone and machinery companies (all in red).

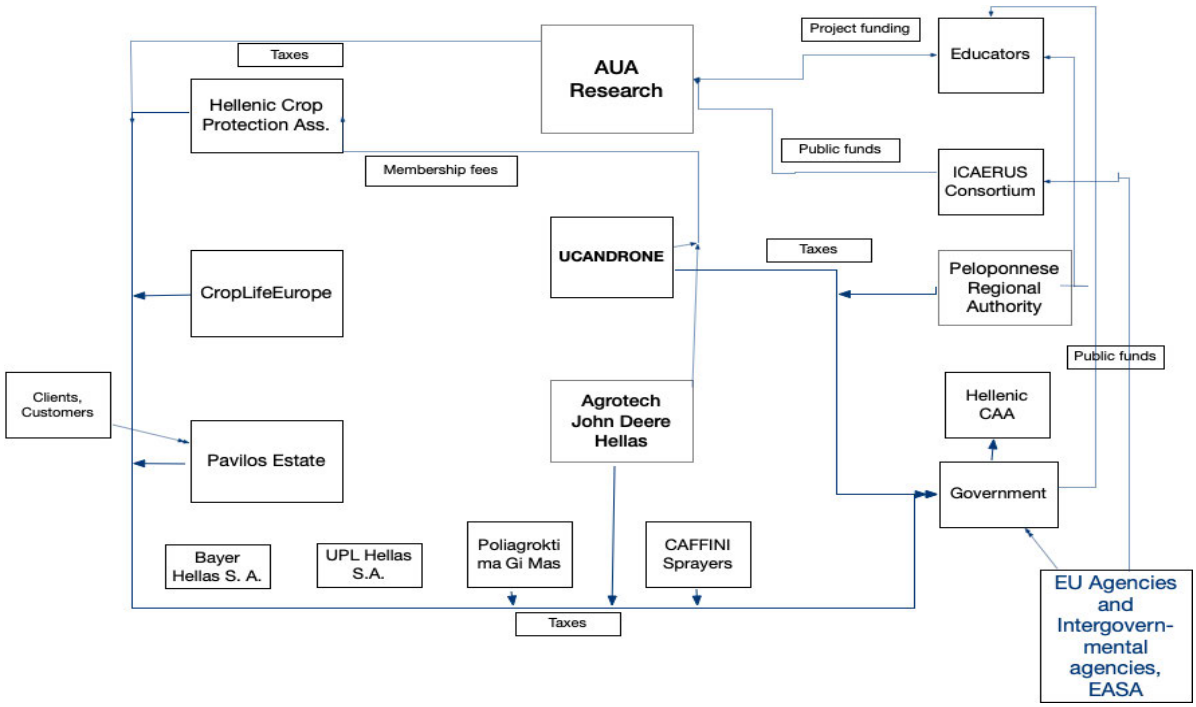

Figure 52 Monetary value flows in UC2 network

Second, there is a separate circle of informative content such as social media posts that facilitates the exchange of information between ICAERUS activities and UC2 stakeholders. **Third**, an individual flow of

"plans and reports with economic evidence" moves between UCANDRONE and the agricultural associations, vineyard holders such as Pavilos Estate and Poliagroktima Gi Mas.

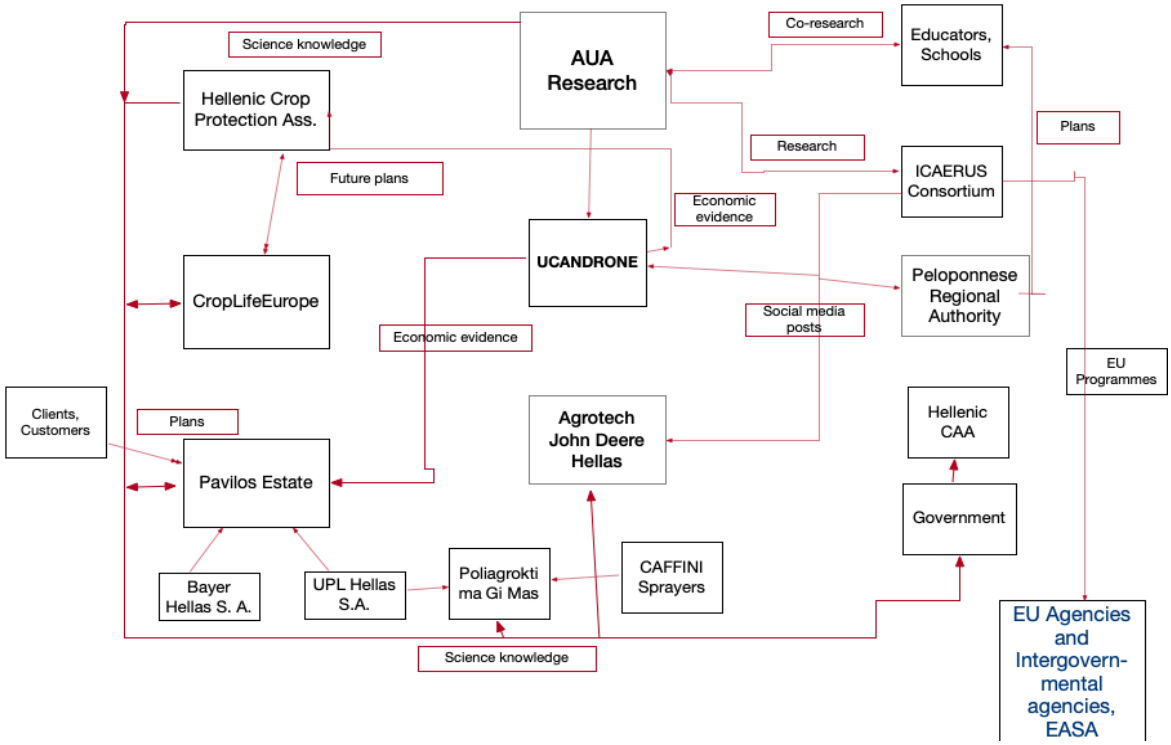

Figure 53 Knowledge & informative content value flows in UC2 network

For the understanding of the value flow maps in this section, the most important specific needs of UC2 stakeholders are included in Table 29:

Table 29 Prioritised needs of UC2 stakeholders

NEED	Stakeholder
1. Agri-science know how	HCPA
2. Skilled workforce	UCANDRONE, Agrotech
3.Research-based evidence of efficient drone spraying in crop fields of Greece	AUA
4.Guidelines on the optimal use of drones in crop protection in Greece	GiMas
5. Knowledge on optimal and safe UAV spraying in Greece	CAFFINI Sprayers Equipment
6. Specialised machinery knowledge	Agrotech
7. Knowledge about precision applications and environmental safety	CropLife Europe
8. Understanding better the community needs of how spraying UAVs have potential to improve the quality of life of local farmers and rural areas	Peloponnese Regional Authority
9. Understanding the importance of spraying UAVs as a novel / green tool	Civil Aviation Authority
10. Community acceptance for safety & environmental protection	EASA

These are the top ten needs of the UC2 stakeholders that are illustrated on the maps (Fig. 54-55) as science knowledge, economic evidence, research, policy, and plans.
In Figure 55, more interactions are added, including the policy collaboration and engagement, data & drone services to the existing knowledge value flows which were presented above. The regulatory interaction between the Hellenic CAA and the European Aviation Safety Agency with the drone industry actors, in UC2 network represented by UCANDRONE, are shown as a value flow of standards & regulations in a green colour.

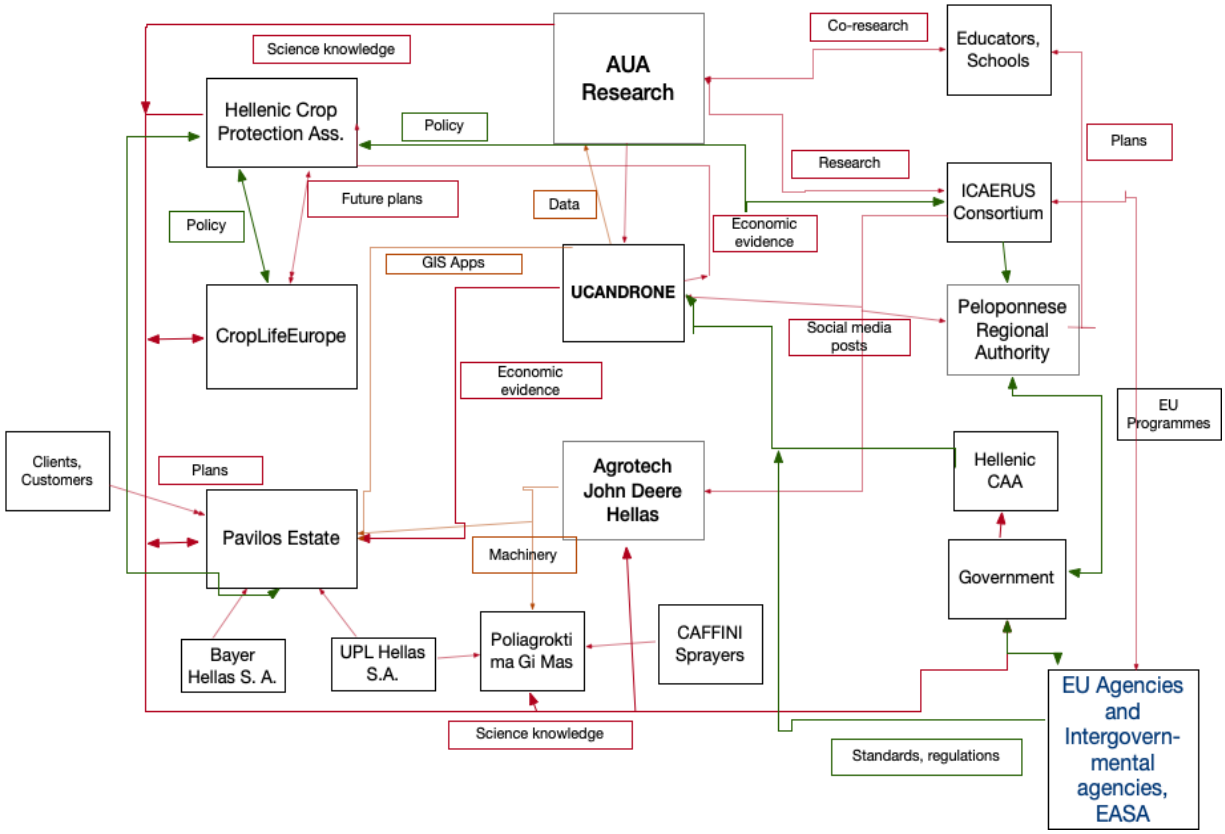

Figure 54 Knowledge & informative, policy &opinions, data, drone services value flows in UC2 network

For strategic management purposes, the model of these maps which is viewed as the “value network” model in **UC2** and the rest of use cases is a set of economic entities connected through transfer of offerings that yield a structural network whose aim is to deliver a common value to a specific end-user or market. Economic entities may be firms, research organisations, or business units. An end-user is a special node in the network, which role is to consume or appreciate the value creation of the overall network.

As a general conclusion, one can argue that the stakeholders network model or the value network model includes flexible and customisable elements or nodes. This flexibility also appears in the relationships between the specified stakeholders or actors of the network. As a result, our approach can be applied on multiple levels: the company, the industry, and even the whole economy. As it exhibits a high degree of tailoring capabilities, for the purposes of ICAERUS, it can be applied at a company level as well as an industry one, in our project – the precision agriculture and the aerial supply-chain management (rural logistics). Furthermore, it foresees self-sustainability of the network by ensuring value creation for all, but the network of course might be governed by a leader.

5.1.4 Use Case 3 Network

It is a standard business practice to perform a stakeholder analysis at the beginning of any major project. By performing it, one defines the stakeholder expectations for our project too as it designs and plans more thoroughly the use cases and any business scenarios.

The stakeholder expectations process usually involves a few activities:

1. Establish a list of customers and stakeholders interested in the service
2. Elicit the expectations of customers & stakeholders – needs, wants, desires, capabilities
3. Establish operational concepts
4. Define stakeholder expectations in acceptable statements such as “can be validated”, or “consistent”, or “feasible to satisfy”
5. Analyse the expectation statements to establish a set of measures of effectiveness

The stakeholder analysis described in this chapter is consistent with the process of identifying and meeting stakeholder expectations and we continue with the description of UC3 network.

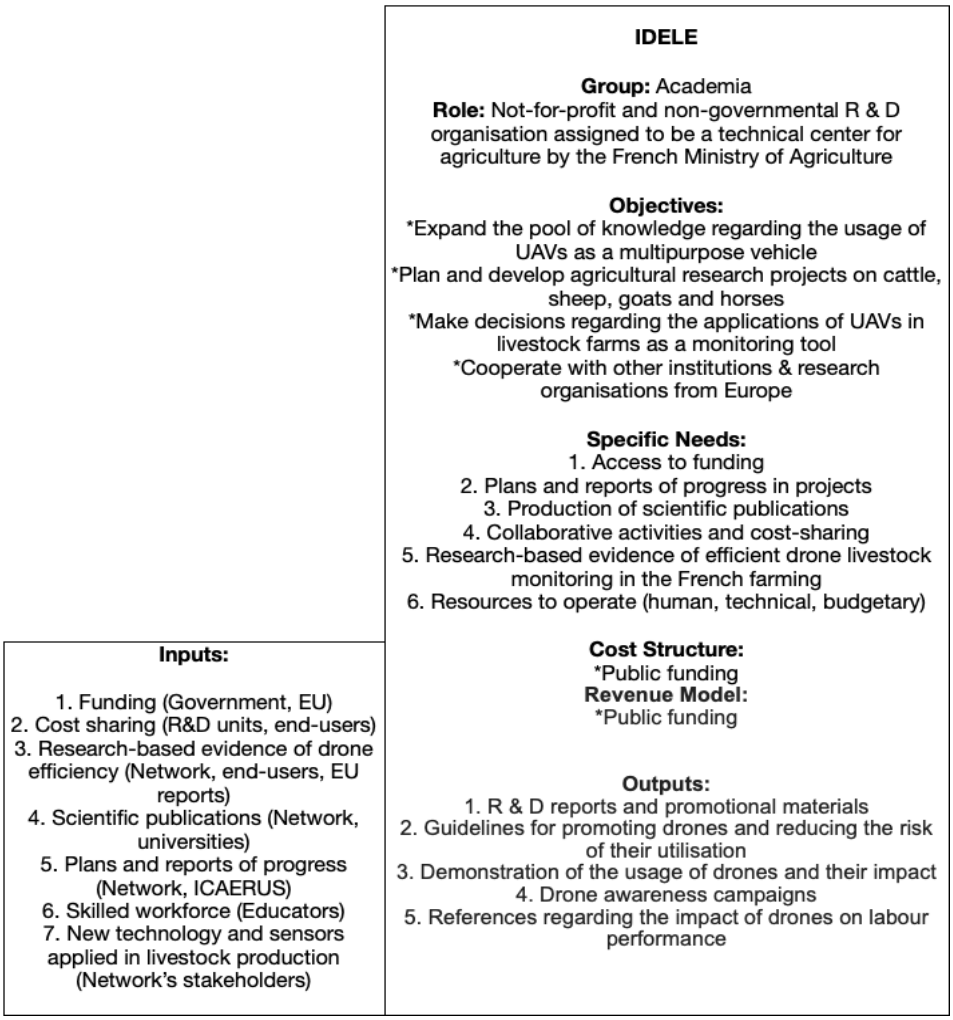

Figure 55 UC3 Stakeholder description - IDELE

Starting with figures 56-58 that describe three of the stakeholders of UC3, populated with the necessary information, collected by the UC Leader, IDELE in France, by following the provided template. Some of the information was provided directly by the stakeholder, other was initially collected from their websites or public documents. The profiles of the rest of UC3 stakeholders are added in Annex VI.

It is well understood that the meaning of "specific needs" indicates the resources necessary by the stakeholder to achieve their objectives. Taking a specific need of IDELE in UC3 as an example – to collect research-based evidence of efficient drone livestock monitoring in the French farming – to do so they need science publications, skilled workforce, public funding to operate, cost-sharing projects with R&D farms and other end-users, new technology and sensors for field trials in livestock production. In UC3, both farms – Jalogny and Carmejane – as experimental farms (see Fig. 57) represent the academic industry, but in this analysis, they are presented as end-users since this is the role, they will play in the demonstrations later in WP3. The expected output from them is to make possible the achievement of project's progress by demonstrating the use of UAVs in beef and sheep production in grassland systems in the French region of Alpes as well as progressing the market development of UC3.

In more details, Fig. 59-61 show the value flows into and out of three stakeholders (both farms have similar needs). For instance, stakeholder "**IDELE",** which is a research institute appointed by the French Ministry of Agriculture to be a technical centre responsible for implementing new technology in the agricultural sector. It began its activities in 1991 as a result of a merger of two research organisations – the Technical Institute for Cattle breeding (ITEB) launched in 1962 and the Technical Institute for Sheep and Goat breeding (ITOVIC) launched in1968. IDELE specialises on genetics, breeding techniques, breeder profession, environment and health, animal wellbeing, product quality, informatics, economics of sectors and international cooperation[167].

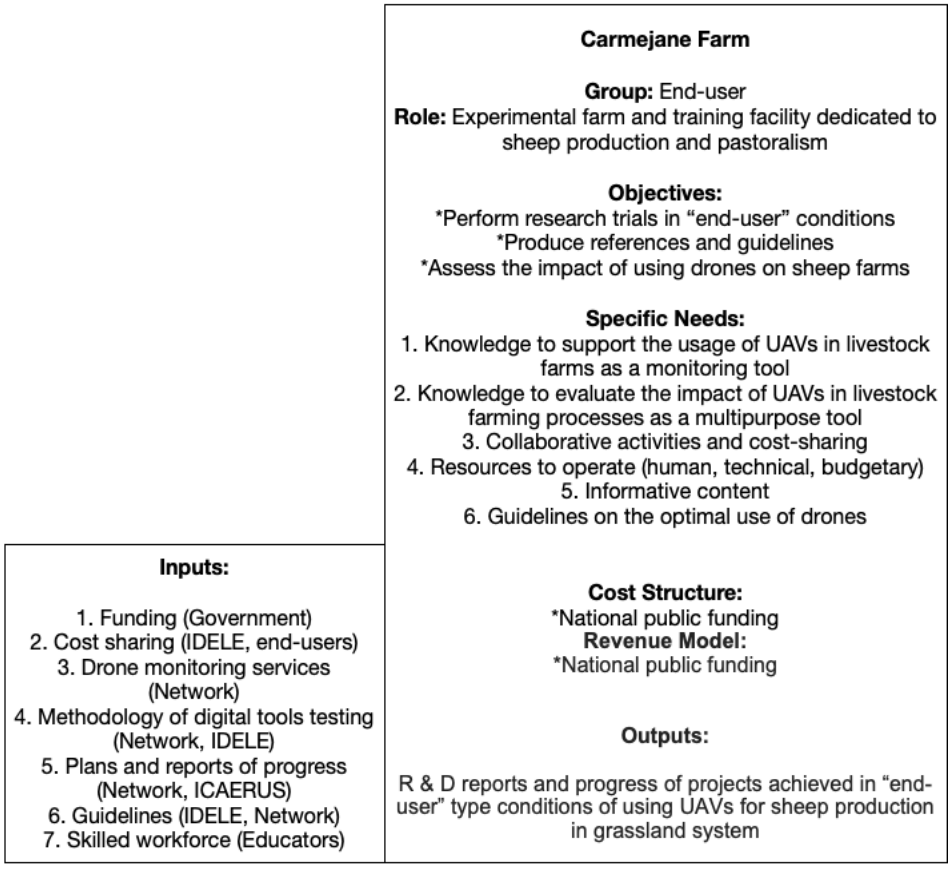

Figure 56 UC3 Stakeholder description – Carmejane Farm

[167] www.idele.fr

	Flying Eye **Group:** Drone manufacturer and support service provider **Role:** Responsible for the development and deployment of training programmes for drone pilots and manufacturing of UAVs **Objectives:** *Provide drone services to end-users *Support drone services *Empower farmers/users/pilots with training programmes **Specific Needs:** 1. Collaboration with other stakeholders and end-users to offer certification and legalisation of drone services 2. Science & technical knowledge 3. Components to manufacture drones 4. Resources (budgetary, human, technical) 5. Commercial clients 6. Communication with customers **Cost Structure:** *Private cost model **Revenue Model:** *Sells revenue stream **Outputs:** 1. Production of drones 2. Drone service support 3. Offered services 4. Documented risk assessment
Inputs: 1. Manufacturing components (Other stakeholders and suppliers) 2. Commercial funding (Clients) 3. Science knowledge on drone technology and ecosystem (IDELE, universities) 4. Communication with customers (End-users) 5. Manufacturing business processes (Workforce) 6. Skilled workforce (Educators)	

Figure 57 UC3 Stakeholder description – Flying Eye

IDELE receives public funding from the French government and EU-funded projects; scientific publications from various universities and their network; plans, reports of progress and new technology from the network; skilled workforce from the educators (schools and colleges) and research-based evidence of drone efficiency from the end-users (experimental farms). The team of researchers at IDELE can provide R&D materials, guidelines, references, promotional brochures, and drone demonstrations to the end-users (farm holders). It can organise drone awareness campaigns to inform the community about the benefits of the drone usage in rural areas.

VALUE FLOWS INTO 1. Funding EU, Government 2. Cost-sharing **R&D Units, end-users** 3. Research-based evidence of drone efficiency End users, EU reports 4. Skilled workforce **Educators** 5. Scientific publications **Network, universities** 6. Plans and reports of progress **Network, ICAERUS** 7. New Technology and sensors **Network**	**IDELE**	***VALUE FLOWS OUT*** 1. References regarding impact of drones on labour performance End-users 2. R&D reports and promotional materials **End-users** 3. Guidelines for promoting drones and reducing the risk of their utilisation **End-users: farms** 4. Demonstration of the usage of drones **End-users: Jalogny farm, Carmejane farm** 5. Drone Awareness Campaigns Community

Figure 58 Value flows into and out of stakeholder: IDELE

Similarly, both farms – **Carmejane and Jalogny** – were established to provide the "end-user" type of conditions to examine the effects of livestock drone monitoring in grassland systems.

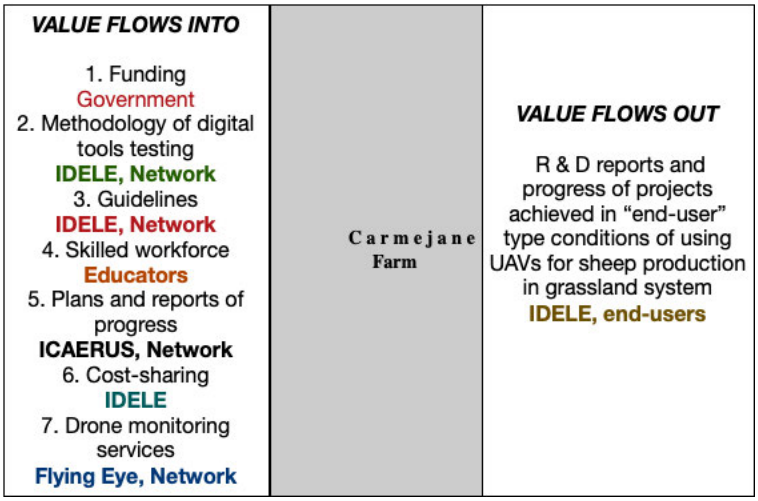

Figure 59 Value flows into and out of stakeholder: Carmejane farm

The material outputs from this experiment are R & D reports and publications that make possible the implementation of drone activities in real-life farming by developing a proper scientific methodology and livestock production processes. The necessary input that flows to both farms is the public funding from the French government; methodology, guidelines, references, and plans from IDELE; cost-sharing projects with IDELE, and drone monitoring services offered by Flying Eye[168] (see Fig. 60).

The last stakeholder that is explained here is the drone manufacturer and drone service supporter "**Flying Eye**", which is a French brand for professional drones created in 2009. They cover a wide range of professional drone services plus offer various types of drones in their shops. The value flows into and out of Flying Eye are presented in Fig. 61.

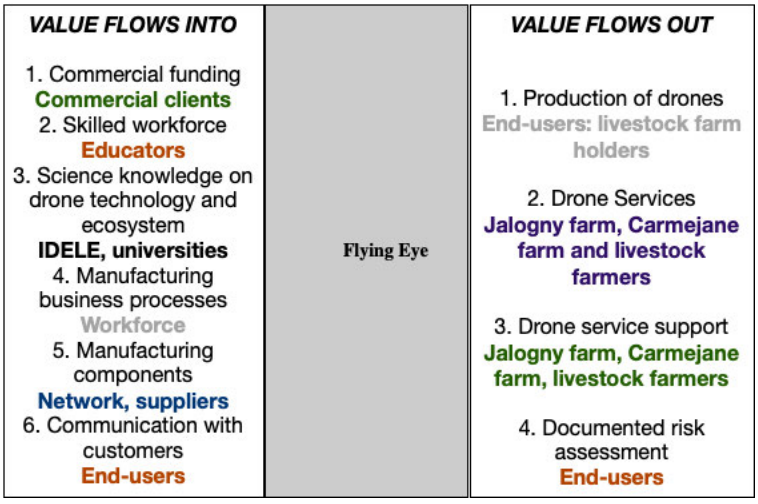

Figure 60 Value flows into and out of stakeholder: Flying Eye

Next step – the value network model has been visually created by linking all value flows within one case. Here are three maps that present different exchanges among the UC3 stakeholders. In Fig. 62, we begin with the analysis of the monetary transactions – taxes, public funds, and fees. The public funds move from governmental institutions. The EU public funding flows from ICAERUS consortium, which reallocates funds to the relevant partners (IDELE, GeoSense).

[168] https://www.flyingeye.fr/en/

Fig. 63 presents the knowledge and informative content value flows such as research reports, guidelines and references, and plans & reports that circulate between the government, EU institutions and local municipalities.

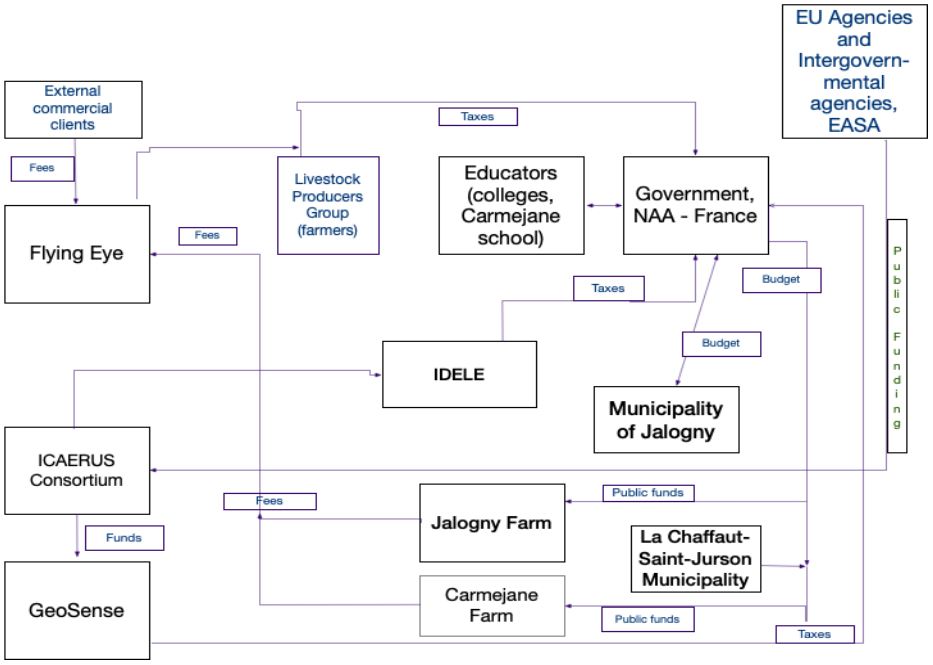

Figure 61 Monetary value flows in UC3 network

There is a separate loop of guidelines material that goes out of IDELE to the Jalogny and Carmejane farms as well as the Livestock production group (farms) and comes back to IDELE as field trials evidence of the efficiency of livestock drone monitoring in "end-user" type conditions. The third circle facilitates the flow of informative content (social media posts) among the ICAERUS partners, EU agencies and French public bodies like municipalities. In Figure 64, more interactions are added, including the policy collaboration and engagement, data & drone services to the existing knowledge value flows which were presented above. The regulatory interactions with the drone industry actors (Flying Eye and GeoSense) are shown as a value flow of standards & regulations in a green colour. These are EU Regulation 2019/945 and 947, U-Space regulatory package, any national standards & regulations, decrees, and others.

To support the value flow maps, here are presented the top specific needs of UC3 stakeholders, which are illustrated as guidelines, field trial evidence, research reports, plans and feedback on Fig. 63-64:

Table 30 Prioritised needs of UC3 stakeholders

NEED	Stakeholder
1. Communication with customers	Flying Eye
2. User opinion (feedback)	Livestock Farmers
3. Plans and reports of progress in projects' participation	IDELE
4. Guidelines on the optimal use of drones in livestock monitoring and its impact on farming in France	Jalogny farm, Carmejane farm
5. No conflict among the population	La Chaffaut-Saint-Jurson Municipality
6. Meetings with drone industry representatives	French Aviation Authority
7. Available time for educational initiatives	Schools
8. Community acceptance for safety & environmental protection	EASA

From all five industrial use cases of ICAERUS, only **UC3** is at the very early steps of emerging. The R&D organisations are overwhelmingly present in this case due to the experimental stage, but once the stakeholders begin to interact properly and determine their business model, the use case has an immense potential of market development and scaling-up. Finally, UC3 can be presented as a business-to-business case (B2B) once it takes off and real farm holders and livestock owners as business entities represent the end-users on the demand-side.

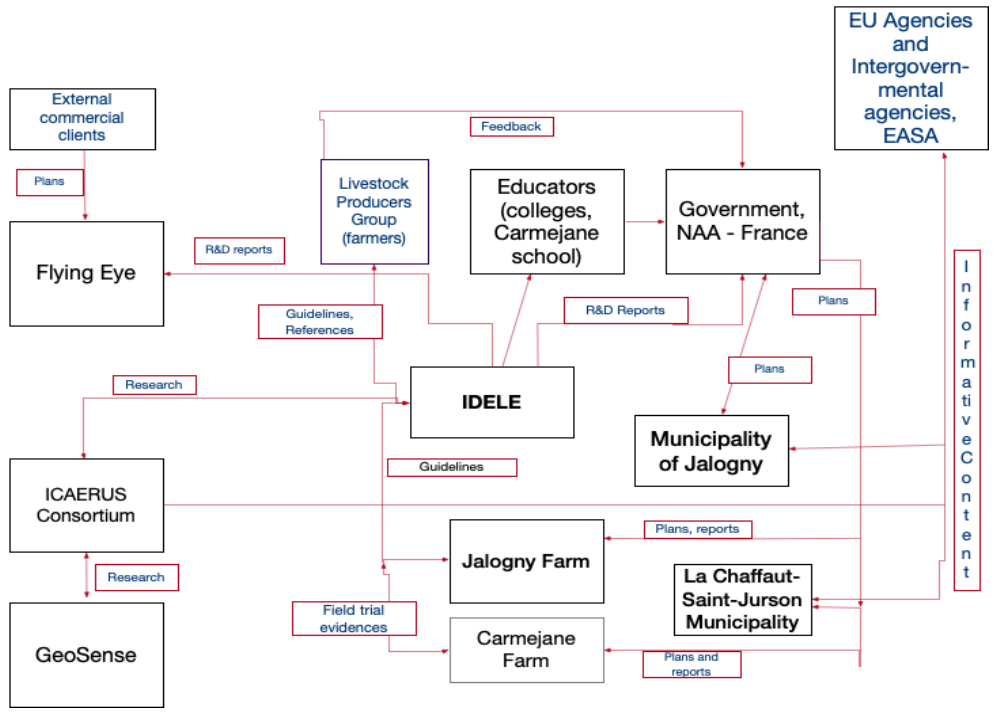

Figure 62 Knowledge & informative content value flows in UC3 network

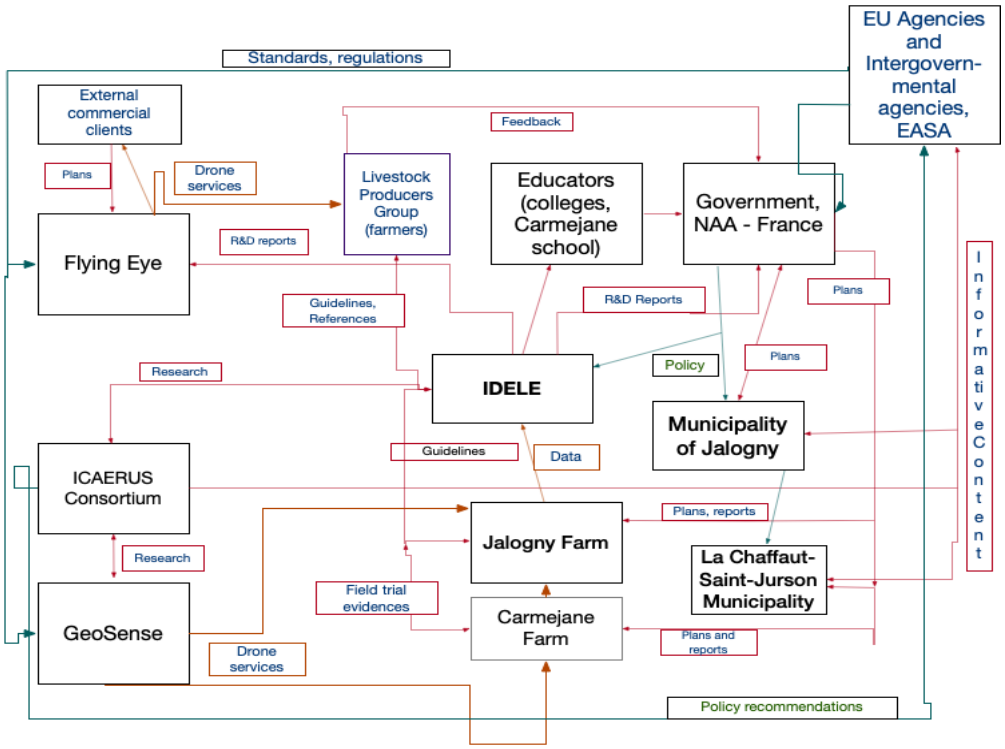

Figure 63 Knowledge &informative, policy & opinions, data, drone services value flows in UC3 network

5.1.5 Use Case 4 Network

Although researchers agree that focusing on value generation is necessary to compete nowadays, there are still variations in the definition of value. Some scientists define value as the perceived worth in monetary units of the set of economic, technical, service, and social benefits received by a customer in exchange for the price paid for a product, taking into consideration the available suppliers' offers and prices[169]. Others define it as the satisfaction of a need, or an expectation of a beneficiary party expressed by the appreciation of the performances realised by the company[170]. Regardless of the adopted definition of value, the framework used for strategic analysis for value chains or value network with mapping the value transactions enable us to make certain decisions on how customers or end-users perceive value.

We continue with describing and mapping stakeholders of UC4 that will allow us to make some strategic recommendations later. If it is started with figures 65-68 that describe four of the stakeholders of UC4, populated with the necessary information, collected by the UC Leader, ART21 in Lithuania, by following the provided template. The profiles of the rest of UC4 stakeholders are added in Annex VII.

	Lithuania State Forest Services (SFS) **Group:** End-user **Role:** It performs annual GHG accounting in land-use, land-use change and forestry sector (LULUCF), and provides opinions about political decisions to the Ministry of Environment **Objectives:** *Provide oversight of public programmes *Appropriate funds to public programmes *Collect periodic and accurate monitoring data of forests for managment and governance purposes *Promote actions to obtain periodic and accurate monitoring data of forestry areas for statistical purposes *Sustain political support for the environment **Specific Needs:** 1. Resources to implement objectives (budgetary) 2. Drone monitoring technical services 3. Periodic data and user-friendly tools 4. Policy collaboration with the MInistry of Environment and other agencies 5. Guidelines on optimal use of drones in forest monitoring and wild animals protection in Lithuania 6. General information (scientific, technical, social, etc.) 7. Skilled workforce **Cost Structure:** Central budgeting **Revenue Model:** Public taxation **Outputs:** 1. Statistical data and inventories 2. Knowledge creation (forest-related) 3. Recommendations
Inputs 1. Data (Data providers; other government agencies) 2. Plans and reports of progress (Municipality, other Public Administration, Associations) 3. Science knowledge (VMU, RCAF) 4. Technology (Network) 5. Informative & disseminative content (Social media, ICAERUS) 6. Data analytics for their daily services (Network)	

Figure 64 UC4 Stakeholder description – Lithuania State Forest Services

By taking a specific need of the Lithuania SFS in UC4 as an example (see Fig. 65) – to collect periodic and accurate monitoring data from forest terrains for governance and management purposes – to do so the SFS needs technology, data, data analytics, plans and reports of progress, science knowledge and informative content.

[169] Anderson J. C., D. C. Jain, and P. K. Chintagunta, (1993), "Customer Value Assessment in Business Markets: A state of practice study", Journal of business-to-business marketing 1 (1): 3 – 30

[170] Elhamdi G., (2005), Modélisation et simulation de chaines de valeurs en entreprise: Une approche dynamique des systèmes et aide a la décision: SimulValor [Modelling and Simulation of Value chains in Companies – An approach based on system dynamics and decision making: SimulValor] Ph D Thesis, Ecole Central Paris, France

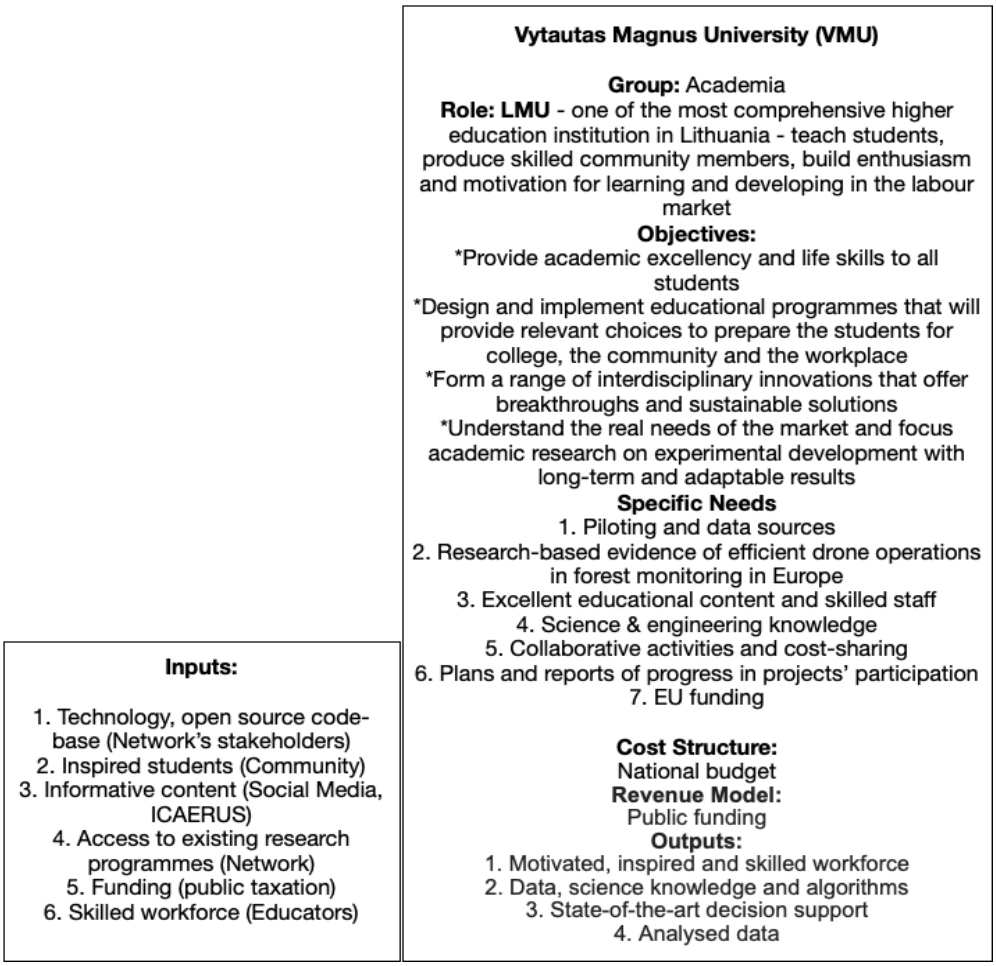

Figure 65 UC4 Stakeholder description – Vytautas Magnus University

Similarly, for the other stakeholder – Vytautas Magnus University (VMU) – one of their needs is "research-based evidence of efficient drone operations in forest monitoring in Europe" and to satisfy this need they will have to have technology, open-source code-base algorithms, access to existing research programmes, funding, and skilled workforce (see Fig. 66). The other figures present the needs and objectives of the stakeholders – DroneA and the National Paying Agency. The mission of DroneA is to:

- DroneA brings together companies and local authorities (municipalities) to showcase innovative solutions and support their replication at scale in key market segments
- By bringing stakeholders together they aim to understand public and private needs

And collaborative activities are their main input to produce their final outputs such as regulatory documentation, reports, showcases and meetings.

	DroneA **Group:** Association **Role:** From fundamental research to industry-focused body led by key members of air traffic managemnt (ATM) and communications technology industry (ICT) **Objectives:** *Collaborate and promote development of the DRONE ecosystem that is simple to use, affordable, commercially and operationally friendly, yet capable of addressing all societal concerns such as safety, security, privacy and environmental protection *Assist EC in the preparation of delegated acts *Act as a sounding board for the conception and implementation of the EU drone policy *Draw on best practice and "lessons learned" in other regions and industrial sectors that can be instrumental for the purposes referred to herein **Specific Needs:** 1. Collaboration with other stakeholders and end-users to design incentives to foster marketing policies that can attract new users 2. Science & technical knowledge 3. Interaction with end-users 4. Resources (budgetary, human, technical) 5. Improving and developing regulations **Cost Structure:** Not-for-profit **Revenue Model:** Not-for-profit **Outputs:** 1. Intermediating between users and regulators 2. Regulatory documentation 3. Showcases
Inputs: 1. Collaborative activities (Other stakeholders and partners) 2. Public funding (EU) 3. Fundamental research (Network's stakeholders) 4. Regulatory reports and acts (Network stakeholders) 5. Skilled workforce (Educators)	

Figure 66 UC4 Stakeholder description - DroneA

	National Paying Agency (NPA) **Group:** End-user **Role:** The NPA under the Ministry of Agriculture of Lithuania is an accredited institution managing the measures of support for agriculture, rural development and fisheries **Objectives:** *Provide support for investment in development of forest areas and improvement of forest viability *Appropriate funds to public programmes *Introduce prevention measures against possible forest fires, natural disasters and calamities, and reimbursement of forest damage *Promote actions to obtain periodic and accurate monitoring data required for governance and information *Invest to increase forest ecosystems resilience and environmental values as well as technologies **Specific Needs:** 1. Resources to implement objectives (budgetary) 2. Periodic data and user-friendly tools 3. Drone monitoring services 4. Expert scientific, technical and policy advice 5. Collaborative activities and cost-sharing with other government agencies to improve forest ecosystem resilience 6. Knowledge on optimal and safe UAV monitoring of land and forest 7. Skilled workforce **Cost Structure:** Central budgeting **Revenue Model:** Public budget **Outputs:** 1. Knowledge creation (forest-related) 2. Statistical data
Inputs 1. Data (Data providers; other government agencies) 2. Plans and reports of progress (Municipality, other Public Administration, Associations) 3. Science knowledge (LMU, RCAF)) 4. Data analytics (Network) 5. Informative & disseminative content (Social media, ICAERUS) 6. Technology (Network's stakeholders)	

Figure 67 UC4 Stakeholder description – National Paying Agency

If we look at the value flows separately, the *value flow* indicates the output of one stakeholder as the input to another, and Fig. 69-72 illustrate the value flows into and out of UC4 stakeholders. For instance, stakeholder "**SFS",** which is a governmental institution under the remit of the Lithuanian Ministry of Environment. Its activities focus on forest cadastre, forest genetic resources, forest use and statistics, forest seeds and seedlings, forest sanitary protection, forestry maintenance, forest management, national forest inventory, national greenhouse gas inventorisation.

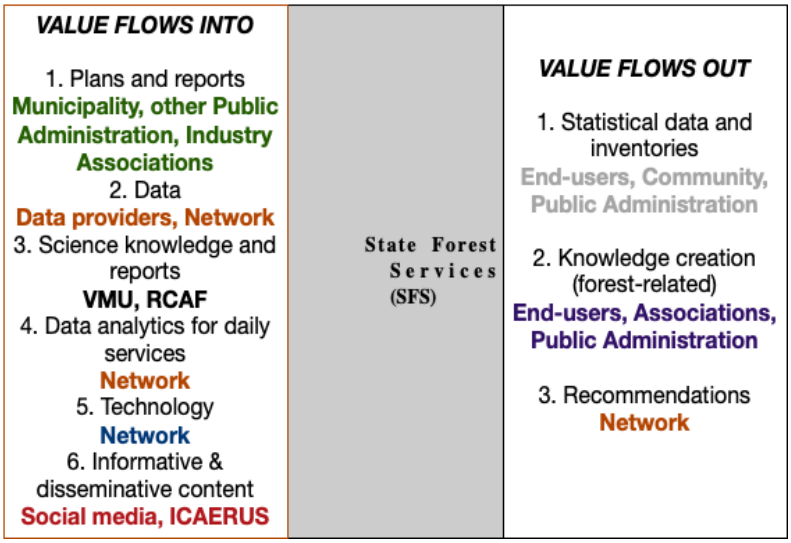

Figure 68 Value flows into and out of stakeholder: State Forest Services

The value flows going into the agency's operations are data, data analytics, technology from the network's stakeholders; plans and reports of progress from other public administration, municipalities, industry associations; science knowledge and reports from the universities, and informative & disseminative content from social media and ICAERUS consortium as a partner. Simultaneously, the value flows that go out as outputs of the SFS activities are statistical data and inventory to the end-users; knowledge creation to the end-users and public administration, and recommendations to the network's stakeholders (Fig. 69).

The other stakeholder "**Vytautas Magnus University Agriculture Academy**" – VMU, represents the Lithuanian academia with close collaboration between businesses and the government. It actively participates in R & D projects on forest monitoring based on remote sensing, artificial intelligence, and Internet of Things (Fig. 70).

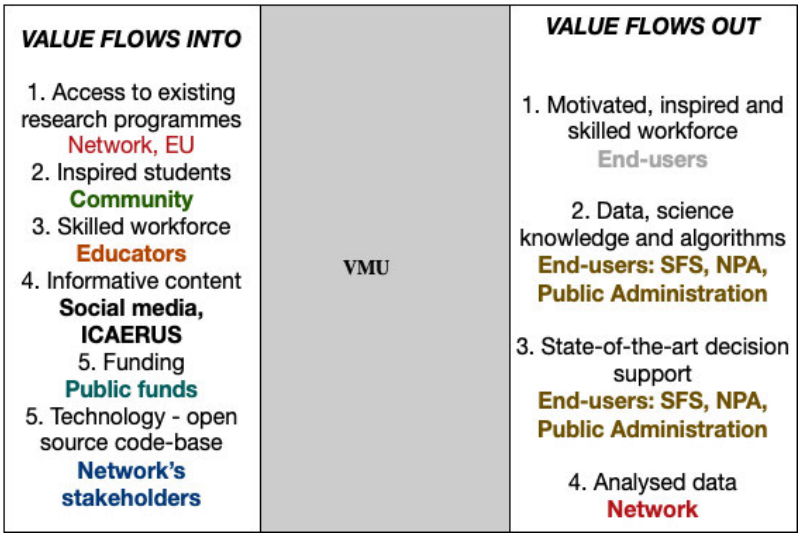

Figure 69 Value flows into and out of stakeholder: VMU

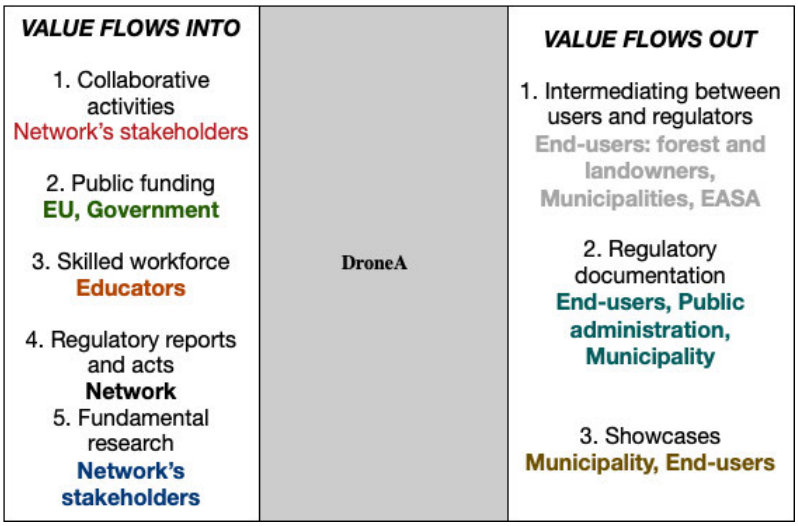

Figure 70 Value flows into and out of stakeholder: DroneA

Its research fields are:

- Forest policy, economy, and forest enterprise management: "output" – recommendations for forest policy makers
- Forest yield and growth modelling: "output" – stochastic models for tree and stand yield and growth
- Remote sensing & GIS (new technologies like satellite images, LiDAR, aerophotogrametry)
- Improving forest management approaches
- Forest health monitoring: "output" – permanent monitoring of protected areas, leadership at the university in publications with impact factor
- Forest logging technologies

Additionally, Fig. 70 shows the value flows that go into the VMU actions such as access to existing research programmes from the EU; technology – open-source codebase from the network's stakeholders; informative content from social media and ICAERUS consortium; funding from the national government and EU-projects, and skilled workforce from the educators.

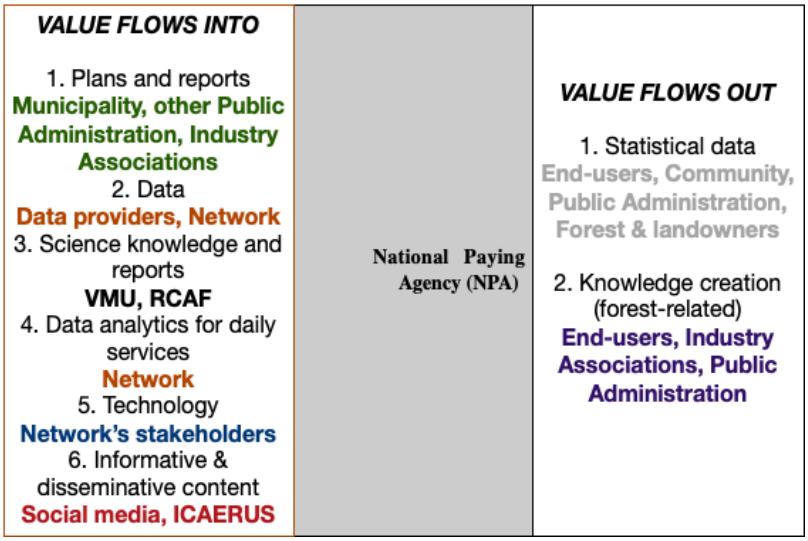

Figure 71 Value flows into and out of stakeholder: National Paying Agency

The stakeholder "**National Paying Agency**" – NPA on Fig. 72, is an accredited institution under the remit of the Lithuanian Ministry of Agriculture, managing the measures of support for agriculture, the rural development, and fisheries. More details about the nature of this stakeholder in UC4 network, which is provided by the UC4 leader – ART21 follow below:

- Owns and operates drones (10 drones) to inspect rooftops and hardly accessible areas (forests, wetlands) and 4 drones for local cartography
- For NPA automation and drone services (incl. necessary software and other equipment for large data processing) are needed
- Their operations in terms of forest monitoring are seasonal
- Their need is either to pilot the drones themselves or buy a service that includes both the piloting of drones, assessing the species diversity and providing algorithms for data processing
- In general, in their opinion, using drones for forestry monitoring is well accepted by their clients, as drone imagery is a solid proof to be used in argued cases
- In terms of quality and reliability of data and potentially provided services, the NPA would set-up validation measures to ensure the quality of the service provided by contractors
- NPA suggests that satellites have an advantage over drone services because of the smaller costs. They themselves considered different options and decided to use satellite services.

The value flows that move out of NPA are the statistical data or various measurements that they oversee and can be used by the end-users or other public administration; and knowledge creation, which is based on their operations and experience, and could be applied by the end-users, industry associations and governmental agencies.

Finally, the value network model has been visually created by linking all value flows within one case. Here are three maps that present different exchanges among the UC4 stakeholders. Fig. 73, demonstrates the analysis of monetary transactions – taxes, public funds, and fees. The public funds move from governmental institutions towards the public bodies, universities, municipalities. The EU public funding moves to the ICAERUS consortium, and then to the relevant partners (all in blue). In Fig. 74, the knowledge and informative content value flows are added. There is a separate circle of informative content, reports that goes out of ART21 to the state agencies such as SFS, NPA, SFVS and the Association of private forest holders and landowners (FOAL). Another loop facilitates the flow of social media posts among the ICAERUS partners, EU agencies and municipalities.

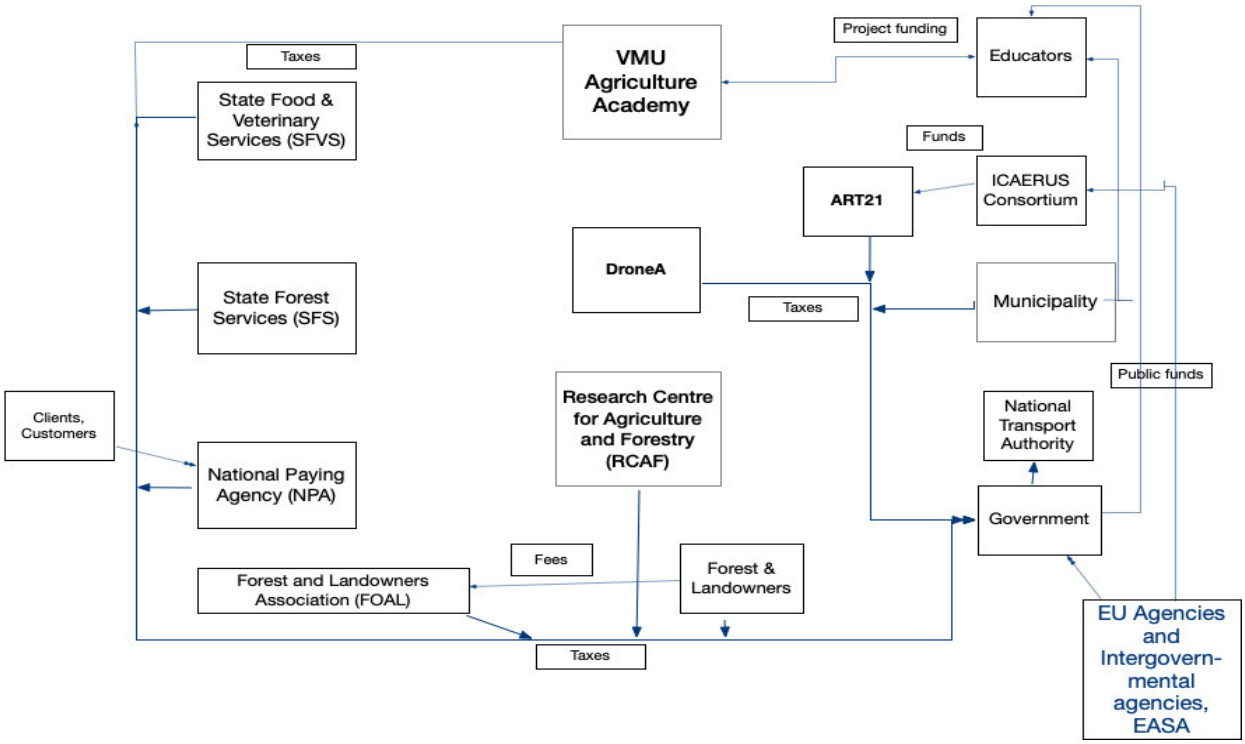

Figure 72 Monetary value flows in UC4 network

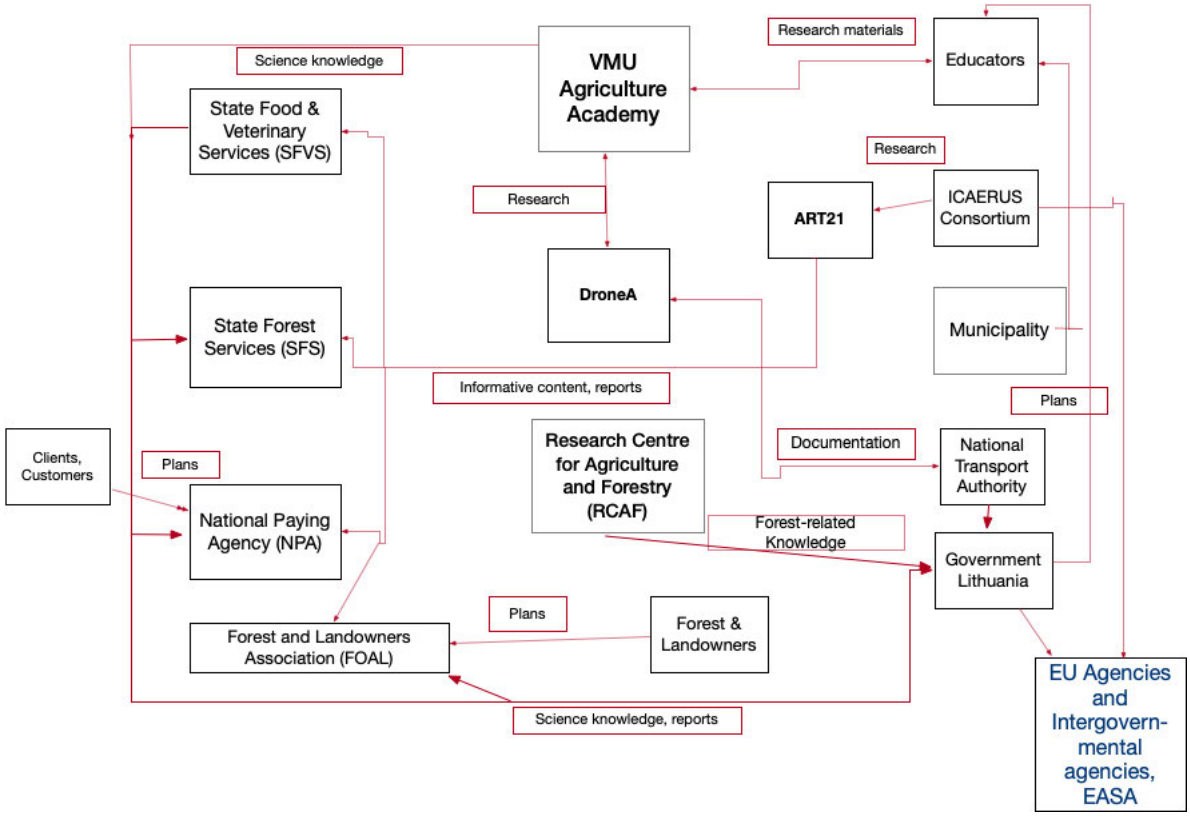

Figure 73 Knowledge & informative content value flows in UC4 network

In support of the value flow maps in this section, here are presented the top specific needs of UC4 stakeholders illustrated on Fig. 74-75 as science knowledge, reports, plans, informative content, data, models, and policy:

Table 31 Prioritised needs of UC4 stakeholders

NEED	Stakeholder
1. Improving and developing regulations	DroneA
2. Collaboration with other stakeholders to design incentives to foster dissemination practices that can attract new users	DroneA
3. Plan information exchange with landowners	FOAL
4. Science opinions and scientific publications	VMU
5. Guidelines on optimal use of drones for wildlife monitoring in Lithuania	SFVS
6. Periodic data and user-friendly tools	SFS, NPA (end-users)
7. Piloting and data sources to collect research-based evidence for science advances and publications	RCAF
8. Understanding the importance of monitoring UAVs as a novel / green tool	Transport Competence Agency

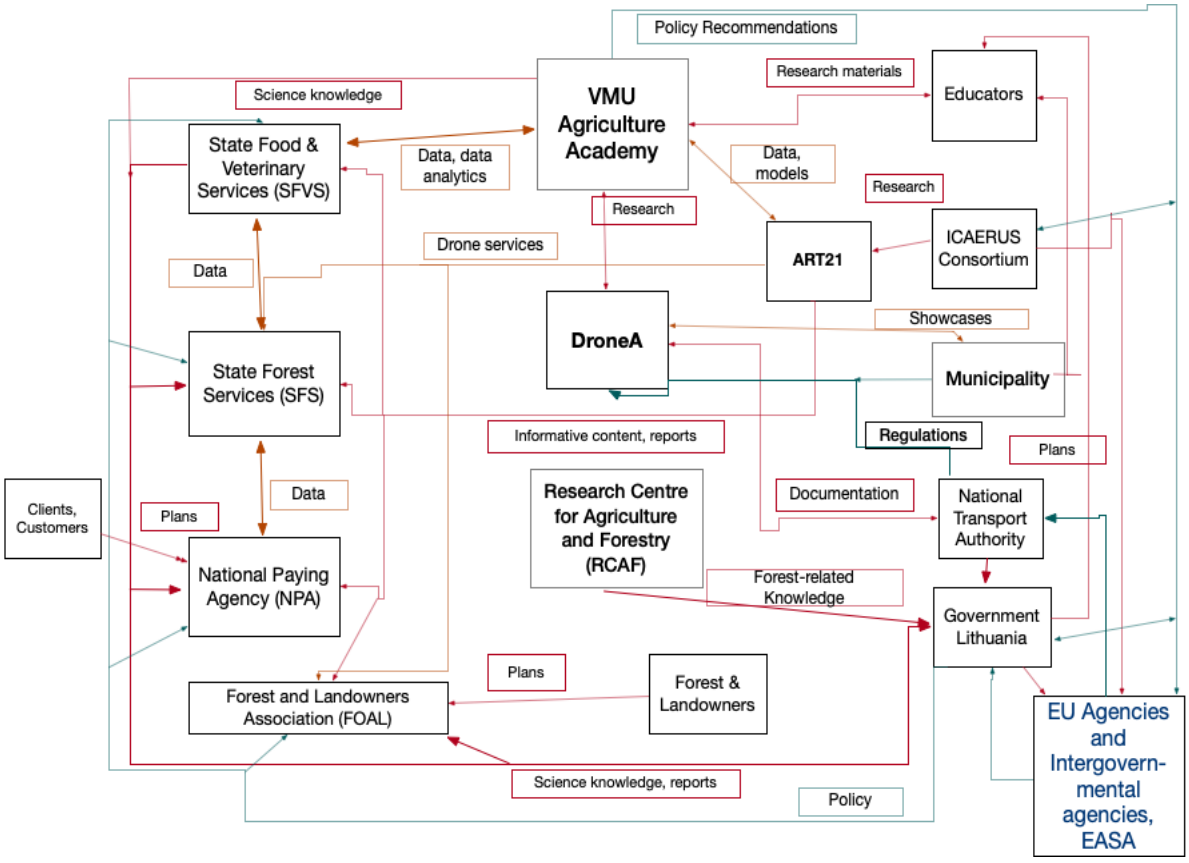

Figure 74 Knowledge & informative, policy & opinions, data, drone services value flows in UC4 network

In Figure 75, more interactions are added, including the policy collaboration and engagement. The regulatory interactions between the National Transport Authority and the EASA with DroneA and ART21 are shown as a value flow of standards & regulations in a green colour. Policy directions flow from the Lithuanian government to the State Forest Services, National Paying Agency, and the State Food & Veterinary Services. Policy recommendations related to forest protection go out of the VMU Agriculture Academy to the government services and EU institutions. ICAERUS consortium takes part in this value flow with its contribution to policy recommendations.

Throughout a direct communication of the UC4 leader and the State Forest Services additional stakeholders were identified – **1**) The Forest control department of the Environment Protection Department under the Ministry of Environment, and **2**) State Forestry Enterprise. They are not included in the initial list of UC4 stakeholders, which will be refined later and adjusted to any new entries.

State bodies with the major responsibilities to ensure forest health and implementation of relevant national and EU-level regulations related to forest management already use drones in fulfilling some of their assigned tasks. However, all stakeholders, including those actively using drones, confirm that there is much potential for expanding the scope of drone usage in their respective organisations. The **UC4** network can expand in terms of the tasks where drones could be applied to help get higher quality results and increase resource efficiency or further tailoring of drone services offered, which might be an opportunity for new service providers to enter the network. This will facilitate the path for further market developments and potential scaling-up of the UC4 in the region of Scandinavia as a business-to-business (B2B) use case.

5.1.6 Use Case 5 Network

By adopting the stakeholders network approach in this deliverable and in the whole of WP1, the focus is not on one organisation or company, but rather on the system of value creation. To co-create this value, different economic entities such as suppliers, partners or end-users work together within the network. Also, to evaluate the performance of all stakeholders in the network, it is better to use the concept of networks rather than of chains. For instance, Mizgier, Juttner and Wagner define the supply chain network as a complex system of interconnected firms and propose a method for bottleneck identification based on this concept[171].

The UC5 network is defined and consists of 20 stakeholders initially identified and described by the UC5 leader – GeoSense and AgFutura Technologies – located in Northern Greece and North Macedonia. This is the only use case that represents the rural logistics, and the network consists of stakeholders from two countries, one of which is not a member of the EU. Therefore, both organisations have kept a direct communication with their local stakeholders and collected the necessary information either from the stakeholders' websites or via an exchange of emails. Beginning with figures 76-79 that describe four of the stakeholders of UC5, populated with the necessary information, collected by the UC Leaders, by following the provided template. The profiles of the rest of UC5 stakeholders are added in Annex VIII.

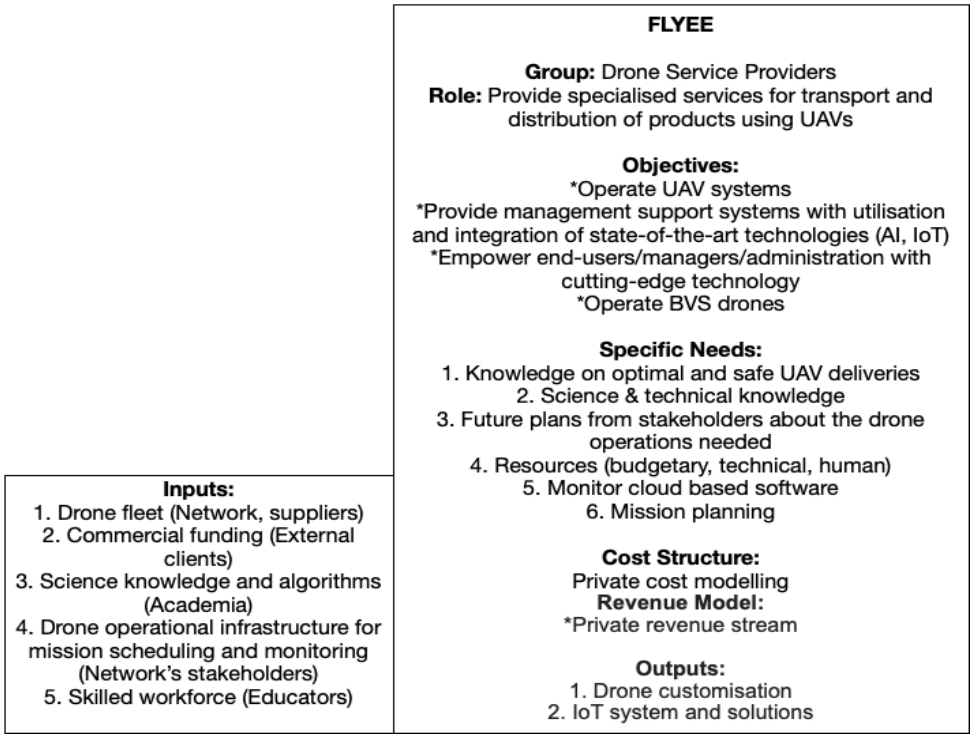

Figure 75 UC5 Stakeholder description - FLYEE

Moving to the "specific needs" in our analysis and by taking a specific need of the Greek start-up FLYEE in UC5 as an example (see Fig. 76) – to obtain plans for future activities from network's stakeholders about their needs of drone operations – to do so FLYEE needs drone fleet, commercial funding to be operative, drone operational infrastructure for mission planning and monitoring, skilled workforce, science knowledge and algorithms. All these are necessary so that the company can organise their activities and business processes. Simultaneously, one of their operational objectives is to provide management support systems with utilisation and integration of state-of-the-art technologies (artificial intelligence, Internet of Things) and to be able to fulfil it, they have identified six needs – one of which was already discussed.

[171] Mizgier, K. J., M. Juttner, S.M. Wagner (2013), „Bottleneck identification in supply-chain networks", *International Journal of Production Research* 51 (5): 1477 -1490

Medecins Sans Frontieres (MSF)
The Greek office

Group: End-users
Role: It brings humanitarian medical assistance to victims of conflict, natural disasters, epidemics or healthcare exclusion

Objectives:
*Organise medical humanitarian deliveries
*Coordinate members to reach affected people in armed conflicts, epidemics, natural disaster areas
*Advocate for specific policy decisions
*Assist people in need irrespective of their race, religion, gender or political affiliation

Specific Needs:
1. Donations
2. Research-based evidence of the efficiency of UAVs usage in natural disasters and cases of healthcare exclusion worldwide
3. Access to medicines, blood and medical technology to deliver emergency aid
4. Drone delivery services
5. Know-how transfer from country to country
6. Skilled workforce

Cost Structure:
Private cost modelling
Revenue Model:
More than 6.3 million donors around the world provide some 95% of MSF funding

Outputs:
1. Invaluable know-how transfer through accumulated experience and presence in more than 60 countries
2. Awareness campaigns

Inputs:

1. Operative funding (Donators)
2. Centralised drone operational infrastructure (Municipality, Network)
3. Qualitative and quantitative characteristics of the transported cargo (Network's stakeholders)
4. Skilled workforce (Educators)

Figure 76 UC5 Stakeholder description - MSF

Makedonski Telekom AD

Group: Infrastructure Provider
Role: Provider of 4G and 5G network, rely on commercial contracts for mobile communication services, enables long-distanced drone flights

Objectives:
1. Provide jobs in the industry
2. Enter new market niches
3. Respond to new market and technological opportunities - understand better the needs of the drone industry
4. Provide network infrastructure specifics for the UAV-based rural logistics

Specific Needs:
1. Resources (budgetary, human, technical)
2. Launch new mobile services
3. Expert knowledge on UAV-based rural logistics
4. Drone science knowledge
5. Market analysis and data support
6. Skilled workforce

Cost Structure:
Private cost structure
Revenue Model:
Private revenue stream

Outputs:
1. Enhanced mobile connectivity
2. Launched new mobile services to support the future rural logistics market based on UAVs
3. Increased network coverage (4G and 5G)

Inputs:
1. Skilled workforce (Educators)
2. Future plans information (Network)
3. Policy directions in smart services and smart mobility (Municipality, Government)
4. Science knowledge (Universities, Telecom R&D department)
5. Sustainable mobility support for the rural logistics (Municipality, Network's stakeholders)

Figure 77 UC5 Stakeholder description – Makedonski Telekom AD

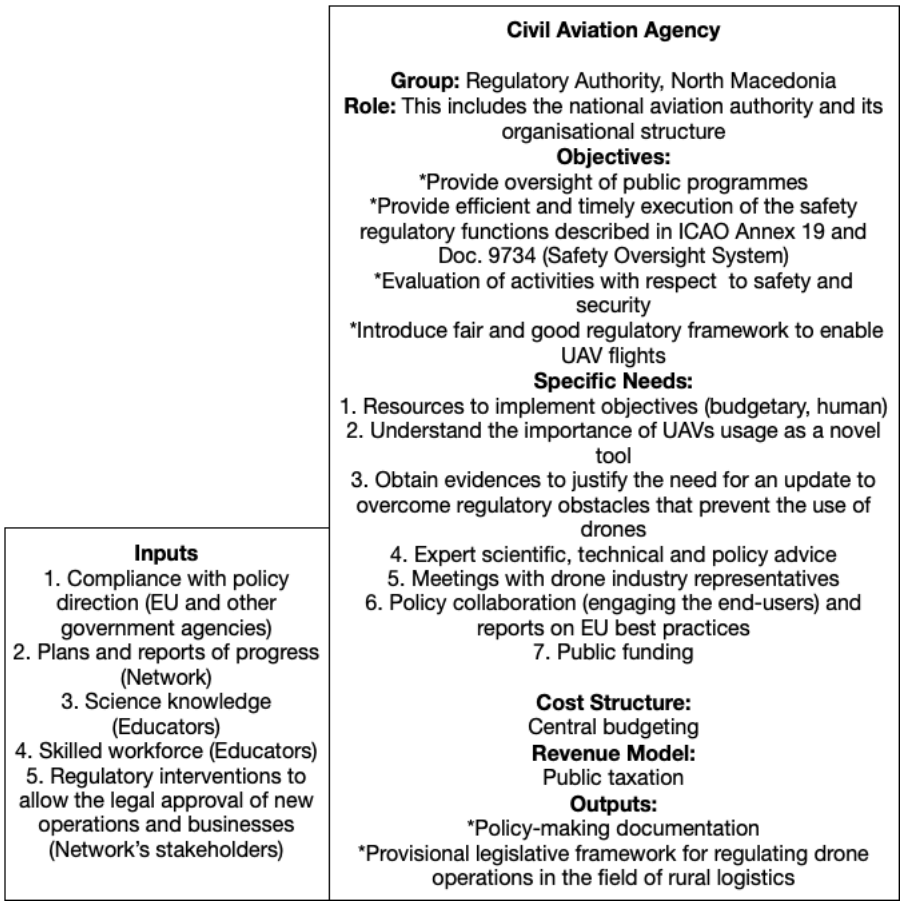

Figure 78 UC5 Stakeholder description - CAA

Similarly for the other stakeholder in Fig. 78 – Makedonski Telekom AD – this is the telecom operator of North Macedonia, and they have four company's objectives, which they aim to fulfil. They have identified six specific needs, one of which is "market analysis and data support". To provide the connectivity in the country and the mobile infrastructure, they will need as inputs policy directions in smart mobility and smart services, skilled workforce to facilitate the business processes, science knowledge from the academia or the company's R&D unit, plans and information from other stakeholders, and sustainable mobility support for rural logistics – these all is in terms of the UC5's goals, activities, and targets.

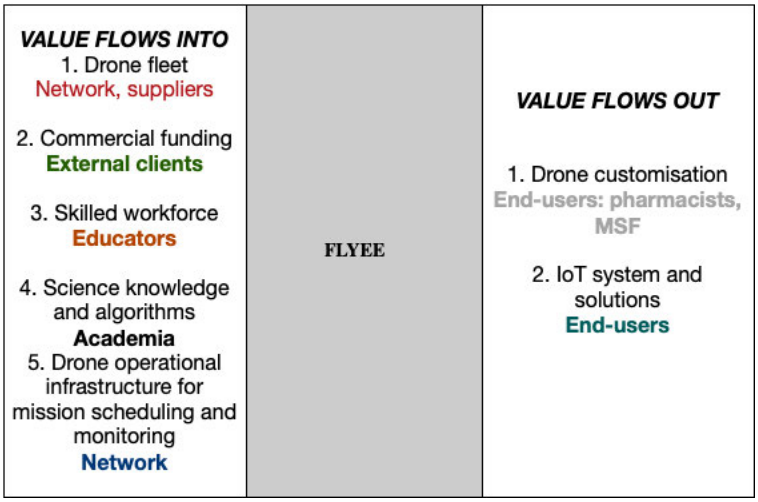

Figure 79 Value flows into and out of stakeholder: FLYEE

Looking at the value flows separately, Fig. 80-83 illustrate the value flows into and out of UC5 stakeholders, also supporting the design of the value flow maps (Fig. 84-86). For instance, stakeholder "**FLYEE",** which

is a newly established start-up in Thessaloniki (2020, Greece) provides specialised services for transport and distribution of products using unmanned aircraft systems[172]. The value flows going into the company as inputs are drone fleet from suppliers, commercial funding from clients, science knowledge and algorithms from academia, skilled workforce from educators and drone operational infrastructure from the network's stakeholders. The value flows that go out as outputs are drone customisation offered to the end-users; and IoT system and solutions offered to the end-users. In the case of UC5, this customised service will be provided to various pharmacies in North Macedonia and during the demonstration phase all demos will be piloted by the consortium's partner GeoSense.

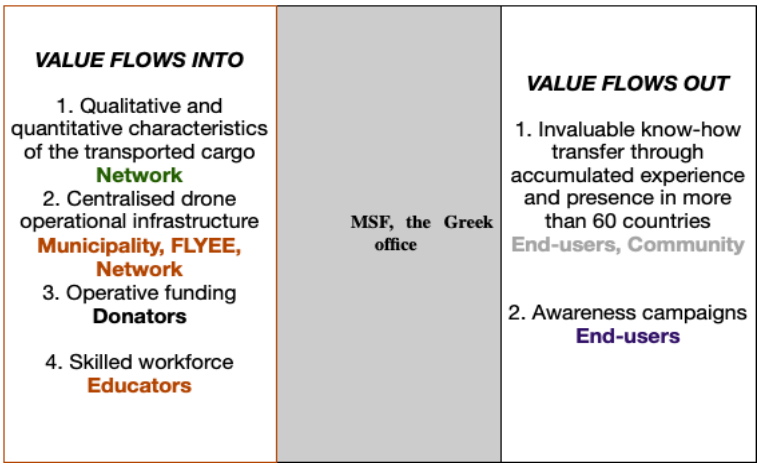

Figure 80 Value flows into and out of stakeholder: MSF

The other Greek stakeholder is MSF – **Médecins sans Frontières** – which is an international humanitarian organisation with activities all over the world. It offers basic healthcare, perform surgery, rehabilitation and run hospitals and clinics, carry out vaccination campaigns, operate nutrition centres and provide mental healthcare. They fight epidemics and treat injuries, diseases as well as provide maternal care and humanitarian aid. If necessary, they might set up sanitation systems, supply safe drinking water, and distribute relief to assist survival. In UC5 the participating stakeholder is the Greek office based in Thessaloniki[173].

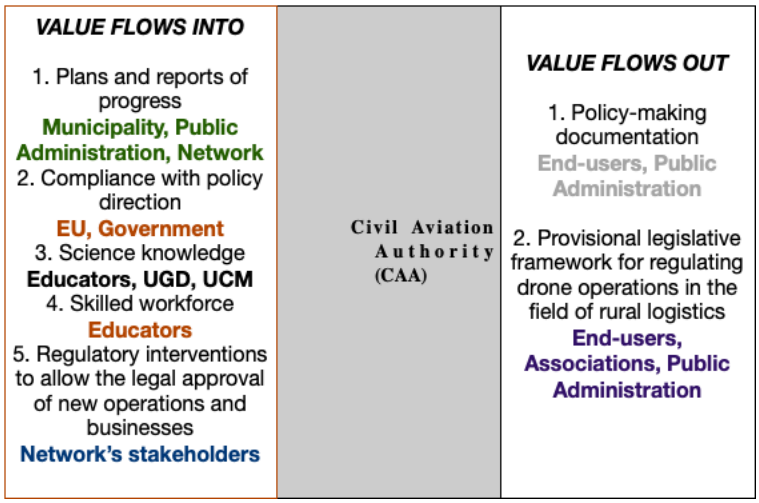

Figure 81 Value flows into and out of stakeholder: CAA, North Macedonia

In Fig. 81 the value flows going into their activities as inputs are operative funding from donors; centralised drone operational infrastructure from FLYEE, the network and municipalities; skilled workforce from educators; and qualitative & quantitative characteristics of the transported cargo. The value flows going

[172] https://flyee.gr/#what-we-do-section
[173] *https://msf.gr*

out as outputs are know-how transfer through accumulated experience and presence in more than 60 countries. And through their activities they also provide awareness campaigns to the communities.

VALUE FLOWS INTO		VALUE FLOWS OUT
1. Future plans information Network 2. Skilled workforce Educators 2. Commercial funding External clients 3. Policy directions in smart services and smart mobility Municipality, Government 4. Science knowledge Academia, Telecom R&D Unit 5. Sustainable mobility support for the rural logistics Network, Municipality	Makedonski Telekom AD	1. Enhanced mobile connectivity End-users, pharmacists, MSF, FLYEE, Network 2. Launched new mobile services to support the future rural logistics market based on UAVs End-users 3. Increased network coverage (4G and 5G) End-users, Municipalities, MSF, FLYEE, Network

Figure 82 Value flows into and out of stakeholder: Makedonski Telekom AD

One of the stakeholders in North Macedonia is the **Civil Aviation Agency** (CAA), which is the national authority and organisational structure for safety and security oversight of the air traffic system[174]. They provide safe and efficient transport system integrated into the European transport system. Their regulatory functions in "Operations" are: 1) certification of the aviation industry for different types of flight operations (aviation, aerial work, aviation-sports-activities); 2) continuing inspection of the certificated entities from the industry and inspection of any type of flying. The CAA has many regulatory functions in different areas of the transport sector.

As shown in Fig. 82, the value flows that go into their operations as inputs are compliance with policy directions from the EU and the national government; plans and reports of progress from other parts of the Public Administration and the network; science knowledge about the aviation sector from the academia (various universities); skilled workforce from educators; and regulatory interventions to allow the legal approval of operations and businesses. The value flows that go out as outputs of the Authority are differing policy-making documentation that are exchanged with other state agencies and the public administration; and provisional legislative framework for regulating drone operations in the field of rural logistics exchanged with industry associations, the public administration, and the end-users. These two outputs of the CAA's operations closely relate to the activities planned to take place in UC5. Similarly, the value flows into and out of the last stakeholders – Makedonski Telekom AD – are illustrated in Fig. 83.

As a final step, the value network model has been visually created by linking all value flows within one case. Different exchanges among the UC5 stakeholders are presented in three different maps and colours. In Fig. 84, it is started with the analysis of the monetary transactions – taxes, public funds, and donations. In Fig. 85, solely looking at the knowledge and informative content value flows such as research reports, science knowledge, and informative content including social media, and an exchange of plans that circulate between the government, EU institutions and local municipalities. Also plans circulate between the pharmacies as end-users, MSF and GeoSense as a provider of drone services in the demos. There is a separate circle of informative content, reports that go out of GeoSense and FLYEE to the national regulatory agencies such as Hellenic CAA and the CAA of North Macedonia, which will be monitoring the drone flying in UC5 on their territory. They also have their own rules to be followed by drone operators since the Republic of North Macedonia is not a full member of the EU yet. The third loop facilitates the flow of social media posts among the ICAERUS partners, EU agencies and municipalities.

[174] www.caa.gov.mk

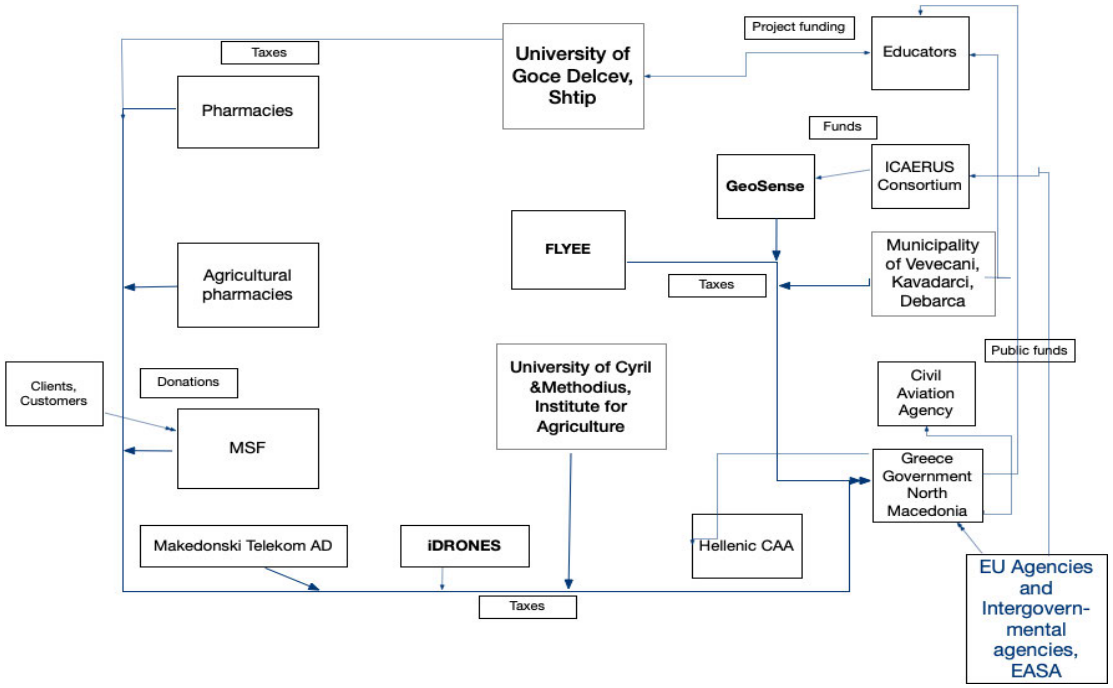

Figure 83 Monetary value flows in UC5 network

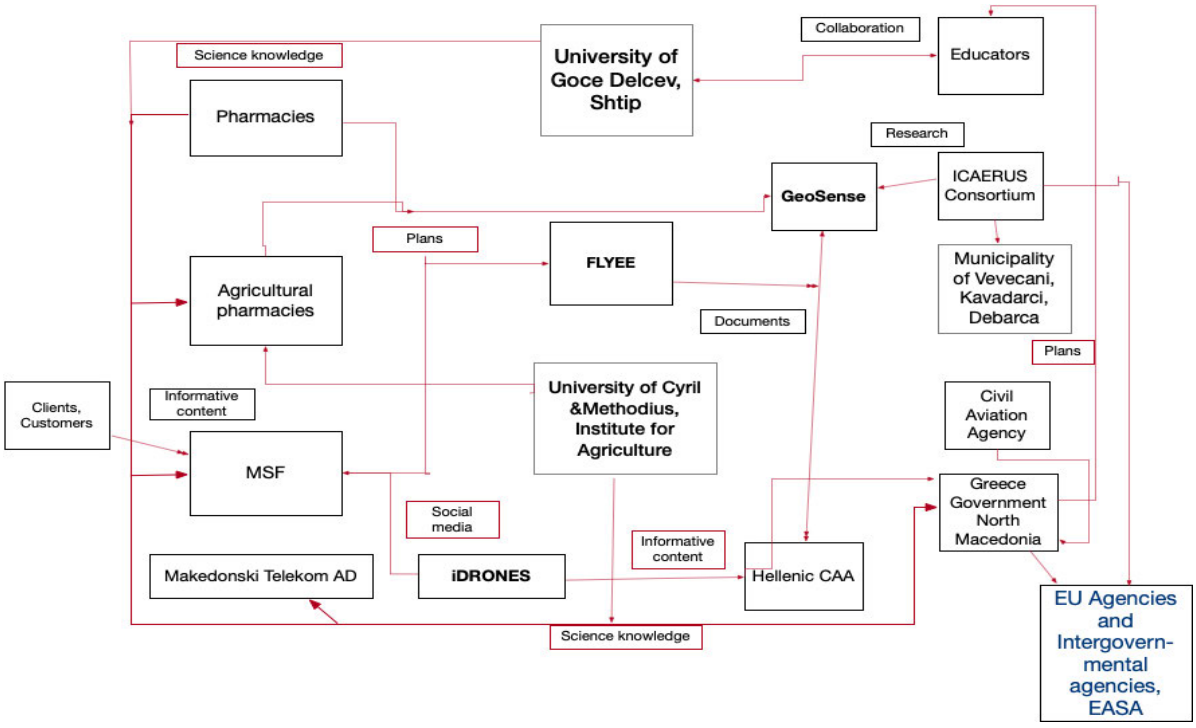

Figure 84 Knowledge & informative content value flows in UC5 network

For the understanding of the value flow maps in Fig. 85-86, here are presented the top specific needs of UC5 stakeholders, illustrated as science knowledge, research, plan reports, informative content, and collaboration on the maps:

Table 32 Prioritised needs of UC5 stakeholders

NEED	Stakeholder
1. Market analysis and data support	Makedonski Telecom AD
2. Access to medicines, blood, and medical technology to deliver emergency aid	MSF

3. Research-based insights of the economic aspects of rural logistics based on UAVs	UGD, UCM
4. Compliance with policy directions about digitalisation	Government
5. Drone delivery services	Pharmacies (end-users)
6. Guidelines on the optimal use of drones in rural logistics and in less accessible areas	Pharmacy, Ohrid
7. Collaborative activities and cost-sharing	Agri-pharmacy
8. Policy collaboration (engaging the community)	Municipality of Debarca, Kavadarci, Vevecani
9. Obtaining concrete evidence to justify the need for an update on regulatory obstacles that prevent the use of drones	Civil Aviation Agency
10. Skilled workforce	EASA

In the last Fig. 86, more interactions are added, including the policy collaboration and engagement, data & drone services to the existing knowledge value flows. These are:

1) The regulatory interaction between the Civil Aviation Authorities and the European Aviation Safety Agency with the drone industry actors, in UC5 network represented by FLYEE and GeoSense, are shown as a value flow of standards & regulations in a green colour.
2) Drone services flow from FLYEE and GeoSense to the pharmacies, agricultural pharmacies, and MSF as end-users are presented in a light mocha colour.
3) Policy recommendations related to aerial supply management or rural logistics go out of the MSF and ICAERUS consortium to the government services and EU institutions. ICAERUS consortium takes part in this value flow with its contribution of policy recommendations in various deliverables.

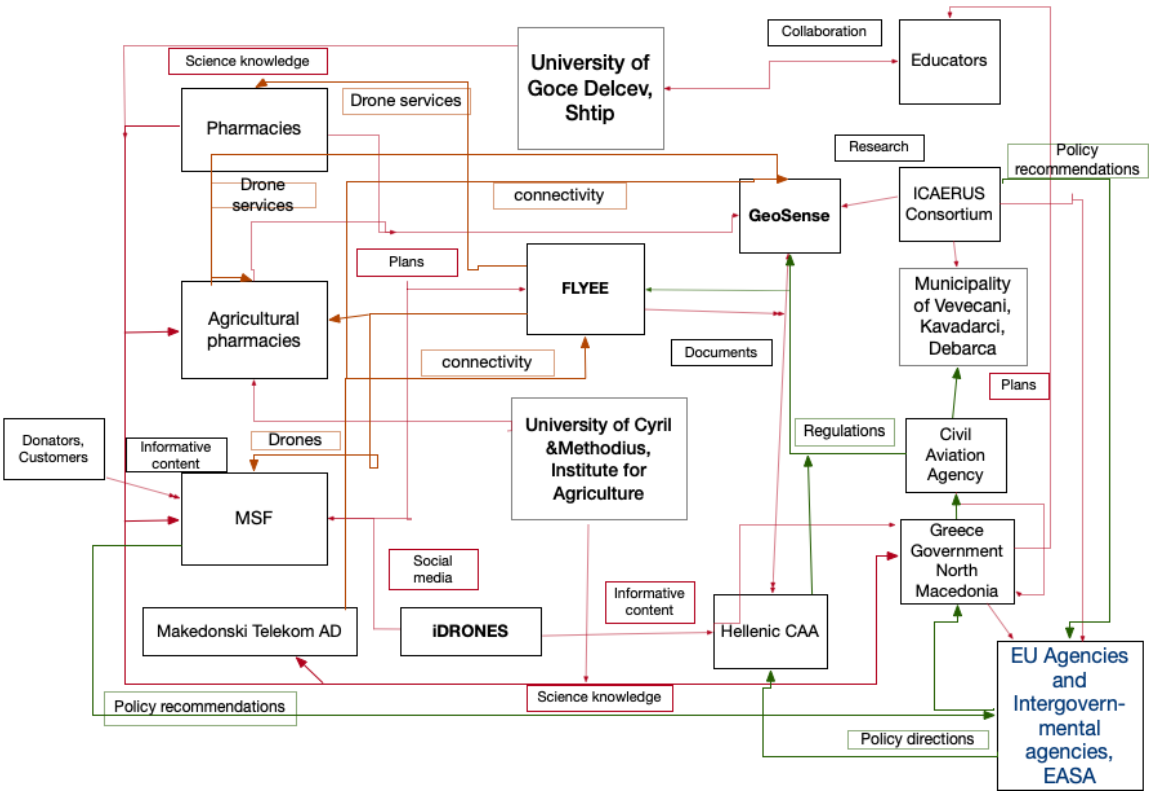

Figure 85 Knowledge & informative, policy & opinions, data, connectivity, drone services value flows in UC5 network

By performing the stakeholders network analysis on **UC5** it can be concluded that the network is at an emerging stage and will require more collaborative work on the side of the end-users, both businesses and customers. The stakeholders need time and knowledge to adopt the concept of the "business ecosystem" and the concept of "networks" in their daily business operations. While the drone operators representing the drone industry and the supply-side in this UC could customise the service relatively easy, the end-users will have to prepare and co-work with the rest of the network on a more frequent basis. Finally, the UC5 is presented as a mixture of business-to-customers and business-to-business case, which differs from the rest of the UCs, which are presented as only business-to-business cases.

5.1.7 Summary of Qualitative Stakeholders Analysis

To sum it up, networks, depending on their structure, may be formed by formal contractual relationships. The less hierarchical and bureaucratic, the more social mechanisms govern the network. Informal relations, their type and form play an important role in networks that facilitate an easy exchange of information. Stronger ties in the network are determined by strong mutual and frequent interactions[175]. The hierarchical organisations usually rely on close and frequent ties with their partners that are formally structured.

The qualitative stakeholder analysis in this D1.1 builds upon the network approach embedded in T1.1 and provides a thorough understanding of how each ICAERUS use case delivers value to the entire network of stakeholders. There are five main points identified throughout:

- Via the qualitative analysis it is summarised an initial list of stakeholders for each UC
- The objectives and specific needs of each stakeholder were discussed
- A template for each stakeholder's profile has been applied
- The inputs to each stakeholder were used to develop the preliminary value flow maps in each UC
- Different categories of value flows, quantifiable and non-quantifiable, were represented on the maps via differing colours.

To apply these maps in strategic analysis, the following steps might be useful to be followed by all UCs of the ICAERUS project:

- ✓ Define a strategic value proposition
- ✓ Specify the value flows each stakeholder in the network can provide
- ✓ Select proper partners based on the initial evaluation of transactions and determine the links that transfer all the value
- ✓ Add cost and revenue to each offering and analyse the value network theoretically or by simulation
- ✓ The last three steps may be repeated several times until a satisfactory model is achieved

By nature, the value flows are only qualitative in this analysis, but all maps of value flows establish the foundation for the quantitative stakeholder network analysis and model that will be performed in Year 2 and Year 3 and described in the final version of this report (2025). Also, it was described a summary of UC1, UC2, UC3 and UC4 as business-to-business cases and UC5 as a mixture of business-to-business and business-to-customers case separately in the section of each use case.

[175] Pulles, N.J. Schiele, H., (2013). Social capital determinants of preferential resource allocation in regional clusters. Management Revue, Vol. 24, No2, p.96-113

5.2 Surveys and Interviews

5.2.1 Results and questionnaires of two global surveys

The objective of this global survey named “Understanding the drone market” is to identify the needs and interests of drone industry stakeholders and end-users of drone services. Its goal is to understand in general terms more about the drone innovators, manufacturers, operators, and customers as part of the stakeholder analysis. It aimed to reach a global audience from Europe and beyond and was run from M4 to M9. As a primary means of dissemination, the survey was promoted through the ICAERUS website at https://icaerus.eu/understanding-the-drone-market/. In addition, more than 500 drone industry stakeholders were contacted by email or via social media such as LinkedIn groups, project’s posts and individual consortium members’ posts and Facebook promotional announcements. It collected 100 responses, a combination of online surveys (80) and short interviews (20). It will continue running to collect more opinions from the industries involved in the ICAERUS project.

5.2.1.1 Questionnaires

For the purposes of this Chapter 5: Use Cases’ Stakeholders network analysis, we have conducted two global surveys to assess each specific need of stakeholders. We asked two questions, where stakeholders were able to rank the intensity and importance of their major interactions within their defined network:

1) **Categorising the intensity of each specific need of a stakeholder**

Question 1: How would you categorise the presence or absence of fulfilment of this need?

2) **Defining the source importance**

Question 2: If this need were to be fulfilled, how important would this source be in fulfilling the need?

The satisfaction / regret question asks the participant to evaluate the presence or absence of value flow that fulfils a specific need. The scale ranges from least to greatest, A through E, in an alphabetic order. Each person first answers this question and then follows the second one.

Satisfaction / Regret

Question: How would you categorise the presence or absence of fulfilment of this need?
Responses: A response of A, B, C, D or E will be chosen. Answer E corresponds to "must-have" need.

A. I would be satisfied by its presence, but do not regret its absence
B. I would be satisfied by its presence, but would somewhat regret its absence
C. I would be satisfied by its presence and do regret its absence
D. Its presence is needed
E. Its presence is absolutely essential

The second question asks about the importance of a certain source in fulfilling a stakeholder’s specific needs. The scale ranges from 1 through 5. Number 1 corresponds to “not important”, while number 5 corresponds to “extremely important”. Both questions, Q1 and Q2, use different scales to reinforce to the participants that the two scales measure different attributes and helps prevent the respondent from confusing them.

Importance of Source
Question: If this need were to be fulfilled, how important would this source bel
Responses: A response of 1, 2, 3, 4, or 5 can be chosen. The response 5 corresponds to "'extremely important"

1. Not important
2. Somewhat important
3. Important
4. Very important
5. Extremely important

5.2.1.2 Results of the Drone Stakeholders Survey

This is the first survey ran with drone industry actors, and there are 10 countries represented in the answers, all of them are European, but two are not members of the EU – Switzerland and Turkey. Most responses come from Greek companies and organisations – 42%, while the rest 58% come from the other 9 countries (see Table 33). The first survey is strictly Europe-based with most participants representing commercial firms and only two universities. About 30% of respondents are research professionals, 15% are software engineering professionals, 15% are CEOs, 9% are owners of drone businesses, and others.

Table 33 Survey 1: Geographical distribution

Country	Percentage
Greece	42%
Netherlands	12%
Spain	12%
Lithuania	9%
Portugal	6%
Italy	6%
Germany	3%
Switzerland	3%
Bulgaria	3%
Turkey	3%

At high-level what is observed from the results (see Table 34) is that answer **D** and **E** are the top scores to most identified needs of drone stakeholders[176]. The specific needs are arranged in the table by importance. This means that the needs are "really necessary" and "absolutely essential" for the operations of the actors. Only three specific needs (number 22, 23 and 24) score **C** as a top response obtaining more than 35% of the total responses, which means that for the participants these needs are not essential, but still necessary. This might be explained with the fact that there are not many drone manufacturers that filled in the survey and different stakeholders have differing priorities. Three of the evaluated needs (number 5, 20 and 21) score **D** and **E** equally, so for the participants these needs are essential or "must have". In addition, almost 50% of the respondents ranked "EU R&D projects or collaborating with universities" as a must-have flow, which is understandable since the drone services are knowledge-based and many research professionals participated in the survey.

[176] Some of the sums of percentages do not amount to 100%, because a few respondents did not answer all questions.

Table 34 Responses for each identified stakeholders' need

Needs of drone stakeholders	A	B	C	D	E
1. EU R&D projects or collaborating with universities	3%	9%	18%	21,2%	**48,4%**
2. Assessment of operational risks and treatment actions	9%	0%	24,2%	21%	**45%**
3. Certification and legalisation of drone services	6%	3,2%	15%	30,3%	**42,5%**
4. Training of personnel	6%	6%	10%	33,3%	**42,4%**
5. Working in a network and transferring know-how	3%	6%	9%	42%	**42%**
6. EU policy directives, regulations, and compliance	3%	9%	24,2%	24,2%	**39,4%**
7. Understanding regulatory processes and rules	9%	3%	21%	30%	**39%**
8. Knowledge on optimal, environmental, and safe UAVs operational usage	9,2%	3,2%	18%	33,3%	**36,3%**
9. Commercial clients	6%	9%	15%	**45%**	24,2%
10. Access to new markets in Europe for drone applications	9%	9%	15%	**45%**	21,2%
11. Private investments	10%	3%	21%	**42%**	24%
12. Communication with customers	9%	9%	21%	**40%**	21%
13. Access to new markets worldwide	3%	3%	30,3%	**42,5%**	21,2%
14. Collaborative activities and cost-sharing	3%	3%	24,2%	**42,5%**	21%
15. Processing drone business activities	10%	9%	33%	**42%**	6%
16. Research-based evidence of efficiency of drone usage in rural and isolated areas of Europe	6%	3%	15%	**39,3%**	33,3%
17. Skilled workforce	6%	3%	15%	**39%**	36,3%
18. Science knowledge (drone-related)	6%	6%	21%	**38%**	29%
19. Public-private partnerships	9%	9%	24%	**36%**	18,2%
20. Software development and algorithms	9%	9%	21,2%	**30%**	30%
21. Scientific publications	9%	12%	18%	**30%**	30%
22. Inspections and auditing	3%	3%	**42,4%**	30,3%	21,2%
23. Components to manufacture drones	10%	18%	**42%**	9%	21%
24. Shared values and risks	6%	9%	**36,4%**	24%	21%

The second value flow attribute categorises the importance of a particular source in fulfilling a stakeholder's specific needs. All responses are in the range of "important" to "extremely important", which means that the identified sources are necessary to fulfil any specific need of the stakeholders (see Table 35). Only inspections and auditing from the local authority and public administration scored **3** as important sources to support the companies' process of compliance with regulations and local rules (number 27 and 28). But

"certification and legalisation of drone services from NAA or CAA" was chosen by 60% of respondents as an extremely important source. Participants also assessed the science knowledge (drone-related) obtained from universities and companies' R&D departments as extremely important – nearly 55% of the responses (number 2 and 3). These two sources are essential for the knowledge accumulation in the drone industry and the participants of this survey expressed it via their answers. In addition, the government is also considered as a very important source for the public-private partnerships that can drive-up further developments in particular market segments of the drone activities.

Table 35 Responses for each stakeholders' source

Source fulfilling the need	1	2	3	4	5
1. Certification and legalisation of drone services from NAA or CAA	0%	3%	18,2%	18,2%	**60,6%**
2. Science knowledge (drone-related) from universities	0%	6%	9%	30,3%	**54,5%**
3. Science knowledge from companies' R & D units	0%	3%	21,2%	18,2%	**54,5%**
4. EU policy directives, regulations, and compliance from EU Commission	0%	6%	12%	33,3%	**48,4%**
5. Private investments from investors	0%	3%	18,2%	30,3%	**48,4%**
6. Knowledge on optimal, environmental, and safe UAVs operational usage from collaborating universities	0%	3%	21,2%	30,3%	**45,5%**
7. EU R&D projects or collaborating with universities from EU programmes	0%	12%	15,2%	27,2%	**45,4%**
8. Scientific publications from Research Units	0%	12%	12,3%	30,3%	**45,4%**
9. Research-based evidence of efficiency of drone usage in rural and isolated areas of Europe from collaborating universities	0%	12,2%	12,2%	30,3%	**45,3%**
10. Skilled workforce from educators	0%	9%	15,5%	30%	**45,3%**
11. Software development and algorithms from drone developers	0%	6%	12,2%	36,3%	**45,3%**
12. Understanding regulatory processes and rules from NAA or CAA	0%	8%	8%	39%	**45%**
13. Commercial clients from network	0%	6%	18,2%	33,3%	**42,4%**
14. Certification and legalisation of drone services from local authority	3%	6%	21,2%	27,2%	**39,4%**
15. Training of personnel from universities	0%	18%	12,2%	27,3%	**39,4%**
16. Processing drone business activities from companies' management	0%	9%	12,3%	**57,5%**	21,2%
17. Public-private partnerships from Government	0%	6%	21,2%	**51,5%**	21,2%
18. Science knowledge from network's stakeholders	0%	3%	18%	**48,4%**	24,2%
19. Collaborative activities and cost-sharing on projects from network's stakeholders	3%	0%	27,2%	**48,4%**	18,2%

20. Working in a network and transferring know-how from network	0%	0%	22%	**48%**	30%
21. Assessment of operational risks and treatment actions from workforce	0%	3%	27,2%	**48%**	21,2%
22. Access to new markets worldwide from end-users	0%	0%	21,2%	**46,8%**	32%
23. Access to new markets in Europe for drone applications from end-users	0%	0%	12,2%	**45,5%**	39,3%
24. Components to manufacture drones from suppliers	0%	12%	18,2%	**45,4%**	33,3%
25. Shared values and risks from network	0%	6%	22%	**42%**	30%
26. Communication with customers from marketing and PR departments	0%	9%	18,2%	**39,4%**	33,3%
27. Inspection and auditing from public administration	0%	12%	**42,4%**	21,2%	21,2%
28. Inspection and auditing from local authority	3%	9%	**39%**	27,3%	21,2%

A few respondents left some comments at the end of the survey. Some think that the collection of economic data and their assessment is an essential need as well as identifying viable business cases. This seems to be important for the respondents since the drone usage is gradually emerging and the economic aspects of their activities must be evaluated. Also, one comment raises the question of educating the end-users (farmers) to be drone technology literate, which can be discussed later in WP4 during the identification of learning needs and design of training courses. Some others focus on the drone technology – the introduction of autonomous drones, the security of drone navigation, the definitions in security protocols, the development of aerial network in an urban landscape and the renewals of moving small packages. One comment recommends the collaborations with universities and large companies such as Siemens (DE), Bayer (DE), Milestone Systems (DK) that can be useful sources to fulfil the needs of drone actors.

Overall, all specific 24 value flows identified in this survey's list of assessed needs are deemed to be either "*essential"* (E) or "*its presence is needed*" (D). Similarly for the identified sources by the second question, which are considered by the respondents either "*very important*" (4) or "*extremely important*" (5).

5.2.1.2 Results of the Drone End-users Survey

In the second survey conducted with the end-users, the participants come from 10 countries. Three continents are represented – 80% responses from Europe, 18% from Asia and 2% from South America. 40% of the participants come from Greek organisations, and the other 60% come from 9 different countries – both EU member-states and non-EU states.

In addition, eight universities and research institutes filled in the survey: 1) Greece – Aristotle University of Thessaloniki and Athens University of Agriculture; 2) Turkey – Namik Kemal University and Akdeniz University; 3) United Kingdom – Cranfield University and Global Policy Institute (London); 4) Chile – University of Santiago de Compostela, and 5) China – Northwest A&F University. Therefore, 50% of the respondents are research professionals, incl. university professors. The other 50% of the answers come from commercial organisations.

Table 36 Survey 2: Geographical distribution

Country	Percentage
Greece	40%

North Macedonia	21%
Turkey	9%
China	9%
United Kingdom	6%
Spain	6%
Germany	2%
Switzerland	2%
Italy	2%
Chile	2%

As the results show at high-level, the conclusion is that most of the specific needs of end-users in Table 37 scored **D** or **E**, which means that they are considered either essential or "its presence is needed". Two of them (number 3 and 20) scored equally **D** and **E** by 42% of the respondents and 31% respectively. Shared values and risks are deemed as needed by 66,7% of the participants. Collaborative activities are also needed by the assessment of 55,5% of the individuals. The other scores "**A**, **B** and **C"** never managed to become the most favourite, which in this case means that the identified list of end-users' needs is essential and describes well the interests and expectations of the users (farmers, landowners, vineyard holders, livestock owners, etc.) according to the participants in this survey. Moreover, for the drone ecosystem and local networks to thrive and expand, all stakeholders must collaborate and cooperate with the users of drone services (**D** in number 9). The exchange of know-how appears to be needed and this reflects upon the answers as nearly 47% of the participants evaluate it as necessary (**D** in number 13).

Table 37 Responses for each identified end-users' need

Needs of end-users	A	B	C	D	E
1. Training of personnel	0%	2,2%	9%	40%	**48,8%**
2. EU R&D projects or collaborating with universities	0%	6,7%	13,3%	37,7%	**42,2%**
3. Skilled workforce	2,2%	4,4%	9%	42%	**42%**
4. EU policy directives, regulations, and compliance	2,2%	2,2%	17,8%	35,5%	**40%**
5. Knowledge on optimal, environmental, and safe UAVs operational usage	5%	9%	13,5%	33,3%	**37,7%**
6. Software development and algorithms	2,2%	13,3%	13,3%	31%	**37,7%**
7. Shared values and risks	0%	5%	17,7%	**66,7%**	9%
8. Access to new markets in Europe to increase the food production	0%	5%	24,5%	**57,7%**	11%
9. Collaborative activities and cost-sharing	2,2%	9%	17,7%	**55,5%**	13,3%
10. Research-based evidence of efficiency of drone usage in rural and isolated areas of Europe	0%	2,2%	13,3%	**53,3%**	26,7%
11. Inspections and auditing	0%	6,7%	15,5%	**48,8%**	26,7%

12. Commercial clients	2,2%	9%	15,4%	**48,8%**	20%
13. Working in a network and transferring know-how	0%	2,2%	15,5%	**46,7%**	33,3%
14. Access to new markets worldwide to increase agricultural production, biodiversity, and rural logistics	0%	6,7%	17,7%	**44,4%**	31,1%
15. Private investments	2,2%	9%	27%	**44,4%**	15,5%
16. Scientific publications	0%	2,2%	24,5%	**42,2%**	28,8%
17. Communication with customers & awareness campaigns	2,2%	13,3%	9%	**42%**	33%
18. Public-private partnerships	0%	9%	33,3%	**35,5%**	22%
19. Public opinions from the community	6,7%	4,4%	22,2%	**37,7%**	26,7%
20. Science knowledge (drone-related)	5%	13,3%	20%	**31%**	31%

The second question evaluates the importance of a particular source in fulfilling an end-user's specific need. All responses arranged in Table 38 by percentage are in the range of "very important" to "extremely important", as four of the identified sources in value flows (number 1, 2, 3 and 4) scored **5** or extremely important for fulfilling the specific need. The research-based evidence about the drone's efficiency in various activities in rural and isolated areas in Europe obtained from universities' research units specialising on agricultural studies scored equally **4** and **5.** 42% of the respondents assessed that source as very important and the other 42% marked it as extremely important. In the evaluation of the end-users, the research-based evidence seems to be a priority. Shared values and risks as well as commercial clients are considered very important by a large proportion of respondents – 64,4% and 57,7% respectively. Private investments from investors are also very important for 51% of the participants (**4** in number 9).

Table 38 Responses for each end-users' source of importance

Source fulfilling the need	1	2	3	4	5
1. Training of personnel from universities	0%	6,7%	13,3%	26,7%	**53,3%**
2. Knowledge on optimal, environmental, and safe UAVs operational usage from collaborating universities	0%	2,2%	11%	42,2%	**44,4%**
3. Skilled workforce from educators	0%	9%	9%	35,5%	**44,4%**
4. Research-based evidence of efficiency of drone usage in rural and isolated areas of Europe from universities	0%	2,2%	11,1%	42,2%	**42,2%**
5. Shared values and risks from the network	0%	4,4%	9%	**64,4%**	20%
6. Commercial clients from the network	0%	4,4%	13,3%	**57,7%**	22,2%
7. Science knowledge from network's stakeholders	0%	6,7%	24,4%	**57,7%**	9%
8. Collaborative activities and cost-sharing on projects from network's stakeholders	0%	2,2%	24,4%	**55,5%**	17,7%
9. Private investments from investors	2,2%	2,2%	17,7%	**51,1%**	24,4%

10. Working in a network and transferring know-how from the network	0%	2,2%	8,9%	**51%**	37,7%
11. Scientific publications from research units	0%	9%	13,3%	**51%**	26,7%
12. Public-private partnerships from Government	0%	4,4%	24,4%	**49%**	20%
13. Software development and algorithms from drone developers	0%	2,2%	9%	**48,8%**	37,7%
14. Science knowledge from companies' R&D units	0%	2,2%	15,5%	**48%**	33,3%
15. EU policy directives, regulations, and compliance from European Commission	0%	4,4%	22,2%	**44,4%**	26,7%
16. Access to new markets worldwide to increase agricultural production, biodiversity, and rural logistics from community	0%	9%	17,7%	**44,4%**	26,6%
17. Inspection and auditing from public administration	2,2%	9%	17,7%	**42,2%**	26,7%
18. Public opinions from the community	2,2%	9%	24,4%	**42%**	22,2%
19. Communication with customers & awareness campaigns from marketing & PR departments	2%	3%	22%	**40%**	33%
20. Access to new markets in Europe to increase the food production from community	0%	6,7%	26,6%	**40%**	26,6%
21. Science knowledge (drone-related) from universities	2,2%	2,2%	17,7%	**37,7%**	37,7%
22. EU R&D projects or collaborating with universities from EU programmes	0%	2,2%	22,2%	**37,7%**	35,5%
23. Inspections and auditing from local authorities	2,2%	4,4%	26,7%	**37,7%**	22,2%

There are a few comments left by the participants at the end of the survey. One comment evaluates the survey as successful as it covers in high level the basic requirements of deploying such systems. The other comment adds "feed and forage" as a new specific need particularly for the beef market as an end-user. It recommends an evaluation of the economic impact of "feed and forage" for the dairy market. This comment was submitted by the participant from Chile. Some comments add the need for discovering how the farmers without drone experience and knowledge might be able to apply drone services in their farms. The final comment recommends an efficiency evaluation and CBA (cost-benefit analysis) of the drone technology that will be introduced in the farms.

Overall, all specific 20 value flows identified in this end-user survey's list of assessed needs are deemed to be either "*its presence is needed*" (D) or "*essential*" (E). Similarly for the identified sources by the second question, which are considered "*very important"* (4) or "*extremely important"* (5).

5.2.2 Interviews notes

Together with the online surveys we conducted 20 short interviews in Spain, Greece, Lithuania, and France not only to get some more details about the drone operations, needs and interests of the European stakeholders, but also to use them as a way of validating the surveys' results. The interviews were conducted in the local language with representatives of our use cases' country organisations (see Table

39). To protect the collected data in accordance with the European GDPR legislation, it will be provided only a summary with relevant conclusions from the conversations.

Table 39 Representation of interviewees

Country per Use Case	Companies and Organisations
Spain (Catalonia)	AGT, Valls, CRAG, URV, DARP
Greece	Bayer Hellas, Elanco Hellas, K&N EFTHYMIADIS, Velos Rotors, Megafarm Gi Mas
France	Carmejane Farm, Jalogny Farm, Flying Eye, Idele, Livestock Farmers Association
Lithuania	National Paying Agency, Research Centre for Agriculture and Forestry, DroneA, Vytautas Magnus University Agriculture Academy, State Forest Services

Interviews from Spain

1. The **owner** of AGT – a private company owning several drones to use them for various small tasks – emphasised that the potential for drone businesses is a generational thing since the baby-boomers from the 1950s and 1960s were not up to the new technology. With the shift of farm holding to the younger generations, it would be easier to bring in the new techniques and methods as well as benefit from them.

In his opinion, people need more *drone awareness campaigns* that can explain the rules and regulations of the sector. Farmers do not know well what they are not allowed to do with a drone, or in which cases they need a licence from the aviation authority or the municipality, or even what type of drone they can self-pilot. The policy standpoints have never been explained and people get easily in trouble because of a lack of understanding of what is mandatory and what is not in an inhabited area. Some kind of "educational practices" need to be established for the farmers before entering the drone market. There is a need for more collaborative activities at a community level, even sharing the drone fleet if there is such a community organisation or local schools can contribute by providing more information about drones in their classes.

2. The **second** contributor represents the Centre for Research in Agricultural Genomics based at the campus of the largest university UAB in Bellaterra (Autonomous University of Barcelona). As a public consortium with a legal identity, it incorporates several independent research bodies that devote their work to cutting-edge research in molecular basis of genetic characters of interest of plants and farm animals, and in the applications of molecular approaches for breeding of species important for agriculture and food production. In case of their activities, in the opinion of this contributor, there is no need for a massive use of drones in farming or food production, because he doubts that drone services will improve energy efficiency of farming. His recommendation is for a case-by-case approach to be undertaken, such as in sustainable agriculture where farms are of a small scale and drones can be fitted easily to the needs.

In his opinion, the *science knowledge and publications* are of great importance, but the research centres should not focus only on basic research rather focus on applied scientific knowledge, so that they can cooperate with commercial companies to fund the research studies. Collaboration within the network must be there, but for instance, the Sony Computer Science Laboratory in Paris with high tech equipment, does not shape or participate in networks, it only produces reports and disseminates them. For any network to be efficient and successful, one needs to make sure that strong relationships among the individuals of various stakeholders are established and the communication is smooth. Solid personal relations are essential for any network, and it takes time to implement the "value network" model in the agricultural sector. Another point made, the interest toward farming can be created in kids by bringing them to the fields and showing them how plants and computers work together.

3. The **third** contributor is from Valls – a private robot company that can customise services for the purposes of their clients – who doesn't see the point of farmers buying their own drones, particularly because they do not have the *technical knowledge*. In his view, it is much easier for the farmers or vineyard owners to use external drone service providers for fixed services such as crop monitoring or drone spraying rather than investing in a full-scale modernisation of their processes. They will need forecasting models to justify the investment. And not all farmers will be willing to go to the university to get a technical degree either. Most farmers prefer to book an appointment with a service provider. It is worthwhile that a drone provider makes a demonstration of the suitable services in Spanish farms, and in this way the farmers can see what the benefits of this new technology are.

In addition, he expressed doubts that youngsters that may be attracted to the agricultural fields would be willing to do any official training, even courses from free educational platforms, because most of them learn things from the applications on their iPhones. They want to get the information quickly and easily from the phone. The generational gaps will disappear in the future since wi-fi is everywhere and information can be obtained even in the mountainy areas. No matter the place, youngsters will be able to learn and read on their smartphones, therefore, customisation of services is necessary.

4. The **fourth** contributor from URV – a public university in Tarragona – distinguishes between drones and airplanes by sharing that most of the educational materials in Spain do not make a difference, and it is a misconception. He recognises that university's courses need to distinguish drones from other machines and be based on *scientific knowledge*. There are different restrictions to flying a drone close to inhabited areas or far away. In his view, the civil drone applications should be presented to the students more like a flying camera that takes pictures from various angles, so that young people can see all the possibilities and get inspired without being burden with all technicalities. Moreover, he emphasises that there is no *sufficient informative content* about drone services and applications. Due to the absence of clear concepts and knowledge, people's perception of drones is more of spying, and thus a potential danger or an undesirable kit. Otherwise, drones are a very useful tool both in a combination with satellite services. His last point was about the local aviation authority office in Spain that gets blocked with all requests for flight permissions and drone companies wait for months to be able to plan the flight missions.

5. The **last** two contributors represent the Governmental department of Agriculture in Catalonia. The first one explained that in his field of management and funding, they embark on different projects not piloting but 'real' control projects. They have a supply of very high-resolution images of all of Catalonia annually and with that resolution, it is sufficient to decide whether to fund the project and whether drones would be a good control method. For the *control of financial assistance*, annually with the European Commission and with the "Joint Research Centre" attached to the "Advisory Commission" and the "Commission on technological issues" there are annual meetings of all Paying Agencies to comment on aspects of control of new technologies. In the past, the use of drones had a very high weight, but in recent years the weight of satellite image technologies increased and practically the use of drones in the field of aid management decreased. In fact, 100% of the controls are now being carried out with satellite images.

According to him there is still a role for drones to be played in our societies. Satellites have displaced the interest in drones in some areas, but the drone techniques evolve and progress. In spheres such as the revision of electrical lines, firefighting, or authorisation to detect hot zones, drones have a lot to contribute with and that in his experience in a sense of having alternative images is essential.
The second representative of the department adds the need for more *social campaigns* since there are general misunderstandings of drones. Several areas must be addressed, and the social acceptance of drones is one of them. Sometimes people do not talk about drones because of the relations to the military field, which is not part of the community. More reports need to be produced to provide the necessary basic knowledge. Social acceptance relates to the pool of accumulated knowledge in the society in his views.

Interviews from Greece

1. One of BAYER's fundamental principles as a supporter of farmers with solutions for a wide variety of crops, on which their actions are based is the protection of the environment. It is considered necessary to know how to use drones. For this purpose, *collaborating scientific bodies* like universities are a cradle of new technologies. Any potential use of drones must necessarily be based on *scientific data* and all actors play an important role in the production and accumulation of knowledge. In addition, specialised personnel (operators, agricultural advisors) must be certified. Training can be organised by companies (drone suppliers) who provide the basic know-how. Certification could be provided by agricultural institutions. In general, there should be a solid scientific foundation for all activities, including training.

Considering the data available for the Greek agriculture, fragmented statistics, the *application of digital agriculture methods and tools*, such as drones should be done collectively and not by each individual producer. In this respect, the use of digital farming should be carried out by certified companies and specialised personnel in the form of services to ensure the effectiveness of the method. At the same time, certified drone service companies should be in constant communication and cooperation with crop protection companies that are already developing digital tools for the safe and correct use of crop protection products. To transit to sustainable digital agriculture exchange of structured and officially documented data, and knowledge among all stakeholders involved is necessary.

2. The **second** contributor from Elanco Hellas S.A. – a distribution firm of innovative products for the agricultural sector – added that Greece is characterised by its rugged terrain, fragmented bunch, and a large percentage of surface water. It becomes clear that the use of drones as a plant protection tool will contribute to the safer use of plant protection products, reduction of spray volumes and reduction of water pollution. Some of the possible applications of drones in the Greek context are 1) decoy spraying against Bactrocera oleae; 2) cotton defoliation; and 3) weed control in rice.

3. The **third** contributor from Megafarm – an end-user – was very detailed about their needs and they do not collaborate with any other drone industry stakeholders, but only follow the new advancements of the research work of universities. He believed that more emphasis can be given to differing options, for instance, owning the equipment, or making everything in-the-house, or using external services. According to him, the identification of different needs varies depending on *crop types and cultivation systems*. Within the survey, only a basic distinguishment was made between conventional practices and organic systems, but the type and methods used are often much more variable than just that. An organic vineyard or winery for example, is a completely different system with different needs from a conventional arable farm. Moreover, there is a major gap in the absence of a proper farm machinery testing and certification public body in Greece, something that could have also benefited the domain of spraying UAVs. The interest in adopting novel UAV technologies is often limited by two factors: 1) the scale of the production unit, and 2) the unclear regulatory framework (which is often met with disapproval since plant protection applications are, for most cases, illegal).

4. The **fourth** contributor from K&N EFTHYMIADIS (crop protection industry) considers the fragmented data of the Greek agriculture as the reason for introducing the *application of digital agriculture methods and tools* such as drones, and they will quickly find fertile ground. The Greek farmers were among the first to use the drone as a tool. The reason is the large difference in cost (fuel, quantities of plant protection products (PPPs)) between conventional spraying methods and drones, since it is clear that the use of drones as a crop protection tool will contribute to safer use of PPPs and reduction of spray volumes.

His focus was on the *personnel training* as *essential*. From the point of view of the private sector, there are companies that will generally undertake user training for the drone applications in general. Drone manufacturers will be able to offer expertise in their specific models. It would be preferable not to limit personnel training to universities' courses, as there is a risk of degradation of the quality of training through possible client relationships. Nevertheless, the role of universities remains important in ensuring the rational use of drones as crop protection tools, and the involvement of drone manufacturers is also advisable. The last major point that he focused on was the legal framework, which is urgently needed. In the case of drones, there is a huge need to adapt PPPs for such use. It should be calculated that a

considerable amount of time is necessary to study and adapt the PPPs to the conditions and parameters of drone spraying and a corresponding amount of time to make the amendments to the regulations.

5. The **final** contributor from Velos Rotors – a drone manufacturer – in Greece emphasised the need of knowledge - *knowledge about optimal and safe spraying with the drone is essential* - it is important to know how to fly the drone, but also information about the use of chemicals. The companies that offer drones as a service will need scientific knowledge in the future. It is more difficult for the farmer, but easier for a company offering services to accumulate a pool of scientific evidence and knowledge. To operate they need to have the appropriate equipment and data. Farmers should be able to choose the right technical tools and suitable drone services. According to him, in the current environment where the global growth remains subdued and is expected to slow down to 2% in 2023[177], businesses can survive but farmers (end-users) need funding to reduce their costs, and then they might be able to consider the option of using drones as the business models offered are of great importance.

Interviews from France

1. The interviewees from France were briefly interviewed since monitoring of beef cattle and sheep flocks by drones is not widely introduced, and it was challenging for them to identify their needs or knowledge gaps. That's why the aim of **Idele** as a pioneer of this service is to first make several demonstrations and present the benefits of drone applications to livestock farmers, so that they can have a better understanding of the service. Demonstrations are a preferred means by Jalogny farm to raise *drone awareness* too.

2. For the farm holders and owners according to the Livestock Farmers Group, they dislike guidelines and reports and prefer to simply use the user opinion. They would rather learn on the job or ask their current employees to learn how to pilot a drone than attend training courses. Also, the educational system in France is very centralised and certain requirements must be fulfilled, which are not easily achievable by the farmers. Even feedback to training courses would not change the curriculum and educational innovation is rare.

3. For **Flying Eye**, the drone manufacturer, *knowledge about the optimal, environmental usage of UAVs is essential* and they would be open to develop specific training for some specialised use cases, which might give them a competitive edge to the existing services.

4. The Carmejane and Jalogny farms pointed out various challenges and barriers for introducing the usage of drones, the key ones are: 1) relatively high costs of operating drones, so public funding is mandatory in the case of France; 2) a lack of robust methodologies for livestock monitoring that are tailored to their specific needs, or certain functionalities of drones that are unavailable yet. Furthermore, several interviewees identify lack of knowledge and skilled workforce to develop methodologies, operate drones, or process the collected data within their organisation as an obstacle. Research organisations indicate their openness to both increasing competencies of their own staff or finding advisors to help them with the technology. For them, *collaboration* is the key to establishing a sustainable usage of drones in farming.

5. In terms of the local authority, one of them **Le Chaffaut-Saint-Jurson**, is very small and has no power to organise the airspace or any flight control. Their priority is to have all residents living together in good faith. It is essential for them to have the livestock farming in the village compatible with the rest of all local activities. In the area where sheep farmers look after their herds, they have dogs and frequent accidents happen between these dogs and hikers or bikers. Therefore, the village authority prefers to avoid any activities that might be a source of conflict. For both municipalities involved in the use case, *communication* is the key to preserve peace and calm in the territory.

[177] See more in: OECD Economic Outlook, Interim Report, September 2022

Interviews from Lithuania

All interviewees from Lithuania indicate that forest monitoring by using drones has already been employed. State bodies with major responsibilities to ensure forest health and implementation of relevant national and EU-level regulations related to forest management already use drones in fulfilling some of their assigned tasks. However, all stakeholders including those actively using drones, agreed that there is much potential for expanding the scope of drone usage in their respective organisations.

The needs expressed by the interviewees mainly corresponded to further expansion of tasks where drones could be employed to help get higher quality results and increase resource efficiency. As for the main barriers for further development of using drones for forest monitoring, different stakeholders pinpointed different challenges. Interviewees named relatively high costs of operating drones (as compared to alternatives such as using satellite data), lack of robust methodologies for forest monitoring that are tailored to their specific needs, or certain functionalities of drones that are unavailable yet. In addition, several stakeholders identified lack of competencies or skills to develop the methodologies, operate drones, or process the collected data within their organisation. For the latter challenge, the interviewed public sector organisations indicated they were open for both increasing competencies of their own staff or buying the services from external service providers.

1) National Paying Agency – identified needs / gaps:
    - The monitoring is not automated and not resource-efficient, the methods are relatively underdeveloped and could be upgraded using technologies that would improve both the quality and efficiency of the processes;
    - NPA perceives that services developed in ICAERUS could strengthen State Forest Service's technological readiness (e.g., GPS).
2) Lithuania Research Centre (RCAF) – identified needs / gaps:
    - Stakeholder collaboration is essential for forest monitoring implementation, especially in combining forestry research and technology innovation expertise;
    - RCAF mentioned that private businesses and technology developers could be the link between better collaboration with academia and governmental institutions;
    - By communicating with small private forest owners, they got some feedback that traditional inspection and monitoring methods are still cheaper than autonomous and digital solutions. But it may be the opposite for large forest owners.
3) DroneA – identified needs / gaps:
    - By bringing stakeholders together, DroneA aims to understand public and private needs;
    - One of the main gaps was a lack of knowledge and technology awareness among the public institutions (state agencies, municipalities);
    - The continuous use of drones raises the question of privacy, what data drones collect in public and private areas, and how the data is stored and disseminated;
    - The need for personal data policy implementation was emphasised by stakeholders.
4) VMU Agriculture Academy – identified needs / gaps:
    - Not only private businesses have a lack of knowledge and need research, but also governmental institutions;
    - Lack of innovative solutions, experts, and knowledge in the state departments;
    - It is essential to actively inform, encourage, collaborate, and find synergy between private business, academia and governmental institutions.
5) State Forest Service – identified needs / gaps:
    - Drone potential for forest inventory may be developed by combining remote sensing data and the LIDAR solution;
    - There is potential for drone usage in sanitary cutting, in assessment of diseases and pests, for spraying nurseries and seed plantations, and for individual tree spraying too;

- Need of drone usage for inspection of clear-cutting areas, new forest growing project and monitoring land-use changes.

5.2.3 Concluding remarks

The purpose of T1.1 surveys & interviews was to obtain the necessary information from the stakeholders to perform the stakeholders network analysis and describe the relations in a network. As such they provide the needed input in defining the networks and complement the background information collected by the use case leaders. From the two global surveys' results, the top 10 specific needs are:

I. Drone Stakeholders

1. EU R & D projects or collaborating with universities
2. Assessment of operational risks and treatment
3. Certification and legalisation of drone services
4. Training of personnel
5. Working in a network and transferrin know-how
6. EU policy directives, regulations, and compliance
7. Understanding regulatory processes and rules
8. Knowledge on optimal, environmental, and safe UAVs operational usage
9. Commercial clients
10. Access to new markets in Europe for drone applications

II. End-users

1. Training of personnel
2. EU R&D projects or collaborating with universities
3. Skilled workforce
4. EU policy directives, regulations, and compliance
5. Knowledge on optimal, environmental, and safe UAVs operational usage
6. Software development and algorithms
7. Shared values and risks
8. Access to new markets in Europe to increase food production
9. Collaborative activities and cost-sharing
10. Research-based evidence of efficiency of drone usage in rural and isolated areas of Europe

All interviewees make similar conclusions in recognising the *essentiality* of several specific needs such as:

1. Scientific and technical knowledge
2. Drone awareness campaigns with explanation of regulations
3. Social campaigns in communities with proper explanation of technology
4. Collaboration of stakeholders
5. Sufficient informative content
6. Scientific data and publications
7. Personnel training
8. Attracting younger personnel in agriculture
9. Synergy between private businesses, academia, and the public sector
10. Solid communication among stakeholders and institutions

However, it is noticeable the variations in specific needs from one use case to another, and the purposefully targeted interviews in the countries of our use cases (Spain, Greece, France and Lithuania) that present the current understanding and experienced challenges of involved stakeholders. While most of them focused on the necessity of drone technology applications and methods that can be utilised in the

agricultural, forestry and logistic sectors, some of them distinguished between the opportunities provided by the private or public sector. For instance, the Spanish and Lithuanian interviewees point out that from governmental perspective, the use of drones has been explored and satellite technology has become more relevant. However, from commercial perspective, drone usage has a great potential, and precision agriculture is only one example. On the other hand, the Greek stakeholders understand well the benefits of drone applications, which is justified by the fragmented nature of the Greek territory, and the private usage of drones is recommendable. There are more drone business applications that could be developed, and market segments explored, which will be briefly explored in T1.3 Comparative Analysis & Needs.

Another major difference identified in the taken notes from interviewees is the provision of knowledge or training of personnel. While some of them recognise the significant role of universities in the process of creation and accumulation of scientific and technological knowledge as well as the collaboration between universities and private businesses in the case of Greece and Lithuania, others express the opinions of learning on the job or utilising the wider opportunities provided by internet and smart phone applications in the case of France and Spain. Training of personnel is a common need among all stakeholders, but envisioned in different ways, which also depends on the age of participants.

Overall, all interviews from our use cases' countries proved to be successful and well accepted by stakeholders as well as they confirmed the significance of the obtained surveys' responses. The discussions provided not only insights of the participants' needs, interests and expectations, but also insights for the ICAERUS consortium to be further progressed. In addition, this exercise as a vital part of the stakeholder's analysis, identifying value flows as outputs – inputs and specific needs, gave us a better understanding of the local networks (described in §5.1) and drone business ecosystems in Europe.

Finally, the conducted surveys & interviews collected qualitative and quantitative components of the necessary information and while this chapter presents the qualitative stakeholder analysis and elaboration on the results, the next edition of D1.1 [M42] will demonstrate the precise differences and similarities in stakeholders needs, objectives and roles in a quantitative manner, which numeric results will refine the received background information and support the designed value flow maps in §5.1. These are still sub-tasks to be performed until 2025, and the conducted work in this D1.1 [M10] only marks the beginning of the assessment, which will allow us to categorise stakeholders in our UC networks and rank specific needs by intensity.

6. Conclusions

This document D1.1 *European Landscape of Drone Innovations and Technologies* provides a thorough review of all global information about the drone industry, markets, products, technology, and stakeholders. In addition, global survey was run and questionnaires, interviews feedback and the lists of assessed needs and sources are presented in chapter 5. The aim was to organise all information in four major consecutive chapters to present the results of conducted work under T1.1 *Understanding the Drone Market* and T1.2 *Stock-taking of Drone Technologies*, and further elaborate on definitions, concepts, innovative technologies, and the project's expectations. D1.1 builds upon the established methodology of WP1 that explores the internal business environment of the project's use cases and the stakeholders' landscape.

In general, from the overall analysis, the concluding remark is that local stakeholders do not seem to fully understand each other, although there is an accumulated pool of knowledge, they still need to work on the relationships, business dependencies, and collaborative activities to be able to deliver value-added services. In this respect, the business model and governance of the network are essential for its survival, especially when a technological change takes place and puts pressure on individual firms to adopt it. Our project is to address many different needs from many different stakeholders, globally and locally, and all of them in a very fragile and ever-changing business environment. Said that and as addressed by the use cases work, it is essential to include as much information and analyse it in a flexible rather than a rigid way. This will enable more stakeholders to access and assess themselves by the organised data in the ICAERUS platform as well as find interesting ideas that could be transferred into their own context.

In the end, for all UCs of ICAERUS project to increase the adoption and use of drones in agriculture and forestry, or logistic segments and take full advantage of drone technology, stakeholders should be properly informed, trained and fully collaborative. The following are suggested guidelines that could influence the adoption of agricultural drone applications in a network:

- Future drone applications should focus on the specificities of the different farming segments (e.g., arable farming, livestock, forest protection) or supply-chain segments ("last-mile" commercial drone usage or humanitarian aid deliveries) and their activities, considering specificities such as geography. They should also cover a wider range of activities and combine different technologies such as sensors, mobile apps, and robots as the performed literature review in T1.2 demonstrates (chapter 3).

- Agriculture plays an important role with higher GDP percentages in some EU-member states, and the active participation of public bodies, institutions in the development and diffusion of drone applications, drone innovators and end-users need to set out wider marketing awareness campaigns to inform the public and target the specific customer groups as the market research analysis illustrates (chapter 4).

- Professionals in digital technologies, agronomy, engineering, and others should collaborate with researchers, innovators, agricultural extension agents, strategists, and businesses to co-create specialised, easy-to-operate, and cost-effective drone applications, and the stakeholders network analysis provides numerous insights (chapter 5).

- Policy makers should launch initiatives and develop drone regulations and guidelines for awareness raising, education and training of all stakeholders. Agricultural extension agents or private training providers could play an important role in drone training.

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Annexes

Annex I: Sensor Costs

Payload name	Type	Inquiry	Cost (EUR)
Canon ELPH 520	Digital camera	Discontinued	300
Canon EOS 350D	Digital camera	Discontinued	569
Canon EOS 550D	Digital camera	Discontinued	479
Canon EOS 5D	Digital camera	Discontinued	1799
Canon EOS 5D Mark III	Digital camera	Website	1799
Canon EOS M	Digital camera	Discontinued	880
Canon S400	Digital camera	Discontinued	260
Canon S90	Digital camera	Discontinued	299
Canon IXUS127	Digital camera	Discontinued	128
Canon S100	Digital camera	Discontinued	400
Canon S110	Digital camera	Discontinued	400
Canon S110 NIR	Multispectral camera	Discontinued	400
Canon SD780is	Digital camera	Discontinued	225
Canon SX230	Digital camera	Discontinued	150
CSIRO Hovermap	LiDAR	Mailed	
Cubert UHD185	Hyperspectral camera	Mailed	
DJI Phantom 2	Digital camera	Discontinued	499
DJI Phantom 3	Digital camera	Discontinued	499
DJI Phantom 4	Digital camera	Website	1699
DuncanTech MS3100	Multispectral camera	Discontinued	
FLIR Lepton	Thermal camera	Mailed	
FLIR SC655	Thermal camera	Mailed	

Payload name	Type	Inquiry	Cost (EUR)
FLIR Tau640	Thermal camera	Website	8000
FLIR thermovision A40M	Thermal camera	Mailed	
GoPro Hero 3	Digital camera	Discontinued	399
GoPro Hero 4 Black	Digital camera	Discontinued	399
Headwall Micro Hyperspec VNIR	Hyperspectral camera	Mailed	
Headwall Nano Hyperspec	Hyperspectral camera	Mailed	
Leica ALS70	LiDAR	Mailed	
MAPIR Survey 1	Multispectral camera	Discontinued	
MicaSense RedEdge	Multispectral camera	Discontinued	
MicaSense RedEdge 3	Multispectral camera	Discontinued	
Miricle 307	Thermal camera	Discontinued	
Nikon A100	Digital camera	Discontinued	90
Nikon D7000	Digital camera	Discontinued	640
Olympus E-PM1	Digital camera	Discontinued	490
Panasonic Lumix GF1	Digital camera	Discontinued	499
Panasonic Lumix GX1	Digital camera	Discontinued	800
Panasonic Lumix LX3	Digital camera	Discontinued	409
Parrot Sequoia	Multispectral camera	Website	3840
Pentax A40	Digital camera	Discontinued	300
Ricoh GR3	Digital camera	Discontinued	899
Ricoh GXR A12	Digital camera	Discontinued	530
Rikola DT-0014	Hyperspectral camera	Discontinued	
Samsung Galaxy K-Zoom	Digital camera	Discontinued	430
Samsung NX500	Digital camera	Discontinued	799
Schott RG715 filter	Digital camera	Discontinued	

Payload name	Type	Inquiry	Cost (EUR)
SlantRange 3P	Multispectral camera	Discontinued	
Sony A6000	Digital camera	Website	650
Sony DSC QX100	Digital camera	Discontinued	500
Sony DSC RX100M3	Digital camera	Website	550
Sony DSC-F828	Digital camera	Website	1250
Sony DSC-WX220	Digital camera	Discontinued	250
Sony A5100	Digital camera	Discontinued	500
Sony NEX-5	Digital camera	Website	460
Sony NEX-7	Digital camera	Discontinued	1100
Tetracam ADC	Multispectral camera	Website	1000
Tetracam ADC-lite	Multispectral camera	Website	1000
Tetracam MCA-6	Multispectral camera	Website	15000
Ultracam-XP	Multispectral camera		
Wageningen UR Mapping System	Hyperspectral camera	One-off	
Workswell WIRIS 2	Thermal camera	Discontinued	
Zenmuse X5S	Digital camera	Website	1330
Zenmuse XT	Thermal camera	Discontinued	
Zenmuse X3	Digital camera	Discontinued	
Zoom H1 Handy Recorder	Sound recorder		
MAPIR Survey 3	Multispectral camera	Website	400
MAPIR Kernel2	Multispectral camera	Website	850
MicaSense RedEdge MX	Multispectral camera	Website	5500
MicaSense RedEdge P	Multispectral camera	Website	9999
MicaSense Altum PT	Multispectral camera	Website	19,699
Cubert Ultris X20	Hyperspectral camera	Mailed	45,000
Cubert Ultris X20 plus	Hyperspectral camera	Mailed	55,000

Payload name	Type	Inquiry	Cost (EUR)
Cubert Ultris 5	Hyperspectral camera	Mailed	15,000
Zenmuse L1	LiDAR	Website	13,750
Zenmuse P1	Digital camera	Website	6500
Zenmuse H20	Digital camera	Website	4750
Zenmuse H20T	Digital camera	Website	12,800
Zenmuse X7	Digital camera	Website	1809
Zenmuse H20N	Digital camera	Website	14,999
Workswell WIRIS Enterprise	Multispectral camera	Mailed	13,500
Workswell WIRIS PRO	Thermal camera	Mailed	12,000
Workswell WIRIS AGRO	Thermal camera	Mailed	12,000
Workswell GIS-320	Gas camera	Mailed	65,000
Emesent Hovermap ST	LiDAR	Mailed	57,000
Emesent Hovermap ST-X	LiDAR	Mailed	120,000
Headwall Nano HP	Hyperspectral camera	Mailed	
Headwall Micro 640	Hyperspectral camera	Mailed	

Annex II: Software Costs

Software packages	Type	Function	Cost (EUR)	Cost type
DJI GO	Flight Control	Flight control app for DJI drones	Included with UAV purchase: free app for smartphones	
MAVinci	Flight Planning		Requires MAVinci UAV: Part of the MAVinci UAV mapping ecosystem	
Mission Planner	Flight Planning	ArduPilot Open-source project for Autopiloting	Free and open source	FOSS
BAE SOCET GXP	Geo-Information Package	Remote Sensing and Photogrammetry all-inclusive package	Free demo available, contact BAE systems for price indication	Software as a Service
eCognition Developer	Geo-Information Package	Data Analysis	Requires valid maintance contract with Trimble. Free demo available upon request	Software as a Service
Harris Geospatial ENVI	Geo-Information Package		Contact L3Harris for a quote, website not working	Software as a Service
ERDAS Imagine	Geo-Information Package	Remote Sensing focused	Contact ERDAS fort a quote	Software as a Service
ESRI ArcGIS	Geo-Information Package		Contact ESRI For a quote	Software as a Service
ESRI ArcMap	Geo-Information Package		Discontinued	
GRASS	Geo-Information Package		Free and open source	FOSS
SAGA	Geo-Information Package		Free and open source	FOSS
QGIS	Geo-Information Package		Free and open source	FOSS
CSIRO Scyllarus	Hyperspectral pre-processing		Free for use: need Hyperspectral camera. Can be integrated into other softwares (Matlab)	Available upon request -> cite the original authors
Adobe Photoshop	Image editor	Labeling data	25,00 euro p/month for Photoshop only	Software as a Service
PixelWrench2	Multispectral pre-processing	Specific for TetraCAM products	Free for use: need for Tetracam camera	

Rese Apps PARGE	Image Rectification		Contact ReSe for license key	
CloudCompare	Open-Source 3D program	3D Point Cloud and mesh processing	Free and open source	FOSS
Leica Photogrammetry Suite	Photogrammetry package		Discontinued	
AgiSoft Photoscan Professional	Photogrammetry package		Discontinued: Metashape now	
AutoPano GIGA	Photogrammetry package	Aligning images for panoramic photo's		
DroneDeploy	Photogrammetry package			
Menci	Photogrammetry package			
AgiSoft Metashape	Photogrammetry package		180, - for standard, 3500,- for professional. Locked to node (system)	Software as a Service
MICMAC	Photogrammetry package		Free and open source	FOSS
Pix4Dfields	Photogrammetry package	For precision agricultural maps	95,84 euro/month	Software as a Service
Pix4Dreact	Photogrammetry package	For quick on-location maps	58,40 euro/month	Software as a Service
Pix4Dsurvey	Photogrammetry package	For extracting CAD data	116,67 euro/month	Software as a Service
Pix4Dmapper	Photogrammetry package	Main photogrammetry package	216,67 euro/month	Software as a Service
Pix4Dmatic	Photogrammetry package	Mapper + LiDAR support	250,00 euro/month	Software as a Service
Smart3DCapture	Photogrammetry package		Discontinued	
LASTools	Point cloud processing	Open-Source set of tools for Point cloud processing and visualization	Free and open source	FOSS
MATLAB	Programming Language	Engineering - simulation focus	860, - euro/year	Software as a Service

R	Programming Language	Data science	Free and open source	FOSS
Python	Programming Language	Data science, software development	Free and open source	FOSS
Workswell Core Player	Thermal processing		Free for use: need for Workswell camera	
CUVIS	Hyperspectral pre-processing		Free for use: need for Cubert camera	
PerClass	Hyperspectral pre-processing		Contact perClass for a quote, free demo available	Software as a Service

Annex III: Stakeholders Surveys

For the purposes of Chapter 5: **Use Cases' Stakeholders Network Analysis**, we have conducted surveys to assess each specific need of stakeholders. The online surveys were prepared in English and ran all in English on the project's website: *https://icaerus.eu/understanding-the-drone-market/*.

I. Drone Stakeholders Survey's List of specific needs

Evaluation of drone industry stakeholders needs ("Satisfaction/regret question")

Needs of drone stakeholders	A	B	C	D	E
1. Knowledge on optimal, environmental, and safe UAVs operational usage					
2. Science knowledge (drone-related)					
3. Certification and legalisation of drone services					
4. Assessment of operational risks and treatment actions					
5. Processing drone business activities					
6. Understanding regulatory processes and rules					
7. Components to manufacture drones					
8. Software development and algorithms					
9. Communication with customers					
10. Access to new markets in Europe for drone applications					
11. Access to new markets worldwide					
12. Collaborative activities and cost-sharing					
13. Shared values and risks					
14. Public-private partnerships					
15. Commercial clients					
16. Private investments					
17. EU R&D projects or collaborating with universities					

Needs of drone stakeholders	A	B	C	D	E
18. Working in a network and transferring know-how					
19. Scientific publications					
20. Training of personnel					
21. Inspections and auditing					
22. EU policy directives, regulations, and compliance					
23. Research-based evidence of efficiency of drone usage in rural and isolated areas of Europe					
24. Skilled workforce					

Evaluation of sources of importance to fulfil the needs of drone actors (“Importance of source question”)

Source fulfilling the need	1	2	3	4	5
1.Knowledge on optimal, environmental, and safe UAVs operational usage from collaborating universities					
2.Science knowledge (drone-related) from universities					
3.Science knowledge from network’s stakeholders					
4.Science knowledge from companies’ R & D units					
5.Certification and legalisation of drone services from local authority					
6.Certification and legalisation of drone services from NAA or CAA					
7.Assessment of operational risks and treatment actions from workforce					
8.Processing drone business activities from companies’ management					
9.Understanding regulatory processes and rules from NAA or CAA					
10.Components to manufacture drones from suppliers					

11.Software development and algorithms from drone developers					
12.Communication with customers from marketing and PR departments					
13.Access to new markets in Europe for drone applications from end-users					
14.Access to new markets worldwide from end-users					
15.Collaborative activities and cost-sharing on projects from network's stakeholders					
16.Shared values and risks from network					
17.Public-private partnerships from Government					
18.Commercial clients from network					
19.Private investments from investors					
20.EU R&D projects or collaborating with universities from EU programmes					
21.Working in a network and transferring know-how from network					
22.Scientific publications from Research units					
23.Training of personnel from universities					
24.Inspections and auditing from local authority					
25.Inspections and auditing from public bodies					
26.EU policy directives, regulations, and compliance from EU commission					
27.Research-based evidence of efficiency of drone usage in rural and isolated areas of Europe from collaborating universities					
28.Skilled workforce from educators					

II. Drone End-users Survey's List of specific needs

Evaluation of end-users' needs ("Satisfaction/regret question)

Needs of end-users	A	B	C	D	E
1.Knowledge on optimal, environmental, and safe UAVs operational usage					
2.Science knowledge (drone-related)					
3.Software development and algorithms					

4.Communication with customers & awareness campaigns					
5.Access to new markets in Europe to increase the food production					
6.Access to new markets worldwide to increase agricultural production, biodiversity, and rural logistics					
7.Collaborative activities and cost-sharing					
8.Shared values and risks					
9.Public-private partnerships					
10.Commercial clients					
11.Private investments					
12.EU R&D projects or collaborating with universities					
13.Working in a network and transferring know-how					
14.Scientific publications					
15.Training of personnel					
16.Inspections and auditing					
17.EU policy directives, regulations, and compliance					
18.Research-based evidence of efficiency of drone usage in rural and isolated areas of Europe					
19.Public opinions from the community					
20.Skilled workforce					

Evaluation of sources of importance to fulfil the needs (“Importance of source question”)

Source fulfilling the need	1	2	3	4	5
1.Knowledge on optimal, environmental, and safe UAVs operational usage from collaborating universities					
2.Science knowledge (drone-related) from universities					
3.Science knowledge from network’s stakeholders					
4.Science knowledge from companies’ R&D units					
5.Software development and algorithms from drone developers					

6.Communication with customers & awareness campaigns from marketing & PR departments					
7.Access to new markets in Europe to increase the food production from community					
8.Access to new markets worldwide to increase agricultural production, biodiversity, and rural logistics from community					
9.Collaborative activities and cost-sharing on projects from network's stakeholders					
10.Shared values and risks from the network					
11.Public-private partnerships from Government					
12.Commercial clients from the network					
13.Private investments from investors					
14.EU R&D projects or collaborating with universities from EU programmes					
15.Working in a network and transferring know-how from the network					
16.Scientific publications from research units					
17.Training of personnel from universities					
18.Inspections and auditing from local authorities					
19.Inspection and auditing from public administration					
20.EU policy directives, regulations, and compliance from European Commission					
21.Research-based evidence of efficiency of drone usage in rural and isolated areas of Europe from universities					
22.Public opinions from the community					
23.Skilled workforce from educators					

Annex IV: UC1 Stakeholders and Characteristics

Use Case: Crop Monitoring									
Stakeholder name	**Stakeholder group**	**Stakeholder definition**	**Role**	**Interests/Objectives**	**Needs**	**Costs structure**	**Revenue model**	**Outputs**	**Inputs**
Institute of Agrifood Research and Technology (IRTA)	*Academia*	IRTA promote research and technological development in the area of agri-food, facilitate the transfer of scientific advances and evaluate its own technological advances. Part of the Government of Catalonia and CERCA system. They seek and support coordination and collaboration between the public and private sectors.	They seek and support coordination and collaboration between the public and private sectors. Provide data	IRTA's mission is to contribute to modernising, improving, boosting competitiveness, and fostering sustainable development in the sectors of agriculture, food, agroforestry, aquaculture, and fishing.	1. Budgetary resources to reach their objectives and goals; 2. Data providers to fulfill one of its main functions: general traffic data provision; 3. Deep Knowledge of the traffic ecosystem in order to develop appropiate regulations;	Public funding model	IRTA revenue is public money coming from the Government of Catalonia (Law 04/2009)	1. Reports; 2. Data; 3. Decrees;	1. Science knowledge from research institutes; 2. Taxes/fees from public and commercial bodies; 3. Data from data providers; 4. Technology;
Departament d'Agricultura, Ramaderia, Pesca i Alimentació (DARP)	*Government Agency*	Regional department in Tarragona responsible for Agriculture, Forests and food.	Apply policy and laws. Direct and execute in the territorial scope the programs approved by the Department. Prepare the proposals for the annual plans and work programs of their units.	Successful policy and environmental assessment procedures of the plans and programs relating to agricultural, agro-industrial, forestry and agricultural infrastructure sectors.	1. Data; 2. Surveys; 3. Budgetary requirements; 4. Personnel for rural inspections;	Public funding model	DARP recieves public money recieved from the regional and national government of Catalonia.	1. Reports; 2. Data; 3. Decrees;	Surveys from canvasing, data and research institutes.
Centre for Research in Agricultural Genomics (CRAG)	*Academia*	Three institutions work together at the CRAG: the Spanish National Research Council (CSIC), the Institute of Agrifood Research and Technology (IRTA), the Autonomous University of Barcelona (UAB) and the University of Barcelona (UB).	Providing open data and research about crop health relating to phenotyping and crop monitoring	Improve understanding of crop health. Translate research results into benefits for society and industry and to train the next generation of plant and farm animal scientists.	1. Budgetery resources to implement their program; 2. Collaborative agreements with other institutes; 3. Field data;	Public funding model	CRAG revenue is public money coming from projects and from the UAB and UB universities.	1. Reports; 2. Data; 3. Decrees;	1. Research Data; 2. Field studies; 3. Surveys; and 4. Analytics;
UNIO de Paigesos Catalanes	*Agricultural Association*	The Catalan Farmers Union represents workers in all Catalan regions who are dedicated to agriculture, livestock or forestry defend the agricultural sector. 6,000 members, the majority union and most represented in the Catalonia.	Providing a forum and for debate, publicising and socialising policy and opportunity. Representing farmers.	Defend the agricultural sector in solidarity to improve living conditions and work.	1. Funding opportunities (budgetary constraints); 2. Modernised infrastructure; and 3. Modern dissemination system (marketing)	Membership fees cost modeling	Funded by membership fees, commercial sponsorship.	1. Legal actions; 2. Policy actions in support of decrees.	Surveys from canvasing, data and research institutes.
AGRAWDATA	*Software/Algorthm/Data Operators*	Catalan information systems company dedicated to agriculture geographic and GIS data provision, analysis and decision support systems for farmers.	Real-time Data about farms and advisers to farmers for crop and terrain analysis.	Become a leading certifier for agricultural data,	1. Broader community basis; 2. Further budgetary investments;	€460,000 investment funding generated	Subscription fees for SAAS	1. Data analytics; 2. Prediction models	1. Satelite and drone imigery; 2. Scientific knowledge
AGROXARXA	*Agricultural Association*	Offering farm analytics and surveying. Business management, engineering and financial services.	Paid services arm of UNIO de Paigesos, aimed at supporting farmers and land owners.	Developing service lines to help farmers obtain better prices and conditions for their land and businesses.	1. Improved infrastructure; 2. Competitive access to markets; and 3. Member-wide basis;	Subscription fees cost modeling	Paid services and subscription fees.	Reports, Data, Decrees	Surveys from canvasing, data and research institutes.
OPENVINO	*Software/Algorthm/Data Operators*	Vinyard Data analytics and agrigator, with software and platform infrastructures. Engaging with international networks and the vitivini industry.	Providing services for digitisation, tokenisation, and cryptocurrencies for vinyards.	Leader in self-certification network, their production as organic, carbon-neutral, and other attributes through BioDigital Cert™. Service providor.	1. Access to market; 2. Field deployments; 3. Network tools; 4. Policy integration;	Private cost modeling	Paid services and consultation Regulatory support for standards	1. Data; 2. Technology innovations and services; 3. Digital business models	1. Sensor data; 2. Field data; 3. Market analytics;
FUNDACIO LA PEDRERA	*Agricultural Association*	Largest land owner in Catalonia, a foundation and support network concerned with improved livelihoods, job creation, youth programs and conservation programs.	Coordinating multiple large scale transition programs including training on farms, vinyards and food security projects in Tarragona.	Improved vinyard management for biodiversity and social change.	1. Funding at European scale; 2. Technology solutions; 3. Institutional partners (investors)	Mixed private-public cost modeling	Management of Foundation funds, European Funding, National support funding.	1. Training (educational materials); 2. Improved farm management practices (science knowledge); 3. Conservation actions.	1. Land use Data; 2. Social surveys and statistical analysis data; 3. Reports
AEROCLUB REUS	*Software/Algorthm/Data Operators*	Leading certification and accreditation facilitator in the region with access to drones and aeronautical clubs, institutes and policy makers. Both school and network facilitator.	Bridging policy and on the ground takeup, consultation and network hub	Increased participation and markets in all sectors relating to drones and knowledge takeup.	1.Access to wider European level policy shifts; 2. Market analysis; 3. Inspired communities; 4. Funding; 5. Private investments	Private cost modeling	Subscriptions, Services and fees.	1. Training and knowledge transfer; 2. Coursework (educational materials) and 3. Recognised Certification	1.Knowledge infrastructure; 2. Policy requirements; 3. Personnel (coachers)
MAS MARTINET	*Farm*	Leading organic vinyard in the Priorat region, Known for innovative techniques and sustainable practises as well as cultivation on inclined land.	Use case target farm, with 120 hectares of viticulture production for varied species. Role as exemplar for comparative analysis in crop monitoring.	Improve production methodology by mitigating crop damage, improving organic and sustainability metrics. Gaining sales and access to markets.	1. Funding and investment opportunities; 2. Training and resources for modernisation; 3. Access to new markets	Private cost modeling	Sales of wine and products. Tourism and hosting services	Viticulture products and services	1. Biotic and environmental resources; 2. Labour force; 3. Investments; 4. Knowledge capital; 5. Assessment and market data;
CREAF	*Academia*	Catalan insitute and Centre for Research in Climate, Ecology and Agro Forestry. Connected to multiple data and analysis projects nationally and on the European scale. Conducting leading research in vinyard and crop analysis.	Leading research partner, frameworks and data provider. Service provider.	Improved organic Viticulture and crop yields, sales and access to Markets	1. Collaboration agreements; 2. Research funding and 3. Access to open data networks	Mixed private-public cost modeling	National, European and International research payments. Public and Private investments.	1. Research and Data; 2. Often Open access products	1. Field data; 2. Research documents (publications); 3. Knowledge and know-how;

INCANVI	*Academia*	Catalan institute of vine and wine, providing analytical and support services to the industry.	Offering grape analysis services. Supporting the 'Domicil of Origen' label in the region of catalonia. Linking to certification and offering opportunities to local businesses.	Funding opportunities through sponsorship and coorperate international branding.	1. Collaboration agreements; 2. Marketing notoriety; 3. Events and 4. Funding potentials towards a larger market;	Mixed private-public cost modeling	Public and private sponsorship, research and collaboration funding.	1. Publications; 2. Conferences; 3. Research analytics and policy guidelines for small scale & industrial partners;	1. Research data; 2. Field studies; 3. Surveys; 4. Analytics
Universitat Oberta de Catalunya (UOC)	*Academia / Educator / University*	Open University of Catalonia is one of the largest universities in catalonia. Working with multiples of concortia. In particular (Falset Marçà Agricultural Cooperative in conjunction with Centre Vinícola del Penedès) eg. Xavi Domènech	Our role is to provide support for the digitization process of agricultural enterprises. Specifically, this entails analysing the huge amount of data generated by their e-commerce platform	For companies to take much more calculated commercial decisions than they are generally taking. Personalizing their commercial structure and equipping it with rigorous methods and processes	1. Institutional structural programmes and investments; 2. Broader market outreach; and 3. Collaboration agreements;	Mixed private-public cost modeling	Subscriptions, public grant funding and european research funding as well as private sponsorship programs	1. Educational coursework; 2. Research (scientific knowledge)	1. Knowhow and technical expertise; 2. Funding; 3. Data and analytics
Mas Doix	*Farm*	Priorat became a famous DOC wine producing region through the simultaeneous efforts of five families in the 1980s. Together these famous wineries share a similar model and history.	Major wine producers in Priorat region.	Improvement and consolidation of viti/vini culture in the Camp de Tarragona region.	1. Funding and investment opportunities; 2. Training and resources for modernisation; 3. Access to new markets	Private cost modeling	1. Sales of wine and products. 2. Tourism and hosting services	1. Viticulture products and services; 2. Hosting events and 3. Tourism activities;	1. Blotic and environmental resources; 2. Labour force; 3. Private investments; 4. Knowledge capital; 5. Assessment and market data
Alvario Palacios	*Farm*								
Ferrer Bobet	*Farm*								
Clos Erasmus/Clos Terasses	*Farm*								
Clos Mogador	*Farm*								
Spanish Air Safety Agency (AESA)	*Government Agency*	The Spanish Aviation Authority is responsible for regional and national policy implementation and sets laws ocording to area and type, including drones.	AENA are concerned with coordinations and delivery of safe air traffic control and national air information systems. They inform and implement government and European policy.	Safe and efficient use of airspace	1. Collaboration agreements with multiple regional institutions; 2. Public and private funding and 3. Marketing outreach (promotional activities)	Mixed private-public cost modeling	Sponsorship and grant funding from Public and Private entities.	1. Coordination protocols; 2. Surveillance and monitoring programs; 3. Data analytics; 4. Press releases	1. Funding; 2. Technology; 3. Knowhow; 4. Personal data
The Agricultural Mechanisation Unit (UMA) at the UPC	*Academia / Educator / University*	Participant in optimised Pest Integrated Management to precisely detect and control plant diseases in perennial crops and open-field vegetables (OPTIMA)	Academic research centre working in particular with machine and agricultural innovation.	The Agricultural Machinery Unity (UMA) is a group of transfer and research that it has as central core the world of agricultural machinery, with great experience especially in the field of technology in phytosanitary products application.	1. Funding and investment opportunities; 2. Training and resources for modernisation; 3. Access to new markets	Mixed private-public cost modeling	Public and private sponsorship, research and collaboration funding.	1. Research (science knowledge) and Data; 2. Often Open access products; 3. Prototypes	1. Research Data; 2. Field studies; 3. Surveys and 4. Analytics
Municipality Falset	*Local Authority*	Falset is the central town and capital of the DOC wine region of Priorat. The Falset municipality government or 'council' are well known and deal with larger scale agriculture and community projects. As the five major wineries are situated in this 'comarc' the Falset 'Ayudament' has a direct conection to them and also to other political bodies and policy makers at different scales.	The 'Falset Ayudament' have a role in facilitating regional projects and conections in multi-actor and cross societal way. They will be crucial and necesary in any local delopyment and discussion of policy and its implementation. They should be relevitly accessible also to new ideas and to international dialogues. One of their aims is to support the local economy, bring notariety to the region and to improve welfare for its citizens.	1. To work activily together with the National aviation authority; 2. To engage stakeholders and community in drone awareness campaigns; 3. To liaise with emergency services and police to determine respective responsibilities for dealing with careless and criminal operators; 4. To ensure commercial operators are properly certified;	1. Collaborative activities with other local institutions; 2. Local funding from taxation; 3. Inspired community members; 4. Communication with the public and the commercial operators (drone operators); 5. Awareness campaigns to inform members of the public about drone activities;	Local budget	Local budget	1. Publications; 2. Conferences; 3. Research analytics and policy guidelines for small scale & industrial partners;	1. Funding (public local taxation) 2. Fees
Municipality of Villafranca	*Local Authority*	Villafranca is the central town and capital of the DOP wine region of Penedes. A historically renowed and ancient wine growing region. The Penedes municipality government or 'council' are well known and deal with larger scale agriculture and community projects. As the five major wineries are situated in this 'comarc' the Falset 'Ayudament' has a direct conection to them and also to other political bodies and policy makers at different scales.	The 'Villafranca Ayudament' have a role in facilitating regional projects and conections in multi-actor and cross societal way. They will be crucial and necesary in any local delopyment and discussion of policy and its implementation. They should be relevitly accessible also to new ideas and to international dialogues. One of their aims is to support the local economy, bring notariety to the region and to improve welfare for its citizens.	1. To work activily together with the National aviation authority; 2. To engage stakeholders and community in drone awareness campaigns; 3. To liaise with emergency services and police to determine respective responsibilities for dealing with careless and criminal operators; 4. To ensure commercial operators are properly certified;	1. Collaborative activities with other local institutions; 2. Local funding from taxation; 3. Inspired community members; 4. Communication with the public and the commercial operators (drone operators); 5. Awareness campaigns to inform members of the public about drone activities;	Local budget	Local budget	1. Publications; 2. Conferences; 3. Research analytics and policy guidelines for small scale & industrial partners;	1. Funding (public local taxation) 2. Fees
European Aviation Safety Agency (EASA)	*Regulator*	The European Union Aviation Safety Agency (EASA) is an agency of the European Union (EU) with responsibility for civil aviation safety. It carries out certification, regulation and standardisation and also performs investigation and monitoring. It collects and analyses safety data, drafts and advises on safety legislation and co-ordinates with	EASA is responsible for new type certificates and other design-related airworthiness approvals for aircraft, engines, propellers and parts. EASA works with the EU member states' civil aviation authorities (CAAs) but has taken over many of their functions in the interest of aviation standardisation across the EU and in the non-EU member Turkey. EASA is also responsible for assisting the	1. Ensure the highest common level of safety and environmental protection; 2. Single regulatory and certification process among the Member-states; 3. Facilitate the internal aviation single market and create a level playing field; 4. Work together with other international aviation authorities;	1. Financial resources; 2. General knowledge and information (technical, social, etc.); 3. Drafted rules and regulations to be implemented; 4. Prepared publications; 5. European aviation practices; 6. Community acceptance for safety and environmental protection	Agency budget model - 161 million euros, 2018	Budget structure: 1. Fees paid by the industry (64%); 2. EU Subsidy (23%); 3. Third country contributions (2%); 4. Earmarked funds (11%)	1. Drafted implementing rules; 2. Certified and approved products and organisations (EASA competences); 3. Provided support and oversight to Member-states in the fields where EASA has shared competence (Air Operations, Air Traffic	1. Funding; 2. Partners; 3. Aviation practices; 4. Specialised science-knowledge (airworthiness); 5. Informative content (social media)

Annex V: UC2 Stakeholders and Characteristics

Use Case: [Use Case Name]

Stakeholder	Stakeholder group	Stakeholder definition	Role	Interests/Objectives	Needs	Costs structure	Revenue model	Outputs	Inputs
Hellenic Crop	*Agricultural / Farm / Crop*	Association representing	Safe pedticide use, water protection, prevent	The impact of the Green Deal on	Research-based evidence of the		Membership Fees	Guidelines for the:	Expansion of the
CropLife Europe	*Crop protection Association*	CropLife Europe represents 22 company members and 32 national associations in the area of digital and precision farming, plant biotech innovation and biopesticides	Represents sustainable crop protection solutions: innovative and science-based, our solutions keep crops healthy and contribute to providing Europeans with a safe, affordable, healthy, and sustainable food supply.	Wants to be part of the solution that will help deliver the EU Green Deal and provide greater transparency around the products and substances that are placed on the market. We have therefore put forward commitments towards achieving those goals.	CropLife Europe members invest in precision applications, which enable delivery of the minimum amount of product, at the right place, at the right time.	Membership Cost Modelling	Membership Fees	Research-based knowledge on biopesticides applications, environmental safety and human health through novel spraying technologies.	New members to expand the network and the accumulated practices from the local farmers
Agricultural	*Academia / Research*	The oldest and largest	Research and education on all agricultural	Expand knowledge on the use,	1. Research-based evidence of the	Public budget	Public funding for teaching	1. Knowledge obtained from	1. Safe Use of crop
Poliagroktima Gi	*End users*	A large commercial organic	Potential demontration site and candidate	Integration of spraying drones in	1. Guidelines on the optimal use of	Private cost modelling	Private revenue stream	1. Evidences as cases on the	1. Knowledge obtained
Palivos Estate	*End users*	A large commercial vineyard in	Potential demontration site and candidate	Integration of spraying drones in	1. Guidelines on the optimal use of	Private cost modelling	Private revenue stream	1. Evidence on the efficiency of	1. Knowledge obtained
Ucandrone	*Drone Manufacturer*	A trading company of UAVs and	Research and services on UAVs	Ucandrone provides support to all	Knowledge on optimal and safe UAV	Private cost modelling	Private revenue stream	1. Economic evidence of the	1. Cross-exchange of
CAFFINI Sprayers Equipment	*Sprayers Equipment Manufacturer*	Caffini is specialised in the production of machines dedicated to Crops Protection since 1924	Spraying equipment manufacturer	Design and development of novel spraying components, research on optimal spraying configurations. Focus on topics like Agriculture 4.0 and Environmental Sustainability, by offering ecological and cutting-edge solutions.	1. Knowledge on optimal and safe UAV spraying; 2. Investments; 3. Skillful workforce; 4. Collaborations;	Private cost modelling	Private revenue stream	1. Economic evidence of the efficient use of spraying drones in the commercial sector; 2. Spraying equipment; 3. Spraying solutions; 4. Publications and reports; 5. Research outcomes;	1. Knowledge on the feasibility and efficiency of spraying UAVs as a support-tool for farmers; 2. Funding; 3. Workforce; 4. Informative content;
Agrotech (John Deere Hellas)	*Agricultural Machinery Manufacturer*	Agricultural machinery and parts manufacturer since 1984	Manufacturer and retailer of agricultural machinery, crop protection services provider	Obtain knowledge on the efficiency of spraying drones for various crops and cultivation systems.	1. Knowledge on optimal and safe UAV spraying; 2. Investments; 3. Manufacturing components; 4. Drone fleet; 5. Specialised knowledge;	Private cost modelling	Private revenue stream	1. Economic evidence of the efficient use of spraying drones in the commercial sector; 2. Machinery and components; 3. Innovative services - crop protection, drone spraying;	1. Knowledge on the feasibility and efficiency of spraying UAVs as a support-tool for farmers; 2. Funding; 3. Workforce; 4. Reports;
Hellenic Civil Aviation Authority (CAA)	*Regulators*	*National Aviation Authority (Transport Authority, Traffic Authority)*	Civil Service under the Ministry for Infrastructure,Transport and Networks, directed by its Governor and Deputy Governors. http://www.ypa.gr/en/	The organization, development and control of the country`s airtransport infrastructure and airspace regulation for both ocupied aircrafts and UAVs.	1. To understand the importance of spraying UAVs as a novel and green tool; 2. To obtain concrete evidences that will justify the need for an update on regulatory obsticles that prevent the widespread use of spraying UAV operations and services; 3. Meetings with representatives of the drone industry; 4. Reports with agricultural practices to feed their preparatory process of regulations with relevant background information;	Public budget	Public budget	An updated legisltative framework for regulating spraying drones that properly distinguishes their operation from traditional aerial sprayings.	1. Reports about evidence on the safety (environmental and public) of Spraying drones obtained through numerous field applications and detailed guidelines; 2. Regulatory processes; 3. Agricultural practices; 4. Skilled workforce; 5. Funding;
Peloponesse Regional Authority (zone of NEMEA)	*Region / Municipality*	*Local Authority / Municipality*	A number of local regulatory public bodies, including but not limited to agro-forestry and public safety.	Administrative support for establishing the use of spraying drones in the agricultural sector of the region; Assist in identifying local farmer needs for spraying drones, especially in high risk (e.g. inaccessible/mountainous) locations.	1. To understand the local needs for safe spraying operations; 2. To understand better the community needs of how spraying UAVs have potential in improving the quality of life of local farmers and rural economy; 3. To ensure the public drone awareness campaigns reach out the wider audiance; 4. To ensure commercial drone operators are properly certified; 5. To work together with Hellenic Civil Aviation Authority.	Local budget	Revenues from local taxation and fees	1.User feedback-based reports and evidence on benefits associated with the use of spraying drones in the local agricultural sector; 2. Support on regulatory and legisitative framework guidelines; 3. Rules and local standards for safety, noise and environment; 4. Licences for take-off and landing sites;	1. Report on the economic, environmental and social feasibility of spraying drones for local Peloponesse farmers; 2. Taxation revenues and fees; 3. Skilled workforce;
European Aviation Safety Agency	*Regulators*	The European Union Aviation Safety Agency (EASA) is an agency of the European Union (EU) with responsibility for civil	EASA is responsible for new type certificates and other design-related airworthiness approvals for aircraft, engines, propellers and parts. EASA works with the EU member	1. Ensure the highest common level of safety and environmental protection; 2. Single regulatory and certification process among	1. Financial resources; 2. General knowledge and information (technical, social, etc.); 3. Drafted rules and regulations to be implemented; 4.	Agency budget model - 161 million euros, 2018	Budget structure: 1. Fees paid by the industry (64%); 2. EU Subsidy (23%); 3. Third country contributions	Regulatory procedures, training subjects and standards, Standard Scenarios, PDRA and SORA procedures	Feedback on proposed regulatory framework application. Proposals for a better adapted
UPL HELLAS SA	*Crop protection industry*	UPL offers an integrated portfolio	Placement of plant protection products on	Development and supply a wide	Research-based evidence of the			Research-based knowledge on	Expansion of the
K&N EFTHYMIADIS	*Crop protection and*	K&N Efthymiadis is the largest	Placement of plant protection products on	The basic objective is to	Research-based evidence of the	Private cost modelling	Revenues from Sales of	1) Expertise on pesticide and	1) Research report from
BAYER HELLAS	*Crop protection industry*	Part of Bayer Global, a world-	Placement of plant protection products on	Development and supply a wide	Research-based evidence of the	Private budget including	Commercialization/	Research-based knowledge on	Expansion of the
SYNGENTA HELLAS	*Crop protection industry*	Syngenta is a global leader in the	Placement of plant protection products on	Development and supply a wide	Research-based evidence of the			Research-based knowledge on	Expansion of the
ELANCO HELLAS	*Crop protection industry*	ELANCO Hellas has been	Placement of plant protection products on	Development and supply a wide	Research-based evidence of the			Research-based knowledge on	Expansion of the

Annex VI: UC3 Stakeholders and Characteristics

Use Case: Livestock Monitoring									
Stakeholder name	Stakeholder group	Stakeholder definition	Role	Interests/Objectives	Needs	Costs structure	Revenue model	Outputs	Inputs
Idele	*Academia / Research*	The French Livestock Institute is a	Applied research on cattle, sheep, goats and	Expand knowledge on the use and	knowledge on the use and impact of	Public budget	Public budget	1) Promotion of drones as a low-	Use and evaluation of
Jalogny Farm	*End users & Academia /*	Experimental farm dedicated to	Perform research trials in "end user"	Assess the impact of using drones	knowledge on the use and impact of	National public funding	National public funding	Experience and knowledge	Methodology of digital
Carmejane Farm	*End users & Academia / Research Institute*	Experimental farm and training facility dedicated to sheep production and pastoralism	Perform research trials in "end user" conditions, produce references and guidelines	Assess the impact of using drones on sheep farms. Produce guidelines and references on drones uses	knowledge on the use and impact of drones on livestock farms : 1) as a monitoring tool, 2) as a multipurpose vehicle	National public support	National public support	Experience and knowledge obtainedin end-user type condition of using drone in sheep production in grassland system	Methodology of digital tools testing
Livestock producers groups	*End user*	Local farmers interest by our	Feedback their needs around drones uses.	Have guidelines for a better use of	To utilise drones or the services of	Membership fees	Fees stream	Providing feedback	End user experience with
Carmejane School	*Educators*	The pilot farm is also a training	Allow a link with the next generation of sheep	Arise awareness on the risks of	To receive feedback from the local	National funding	National funding	Vocational skills: Basically	
Flying eye	*Drone support service*	Flying eye is a company that train	Train pilots involved in the project, potential	To offer drone services and to	To receive components to be able to	Private cost model	Revenue stream from the	Manufactured drones; Offered	Knowledge on drones
french National aviation Authority	Government agencies &	National agency for flying safety	Provide national regulations (no direct	A safe use of UAVs and the	To receive feedback from the local	Governmental budget	Governmental budget	Policy documents and	Science knowledge
Jalogny	*Local authority*	Jalogny is a municipality located	Communicate with the population to have a	Having no conflicts between the	Working activity together with the	Local budget	Local budget		Public funding; taxation
Le Chaffaut-Saint-Jurson	*Local authority*	Le Chaffaut-Saint-Jurson is a	Communicate with the population to have a	Having no conflicts between the	Working activity together with the	Local budget	Local budget		Public funding; taxation
European Aviation Safety Agency	*Regulators*	The European Union Aviation	EASA is responsible for new type certificates	1. Ensure the highest common	1. Financial resources; 2. General	Agency budget model - 161	Budget structure: 1. Fees	1. Drafted implementing rules; 2.	1. Funding; 2. Partners;

Annex VII: UC4 Stakeholders and Characteristics

Use Case: Forestry and Biodiversity									
Stakeholder name	**Stakeholder group**	**Stakeholder definition**	**Role**	**Interests/Objectives**	**Needs**	**Costs structure**	**Revenue model**	**Outputs**	**Inputs**
State Food and Veterinary Services (SFVS)	Governmental institutions	The State Food and Veterinary Service (SFVS) develops and implements the Government's policy in food safety and quality as well as in animal health and welfare.	Responsible state body for the African swine fever monitoring and prevention.	A periodic and accurate monitoring date is required for governance and information.	The Periodic data, effectively, cost and user-friendly tools/solutions or services	Governmental institution	No profit organization	Knowledge and data about boars and African swine fever.	Data from data providers. Data analytics for their daily service Technology Future Plans Information Exchange Informative content (Social networks, Media)
Lithuania state forest services (SFS)		Lithuanian State Forest Service performs annual GHG accountings in Land Use, Land Use Change and Forestry (LULUCF) sector, and provides opinion about political decisions to the Ministry of Environment.	Areas of activity: Forest cadastre, Forest genetic resources, Forest use and statistics, Forest seeds and seedlings, Forest sanitary protection, Forestry maintenance, Forest management, National forest inventory.	A periodic and accurate monitoring date is required for governance and information.	The Periodic data, effectively, cost and user-friendly tools/solutions or services	Governmental institution	No profit organization	Knowledge and data about forest; Statistics and inventories; Recommendations	Data from data providers. Data analytics for their daily service Technology Future Plans Information Exchange Informative content (Social networks, Media)
National Paying Agency (NPA)		The National Paying Agency under the Ministry of Agriculture of the Republic of Lithuania is the only accredited institution managing the measures of support for agriculture, rural development and fisheries	Support for investments in development of forest areas and improvement of forest viability: Afforestation; Introducing prevention measures against possible forest fires, natural disasters and calamities and reimbursement of forest damage; Investments for increasing of forest ecosystems resilience and environmental value; Investments in forestry technologies	A periodic and accurate monitoring date is required for governance and information.	The Periodic data, effectively, cost and user-friendly tools/solutions or services	Governmental institution	No profit organization	Knowledge and data about forest	Data from data providers. Data analytics for their daily service Technology Future Plans Information Exchange Informative content (Social networks, Media)
Lithuania Forest and Land Owners Association (FOAL)	Private forest owners representative	Forest and Land Owners Association of Lithuania (FOAL) is the national organization representing interest of family forest owners. Mission of FOAL - to unite Lithuanian private forest owner and private forestry organizations into a self- sufficient association, which represents members of the association and protects their legitimate interest.	FOAL is actively engaged in the private forest policymaking process with The Parliament, The Government, The Ministry of Environment, which is responsible for implementation of forest policy in Lithuania, as well as the Ministry of Agriculture and National Paying Agency, which administers European Union support for rural development.	Individual assessment and monitoring is required.	Effectively, cost and user-friendly tools/solutions or services.	No profit organization	No profit organization	Knowledge and data about forest; Development of specific processes and practices	Data from data providers. Data analytics for their daily service Technology Future Plans Information Exchange Informative content (Social networks, Media)
SMEs	Technology developers/services providers	Drone equipment developers and resellers. Monitoring service providers	Forestry: Equipment for forest measurement and navigation from forest management data: For measuring and navigating forests based on forest management data; For in-kind parcel delineation; For navigation based on forest management data, nesting and nesting site recording; For solving precise geodetic tasks - cadastral surveys, restoration of boundary markers; They assess and record the effects of natural disasters (forest fires, windstorms).	The technological solution test bed	1. Science and technical knowledge; 2. Resources (budgetary, human, technical); 3. Interaction with end-users; 4. Collaboration with other stakeholders to design incentives to foster dissemination practices that can attract new users; 5. Drone aircraft;	Private companies costs	Based on service and product sales	1. Technology; 2. Equipment; 3. Drone and drone-related services; 4. Collected forestry measurements and data; 5. Analysed data for developing new technological innovation and solutions;	1. Acquired data; 2. Commercial funding; 3. Aviation and drone-related science knowledge; 4. Information exchange with other stakeholders and partners
Vytautas Magnus university (VMU)	Academia / Research Institute	Vytautas Magnus University is one of the most comprehensive higher education institutions in Lithuania and is falling between 3 percent of the most comprehensive universities in the world.	University researchers, acting proactively and following the latest innovation trends, work in the following research areas of agro-, forest- and aquatic ecosystems, impacts of climate change: precion agriculture, food technologies, climate change reduction solutions, research on various ecosystems, etc. Faculty of Informatics: provides with expertise in Artificial Intelligence, data analytics. Agriculture Academy: provides with expertise in Smart forestry and related bioeconomy value chains.	Vytautas Magnus University is forming the cradle of interdisciplinary innovations that offer breakthroughs and sustainable solutions. Both researchers and an extensive network of partners allow them to feel the real needs of the market and focus research and experimental development on long-term and adaptable results.	Piloting and data source for scientific publication	No profit organization	No profit organization	Science-related knowledge State-of-the-art decision support Analysed monitoring data Algorithms; Specialised skills; Technical methods; Skilled workforce to enter the labour market	Technology, open source code-base Future Plans Information Exchange Skilled workforce (Educators) Access to existing research programmes Informative content (Social networks, Media)
Lithuanian Research Centre for Agriculture and Forestry (RCAF)		The Lithuanian Research Centre for Agriculture and Forestry is a state research institute. The Centre's strategic objective is to conduct R&D in the fields of agronomy and forestry and the related fields of ecology and environmental sciences, biology, biophysics, botany and zoology	Research fields: Forest plants biology and modeling of silviculture systems for wood quality and stand productivity; Microbiology and plant pathology, toxicology of forest products and materials; Optimization and modeling of forest plant processing and product storage; Sustainability of forest ecosystems and climate change; Forestry systems; the social and economics problems of forestry, forest policy	Research topics: Forest Resources, Economics and Policy, Department of Forest Protection and Game Management.	Piloting and data source for scientific publication	No profit organization	No profit organization	Scientific data*Science-related knowledge State-of-the-art decision support Analysed monitoring data Algorithms	Technology, open source code-base Future Plans Information Exchange Skilled workforce (Educators) Access to existing research programmes Informative content (Social networks, Media)

Municipalities	Local Authority	The territorial administrative units of the Republic of Lithuania are counties and municipalities. The territory of the Republic of Lithuania currently comprises 10 counties and 60 munici-palities. The county is a higher administrative unit. It is formed from the territories of the municipalities characterized by common social, economic and ethno-cultural interests. Therefore, all district municipalities are interested in tree health, fire risk and wild boar monitoring. Especially: Molėtai, Švenčionys, Ignalina, Jonava, Vilkaviškis, Kazlų Rūda, Vilnius districts.	To monitor situation and informed citizens	Forest monitoring: Tree health monitoring Fire risk monitoring Wild boar monitoring	To work activily together with the National aviation authority; To engage stakeholders and community in drone awareness campaigns; To liaise with emergency services and police to determine respective responsibilities for dealing with careless and criminal operators; To ensure commercial operators are properly certified;	Local Budget	Local Budget	Publications; Rules and local standards for safety, noise and environment; Licences for take-off and landing sites; City-wide drone regulations and no-fly zones	1. Funding (public local taxation); 2. Fees
European Aviation Safety Agency	Regulators	Lithuanian National Aviation Authority -Civil Aviation Administration.	It carries out certification, regulation and standardisation, and also performs investigation and monitoring. It collects and analyses safety data, drafts and advises on safety legislation, and coordinates with similar international organisations. It is the European Union Regulatory body on civil aviation safety.	1. Ensure the highest common level of safety and environmental protection; 2. Single regulatory and certification process among the Member-states; 3. Facilitate the internal aviation single market and create a level playing field; 4. Work together with other international aviation authorities	Financial resources; General knowledge and information (technical, social, etc.); Drafted rules and regulations to be implemented; Prepared publications; European aviation practices; Community acceptance for safety and environmental protection	Agency Budget Model - 161 million euros in 2018	Budget structure: 1. Fees paid by the industry (64%); 2. EU Subsidy (23%); 3. Third country contributions (2%); 4. Earmarked funds (11%)	1. Drafted implementing rules; 2. Certified and approved products and organisations (EASA competences); 3. Provided support and oversight to Member-states in the fields where EASA has shared competence (Air Operations, Air Traffic Management, etc.); 4. Promotion	1. Funding; 2. Partners; 3. Aviation practices; 4. Specialised science-knowledge (airworthiness); 5. Informative content (social media)
Local school and associations	Educators	Lithuania local Schools and drone ecosystem developers	Teach children, produce digitally skilled community members and motivate them to learn and develop throughout their life. To represent experts across the aviation community, from civil air navigation service providers to civil airspace users, academia, and municipalities.	The new digital technologies,methods. See the practical assessment of the solutions. The partnership of the leading stakeholders interested in innovative drone solutions, research and development, performance and political processes to advance a drone ecosystem.	Financial resources; Inspired children and adolescents; General knowledge and information (technical, social); New digital and practical education material and sources;	No profit organization	No profit organization	New digitally skilled workforce. Positive impact on society by supporting research, innovation, safety and security.	1. Educational material; 2. Funding (public taxation); 3. Community; 4. Informative content (social media); 5. Membership

Annex VIII: UC5 Stakeholders and Characteristics

Use Case: Rural Logistics									
Stakeholder name	**Stakeholder group**	**Stakeholder definition**	**Role**	**Interests/Objectives**	**Needs**	**Costs structure**	**Revenue model**	**Outputs**	**Inputs**
SKAITECH	*Drone Operator*	A strartup company based in Albania Web: https://skaitech.al/	System Integrator and AI/IoT developer/service provider	Custom solutions for drones that help businesses save hazardous man-houRs and create value in operational benefits	1. Drone As A Service (drone fleet), 2. Swarms and Drone Fleet Management (business management processes); 3. Protocols; 4. Best practices; 5. Funding	Private cost modeling	Private revenue stream	1. Drone customization; 2. IoT	Centralised drone operational infrastracture for mission scheduling and monitoring
HAEMUS	*Drone Manufacturer*	Private owned company located in Bulgaria Web: https://www.unmannedvehicles.eu/	Design, Prototype and Manufacture UAV, UGV, USV, UUV, and ROV.	Complete solutuions for unmanned systems including both hardware and software	1. Business operations; 2. Mission planning; 3. Monitoring cloud-based software; 4. Private investments; 5. Specialised skills (highly educated workforce)	Private cost modeling	Private revenue stream	Custom drones with integrated payloads according to needs	1. Operations management software; 2. Programming and algorithms
SENSEFLY	*Drone Manufacturer*	Founded in 2009, senseFly, an AgEagle company, develops and produces a proprietary line of eBee-branded, high performance fixed wing drones for professional use. Web: https://www.sensefly.com	Design, Prototype and Manufacture high performance fixed wing drones for professional use	Complete solutuions for fixed wing drones including both hardware and software	1. Flight safety processes; 2. Data accuracy; 3. Drone swarm management system; 4. Mission planning and monitoring	Private cost modeling	Private revenue stream	1. Innovative services - fixed wing drone customization; 2. Developed mechanism for risk assesment	Centralised drone operational infrastracture for mission scheduling and monitoring
PIX4D	*Drone software developers*	Pix4D is a market leader in photogrammetry software technology. Web: https://www.pix4d.com/	Pix4D is a Swiss company which started in 2011 as a spinoff of the École Polytechnique Fédérale de Lausanne (EPFL) Computer Vision Lab in Switzerland.It develops a suite of software products that use photogrammetry and computer vision algorithms to transform DSLR, fisheye, RGB, thermal and multispectral images into 3D maps and 3D modeling. (https://en.wikipedia.org/wiki/Pix4D)	Pix4D suite of software products includes: Pix4Dmapper, Pix4Dfields, Pix4Dcloud, Pix4Dinspect, Pix4Dscan, Pix4Dreact, Pix4Dsurvey, Pix4Dcatch, Pix4Dmatic, Pix4Dcapture, and Pix4Dengine.	Real-time 3D mapping or correction of the existing geographical relief cartographic background via the protogrammetry technology	Private cost modeling	Private revenue stream	1. Innovative services - 3D maps; 2. 3D-modelling software	Photogrammetry field data, Pix4D sofware potentional bugs and suggestions in terms of functionality, usability and scalability of its software suite.
CONSORtIS	*Drone Operator*	Consortis is a Private company located in Thessaloniki, Greece that among others are drone operators Web. https://www.consortis.gr/	Consortis is a private company that undertakes both private and public projects offering geospatial. land development, environmental monitoring and transortation studies services. They operated drones mainly for photogrammetry surveys.	Photogrammetry surveying using drones	1. A system for multiple drone operations; 2. Centralized monitoring and activity logging; 3. Private investments; 4. Public engagements	Private cost modeling	Private revenue stream	1. Drone swarms (fleet) and 2. IoT (the system)	Centralised drone operational infrastracture for mission scheduling and monitoring
FLYEE	*Drone service providers*	Start-up company founded in July 2020 in Thessaloniki, Greece. Web: https://www.flyee.gr/	The main objective of the company is the provision of specialized services for the transport and distribution of products using Unmanned Aircraft Systems (UAVs / drones)	-Provision of specialized services for the transport and distribution of products using Unmanned Aircraft Systems (UAVs / drones), accompanied by an ad-hoc self-developed, innovative fleet management system with utilization and integration of state-of-the-art technologies (AI, IoT) and DaaS (Drone as a Service) business model principles. -Urban BVS (Beyond Visual Line of Sight) drone operations	1. Drone Operations; 2. Mission planning and monitoring cloud based software	Private cost modeling	Private revenue stream	1. Drone customization and 2. IoT (the system)	Centralised drone operational infrastracture for mission scheduling and monitoring
Network for the operational Support and Education of the volunteers' Associations in the field of Civil Protection against natural disasters - NSEA	*Users - Civil Protection*	Non profit organisation Web: https://dyopp.gr/	Operational Support and Education of the volunteers' Associations in the field of Civil Protection against natural disasters	Civil Protection and education against natural disasters, like forest fires, floods, earthquakes, extreme weather phenomena	1. Early warnings (mechanism) 2. Real time monitoring and observation (system) 3. Autonomous surveillance, detection and fast and coordinated response based on updated integrated contingency plans to threats against different types of infrastructures in order to support existing security measures, reduce the risk to human personnel and allowing for mitigation in locations that are hard to reach	Public budget	Public budget	Training in basic principles of prediction and response against natural disasters	Operations management software
SPH ENGINEERING	*Drone software developers*	SPH Engineering is a global provider of UAV software solutions, integration services, consulting and custom development to expand drone applications. Web: https://sph-engineering.com	SPH Engineering is a global provider of UAV software solutions, integration services, consulting and custom development to expand drone applications. Its innovations support UAVs of different manufacturers and advance drone technologies for surveying, data collection, and entertainment. Founded in 2013 in Latvia (EU), the company has a global customer and partner network in 150+ countries.	1. Mission planning and flight control software technology; 2. Airborne integrated systems with sensors from diverse manufacturers; 3. Technology to manage drone swarm flights; 4. Knowledge-based services to implement, integrate and develop technologies for the drone industry	1. Flight safety processes; 2. Data accuracy (checking mechanism); 3. Drone swarm management system	Private cost modeling	Private revenue stream	1. Knowledge-based services to implement, integrate and develop technologies for the drone industry.	1. Operations management software; 2. Sensors technologies and communication protocols; 3. Data collection and processing methodologies;

Hellenic Civil Aviation Authority (CAA)	*Hellenic Civil Aviation Authority (Transport Authority, Traffic Authority)*	The Hellenic Civil Aviation Authority (CAA) is a Civil Service under the Ministry for Infrastructure,Transport and Networks, directed by its Governor and Deputy Governors. Web: http://www.ypa.gr/en	CAA's mission is the organization, development and control of the country`s airtransport infrastructure, as well as the study an laying of proposals to the Minister of Infrastructure,Transport and Networks concerning the overall policy formulation in airtransport.	Handling and development of airtransport inside the country and abroad. Care of the development of international aviation relations and participation in International Organizations. Care for the organization of the Hellenic Air Space, the exercise of Air Traffic Control, the installation and operation of aeronautical telecommunictions and air navigation aids, as well as the provision of aeronautical information. Carring out and following the application of standards, regulations and requirements for aircraft exploitation and operation. Inspection of aircraft and Civil Aviation crew suitability and granting of the relevant certificates and licenses. Establishment and operation of the Hellenic airports and continuous care for their development and modernization. Formulation of airtransport legislation. Care for the general`s aviations development and the promotion of airsporting activities. Actions to	1. Air Traffic Control; 2. Navigation aids; 3. Data retreive in real time for provision of air traffic flow management (ATFM); 4. Flight safety processes;	Public budget	Public budget	Policy formulation (draftet documentation)	Data retreive in real time for provision of air traffic flow management (ATFM)
Médecins Sans Frontières (MSF) (Greek section)	*End users*	Médecins Sans Frontières (MSF) is an international, independent, medical humanitarian organisation that delivers emergency aid to people affected by armed conflict, epidemics, natural disasters and exclusion from healthcare. MSF offers assistance to people based on need, irrespective of race, religion, gender or political affiliation. Web: https://msf.gr, https://msf.gr/contact-us	MSF brings humanitarian medical assistance to victims of conflict, natural disasters, epidemics or healthcare exclusion. MSF offers basic healthcare, perform surgery, fight epidemics, rehabilitate and run hospitals and clinics, carry out vaccination campaigns, operate nutrition centres, and provide mental healthcare. MSF activities include the treatment of injuries and disease, maternal care and the provision of humanitarian aid. Where necessary, we set up sanitation systems, supply safe drinking water, and distribute relief to assist survival. In 2018, MSF had 446 projects in 71 countries in addition to search and rescue operations. -11,218,700 outpatient consultations -309,500 births assisted -2,396,200 patients treated for malaria -176,200 HIV patients on ARV treatment -74,200 patients admitted to malnutrition programmes -3,184 migrants and refugees rescued and assisted at sea	Médecins Sans Frontières (MSF) is an international, independent, medical humanitarian organisation that delivers emergency aid to people affected by armed conflict, epidemics, natural disasters and exclusion from healthcare. MSF offers assistance to people based on need, irrespective of race, religion, gender or political affiliation	While medical supplies can be delivered by traditional means, certain circumstances call for quick access to drugs, blood, and medical technology — a need drones could fulfil. [https://www.cbinsights.com/research/drone-impact-society-uav/]. Medications delivery in remote, difficult to reach, locations. 1. **Drone services to deliver medical stuff to isolated and rural regions**	Private cost modeling	More than 6.3 million individual donors around the world provide some 95 per cent of MSF funding	Invaluable know-how transfer through the organization's many years of experience and presence in more than 60 countries	1. Centralised drone operational infrastracture for mission scheduling and monitoring; 2. Details of the type, weight and other qualitative and quantitative characteristics of the transported cargo
Laboratory of Fluid Mechanics and Turbomachinery (LFMT) of the School of Mechanical Engineering of the Aristotle university of Thessaloniki	*Academia / Research Institute*	The Laboratory of Fluid Mechanics & Turbomachinery (LFMT) was established in 1985 and is part of the Energy Department of the School of Mechanical Engineering, Aristotle University of Thessaloniki. LFMT specializes in the aerodynamic layout design and development of UAVs, as well as the research on aero engines parts, utilizing both experimental and computational tools. Web: https://lfmt.gr	UAV design & performance, aerodynamics & stability, structural analysis, manufacturing drawings, flight control system, flight path optimization, data gathering and management software	The research activities of the LFMT cover a wide area in the field of aeronautical engineering, involving layout design, development and testing of fixed-wing Unmanned Aerial Vehicles (UAVs), aerodynamic, stability and performance analysis of fixed-wing UAVs and commercial airliner platforms, transitional flows, heat transfer and flow development in heat exchangers, flow development in turbine blades, active and passive flow control techniques, such as turbulence generators and Dielectric Barrier Discharge (DBD) plasma actuators, CFD modeling, development of turbulence models, innovative aero engine thermodynamic cycles, boundary layer ingestion (BLI) and noise control in aero engines, and hybrid electric architectures for UAVs and other aeronautical applications. During the last 3 years, LFMT focuses its research on innovative concepts, such as solar-powered UAVs, Vertical TakeOff and Landing (VTOL) platforms and the Blended-Wing-Body (BWB) configuration. Aside from aeronautical applications, other	1. Flight safety processes; 2. Data accuracy (checking mechanism); 3. Drone swarm management system; 4. Highly skilled workforce; 5. Funding; 6. Collaborations with universities and other public institutions;	Public budget	Public budget	1. Scientific research work and results; 2. Know how transfer via publications, workshops and conferences; 3. Specialised skills The scientific research work of the LFMT is published in top-rated International Journals in the fields of Aeronautics, Fluid Mechanics and Turbomachinery, such as the Aerospace Science and Technology, the International Journal of Heat and Fluid Flow, the Journal of Applied Thermal Engineering, the AIAA Journal, and the Journal of Fluid Mechanics.	1. Optimization of UAV system behaviour for autonomous operation in large Unmanned Aerial Vehicles; 2. Increment of drone's stability, flight range and payload capacity; 3. Data collection and processing methodologies (These are the inputs the Research Institute needs in order to operate? Where do they obtain them from? Which services do they use?)

Laboratory of Robotics and Automation (LRA) of Democritus University of Thrace	*Academia / Research Institute*	LRA has many years of experience in educational and research activities of automation, robotics, vision, and intelligent systems Web: https://robotics.pme.duth.gr/	Being part of the production and management engineering department, the laboratory of robotics and automation performs and promotes research in application problems that rise in the area of robotics for industrial and service applications, as well as industrial automation.	being part of the production and management engineering department, the laboratory of robotics and automation performs and promotes research in application problems that rise in the area of robotics for industrial and service applications, as well as industrial automation. Looking ahead towards the ongoing 4th industrial revolution the laboratory members utilize state of the art tools to expand the scientific and technological front in their research areas of expertise, which include robotics, artificial vision, intelligent systems and pattern recognition, and seeks ways to integrate them seamlessly with other Industry 4.0 technologies that include internet of things, cybersecurity, cloud computing, big data analytics, simulation, additive manufacturing and augmented reality. Visual SLAM Visual odometry Cognitive vision Semantic mapping Modular, self-configuring, plug-and-work systems Place recognition	1. A new generation perception and obstacle avoidance system; 2. Mid–air collisions avoidance; 3. Flight safety; 4. Highly skilled workforce; 5. Funding; 6. Collaboration with the university and other public institutions;	Public funding	Public funding	1. Scientific research work and results (science-related knowledge); 2. Know how transfer via books and journal publications, workshops and conferences; 3. Creating specialised skills;	1. Data collection and processing methodologies; 2. State-of-the-art sensors technologies and protocols; 3. Data for neural networks training (The same question as before - where do the Research Institute obtain these inputs from in order to operate?)
Municipality (name)	Local Authority			1. To work activily together with the National aviation authority; 2. To engage stakeholders and community in drone awareness campaigns; 3. To liaise with emergency services and police to determine respective responsibilities for dealing with careless and criminal operators; 4. To ensure commercial operators are	1. Collaborative activities with other local institutions; 2. Local funding from taxation; 3. Inspired community members; 4. Communication with the public and the commercial operators (drone operators); 5. Awareness campaigns to inform members of the public about drone activities;	Local budget	Revenues from local taxation and fees	Publications; Rules and local standards for safety, noise and environment; Licences for take-off and landing sites; City-wide drone regulations and no-fly zones	1. Funding (public taxation); 2. Fees
European Aviation Safety Agency	Regulators	The European Union Aviation Safety Agency (EASA) is an agency of the European Union (EU) with responsibility for civil aviation safety. It carries out certification, regulation and standardisation and also performs investigation and monitoring. It collects and analyses safety data, drafts and advises on safety legislation and co-ordinates with similar organisations in other parts of the world.	EASA is responsible for new type certificates and other design-related airworthiness approvals for aircraft, engines, propellers and parts. EASA works with the EU member states' civil aviation authorities (CAAs) but has taken over many of their functions in the interest of aviation standardisation across the EU and in the non-EU member Turkey. EASA is also responsible for assisting the European Commission in negotiating international harmonisation agreements with the "rest of the world" on behalf of the EU member states, and it concludes technical agreements at a working level directly with its counterparts around the world such as the US Federal Aviation Administration (FAA). EASA also sets policy for aeronautical repair stations (Part 145 organisations in Europe and the US, also known as Part 571 organisations in Canada) and issues repair station certificates for repair stations located outside the EU, which permit foreign repair stations to perform work that is acceptable to the EU on its aircraft). EASA has developed regulations for air operations, flight crew licensing and non-EU aircraft used in the EU, which applied since the required European legislation to expand the agency's remit entered into force. The legislation was published on 19 March 2008. EASA have had its scope enlarged to (as part of the new delegation in 2018) also cover	1. Ensure the highest common level of safety and environmental protection; 2. Single regulatory and certification process among the Member-states; 3. Facilitate the internal aviation single market and create a level playing field; 4. Work together with other international aviation authorities;	1. Financial resources; 2. General knowledge and information (technical, social, etc.); 3. Drafted rules and regulations to be implemented; 4. Prepared publications; 5. European aviation practices; 6. Community acceptance for safety and environmental protection	Agency budget model - 161 million euros, 2018	Budget structure: 1. Fees paid by the industry (64%); 2. EU Subsidy (23%); 3. Third country contributions (2%); 4. Earmarked funds (11%)	Regulatory procedures, training subjects and standards, Standard Scenarios, PDRA and SORA procedures	Feedback on proposed regulatory framework application. Proposals for a better adapted drone logistics regulatory framework
iDrones.gr	Specialised and social media	"Most Popular drone news portal in Greece www.idrones.gr"	Promote and communicatate techology, innovation and events happening around the world related to drone technology	New products, new ideas, new applications and every kind of drone related information can be promoted by the portal. Market influencer and lead creator	As journalists can cover drone logistics activities with articles, images and small video, so can interview pilots, companies and end-users be involved in the project	Private cost modeling	Private revenue stream	1. Publicity; 2. Promotion as a communication channel; 3. Media awareness campaigns for drone usage;	1. Any kind of content suitable to be published promoting all the ICAERUS activity; 2. Press releases, Inteviews, articles, images, video etc

Use Case: Rural Logistics										
Stakeholder name	Stakeholder group	Stakeholder definition	Role	Interests/Objectives	Needs	Costs structure	Revenue model	Outputs	Inputs	Direct
Civil Aviation Agency, North Macedonia	*Regulatory authorities*	National Regulatory Athority in North Macedonia (https://www.caa.gov.mk/en/)	Aviation authority of the Republic of North Macedonia and its organizational structure provides efficient and timely execution of the safety regulatory functions described in ICAO Annex 19 and Doc.9734 (Safety Oversight System) as well as the other functions related to security oversight, economic oversight, air traffic rights etc	To know the needs of the drone operators provding rural logistics services (regulatory framework to enable flights for these purposes)	1. To understand the processes of the services for rural logistics supported with UAV's; 2. To know the tools (type of drones, characteristics etc.) that will be used in the services delivery; 3. What are the current regulatory obsticles that present a bottleneck in the process of establishing this type of services;	Public budget	Public budget	1. Provisional legisitative framework for regulating drone operators working in the area of rural logistics	Report about needed regulatory inteventions which will allow legal approval for operators enabeling the development of the business in the area of rural logistics based on UAVs	TRUE
Makedonski Telekom AD, Skopje, North Macedonia	*Provider of Infrastructure*	Provider of 4G and 5G network (https://www.telekom.mk/)	Provider of key infrastructure enabling drone flights expecially long distance flights and flights with higher altitude	To understand the drone industry needs for serving rural logistics; To understand the specific needs (network infrastructure specifics) of the UAV based rural logistics;	1. To get in to the specifics of the market for UAV based rural logistics; 2. Potential size of the market in the context of their services; 3. Future perspetive of the development of this type of market or similar to that; What are the pontetial users and their bahaviour; 4. Market analysis and data support	Private cost structure	Private revenue stream	1. Potential new networks (4G and 5G) in uncovered georgaphical areas that need to be developed and installed to support the future rural logistics market based on UAVs; 2. Type and scale of other services needed to be deloped in order to support the future rural logistics market based on UAVs; 3. Proposals on how less atractive areas can be subsidized by the government	1. Reports on specific network requirments for supporting future rural logistics market based on UAVs as well 2. other specific requests of the main actors in this type of industry	TRUE
Univeristy of Goce Delcev, Faculty of Agriculure, Shtip, North Macedonia	*Universities/research institutes*	Provider of academic knowledge in Rural Development and Agriculture (https://www.ugd.edu.mk/index.php/en/)	Future provider of knowledge (academic subjects/tranings) in the area of using UAVs in rural development / rural logistics ;	To understand the drone industry needs for serving rural logistics; How this industry can contribute for rural development, improving rural life and rural economy. How rural logistics based on UAVs can overcome the challanges of poor infrastruture (expecially road) in rural areas; What are current challenges for implementation of drone solutions for rural logistics in rural areas.	1. To get an insight in the economy of the rural logistics based on UAVs; 2. To understand the technical and technological aspects of the drone industry and how this is correlated with rural economy and rural life; 3. To get knowledge about drones in general (from basics about the devices, about flying, and the implementation environment, needed resources)	Public budget	Public budget	1. Specific educational programs for modern perspectives of rural development - the role of drone technologies; 2. Scientific reseach in the area of the impact of drones on the rural development, rural economy and rural life; 3. Publications, books, articles; 4. Conferences	1. Report on the economy of the rural logistics based on UAVs; 2. Technical and technological aspects of the drone industry and correlation with improving rural economy and rural life; 3. Traning about drones in general, basics about the devices, about flying, and the implementation environment, needed resources; 4. Challenges for implementation of drone solutions for rural logistics in rural areas.	TRUE
Institute for Agriculture, Univeristy of Cyril and Methodius, Skopje, North Macedonia	*Universities/research institutes*	Key actor in conducting applicative science activities in Rural Development and Agriculture in North Macedonia (http://zeminst.ukim.edu.mk/)	Future provider of applicative knowledge in the area of using UAVs in rural development	To understand the drone industry needs for serving rural logistics; How this industry can contribute for rural development, improving rural life and rural economy	1. To get an insight in the economy of the rural logistics based on UAVs; 2. To urnderstand the technical and technological aspect of the drone industry and how this is correlated with rural economy and rural life; 3. To get knowledge about drones in general, from basics about the devices, about fliying, and the implementation environment; 4. Informative content;	Public budget	Public budget	1. Specific educational programs for modern perspectives of rural development - the role of drone technologies; 2. Developing applicative research areas to measure the impact (rural life, economy) of modern rural logistics supported with UAVs; 3. Research on modalities to overcome current chellanges in rural infrastructure with model of rural logistics supported with UAVs	1. Report on the economy of the rural logistics based on UAVs; 2. Technical and technological aspects of the drone industry and correlation with improving rural economy and rural life; 3. Traning about drones in general, basics about the devices, about fliying, and the implementation environment, needed resources; 4. Information about challenges for implementation of drone solutions in rural logistics and rural areas; 5. Skilled workforce; 6. Funding	
Municipality of Vevecani, North Macedonia	*Local Governement*	Important municipality in rural region in the South-West part of North Macedonia (https://vevcani.gov.mk/)	Future user of services from drone operators in function of delivering municipality's services (e.g. delivering important documents to local citizens); Assisting and providing administrational/local regulation support for establishing the rural logistics market; Providing reports in local needs for rural logistic supported with drones	To understand the drone industry needs for serving rural logistics; How this industry can contribute for rural development, improving rural life and rural economy;	1. Information about the ways to improve general access from distant and less accesible rural areas with logistic models based on UAVs in order to achieve safer and convinient life in these areas; 2. Reports on best cases from Europe; 3. Rural logistics practices; 4. Private investment to explore such opportunities; 5. Public funding; 6. Technical scientific knowledge;	Local budget	Local budget	1. Specific policy measures (financial support, regulations, digital networks) that will enable implemenation of rural logistics services model service different areas of rural life; 2. Rules and standards for safety, local noise and environment; 3. Collaborations with the community; 4. Drone awareness campaigns;	1. Reports on the economy of the rural logistics based on UAVs; 2. Analysis on the scope of services that can be delivered through a model of rural logistics based on UAVs; 3. Information about challenges for implementation of drone solutions for rural logistics in rural areas; 4. Real data and evidences from successful use cases;	TRUE
Municipality of Kavadarci, North Macedonia	*Local Governement*	Important municipality in rural region in the central part of North Macedonia (https://kavadarci.gov.mk/en/main-home-en/)	Future user of services from drone operators in function of delivering municipality's services (e.g. delivering important documents to local citizens); Assisting and providing administrational/local regulation support for establishing the rural logistics market; Providing reports in local needs for rural logistic supported with drones	To understand the drone industry needs for serving rural logistics; How this industry can contribute for rural development, improving rural life and rural economy;	1. Information about the ways to improve general access from distant and less accesible rural areas with logistic models based on UAVs in order to achieve safer and convinient life in these areas; 2. Reports on best cases from Europe; 3. Rural logistics practices; 4. Private investment to explore such opportunities; 5. Public funding; 6. Technical scientific knowledge;	Local budget	Local budget	1. Specific policy measures (financial support, regulations, digital networks) that will enable implemenation of rural logistics services model service different areas of rural life; 2. Rules and standards for safety, local noise and environment; 3. Collaborations with the community	1. Reports on the economy of the rural logistics based on UAVs; 2. Analysis on the scope of services that can be delivered through a model of rural logistics based on UAVs; 3. Information about challenges for implementation of drone solutions for rural logistics in rural areas;	

Municipality of Debarca, North Macedonia	*Local Governement*	Important municipality in rural region in the South-West part of North Macedonia (https://debrca.gov.mk/)	Future user of services from drone operators in function of delivering municipality's services (e.g. delivering important documents to local citizens); Assisting and providing administrational/local regulation support for establishing the rural logistics market; Providing reports in local needs for rural logistic supported with drones	To understand the drone industry needs for serving rural logistics; How this industry can contribute for rural development, improving rural life and rural economy;	1. Information about the ways to improve general access from distant and less accessible rural areas with logistic models based on UAVs in order to achieve safer and convinient life in these areas; 2. Reports on best cases from Europe; 3. Rural logistics practices; 4. Private investment to explore such opportunities; 5. Public funding; 6. Technical scientific knowledge;	Local budget	Local budget	1. Specific policy measures (financial support, regulations, digital networks) that will enable implemenation of rural logistics services model service different areas of rural life; 2. Rules and standards for safety, local noise and environment; 3. Collaborations with the community; 4. Licences for taking-off and landing sites;	1. Reports on the economy of the rural logistics based on UAVs; 2. Analysis on the scope of services that can be delivered through a model of rural logistics based on UAVs; 3. Information about challenges for implementation of drone solutions for rural logistics in rural areas; 4. Real data; 5. Skilled workforce; 6. Funding;	
Pharmacy 1 (the town of Struga)	*User / middleman*	Provider of medical products in the region of Struga (TBD)	Future user of services from drone operators in function of delivering light weight goods (health sector)	To understand how drone operation and processes can fit the model of delivery in the areas of their operation; What is the financial model of drones operation and processes in the context of the pharmacy business model; How the developed logistical model based on UAVs can improve their business model especially the delivery aspect	1. To improve their delivery model to less accessible areas of the market; 2. Drone fleet; 3. Public-private funding; 4. Skillful workforce to implement the business model; 5. Technical knowledge about drones and drone operations; 6. General knowledge (financial, economic, logistical);	Private cost structure	Private revenue stream	1. Improved delivery model of goods; 2. Access to wider market; 3. Final medical products offered	1. Traning of staff about drones in general, basics about the devices, about fliying, and the implementation environment; 2. Reporting on challenges for implementation of drone solutions for rural logistics in rural areas; 3. Financial elements of implementing drones in delivery of goods; 4. Technical specifications of the delivery process; 5. Determined investment model and required technical capacity	TRUE
Pharmaphy 2 (the town of Ohrid)	*User / middleman*	Provider of medical products in the region of Ohrid (TBD)	Future user of services from drone operators in function of delivering light weight goods (health sector)	To understand how drone operation and processes can fit the model of delivery in the areas of their operation; What is the financial model of drones operation and processes in the context of the pharmacy business model; How the developed logistical model based on UAVs can improve their business model especially the delivery aspect	1. To improve their delivery model to less accessible areas of the market; 2. Drone fleet; 3. Public-private funding; 4. Skillful workforce to implement the business model; 5. Technical knowledge about drones and drone operations; 6. General knowledge (financial, economic, logistical);	Private cost structure	Private revenue stream	1. Improved delivery model of goods; 2. Access to wider market; 3. Final medical products offered	1. Traning of staff about drones in general, basics about the devices, about fliying, and the implementation environment; 2. Reporting on challenges for implementation of drone solutions for rural logistics in rural areas; 3. Financial elements of implementing drones in delivery of goods; 4. Technical specifications of the delivery process; 5. Determined investment model and required technical capacity	
Pharmacy 3 (village of Peshtani)	*User / middleman*	Provider of medical products in the region of Peshtani (TBD)	Future user of services from drone operators in function of delivering light weight goods (health sector)	To understand how drone operation and processes can fit the model of delivery in the areas of their operation; What is the financial model of drones operation and processes in the context of the pharmacy business model; How the developed logistical model based on UAVs can improve their business model especially the delivery aspect	1. To improve their delivery model to less accessible areas of the market; 2. Drone fleet; 3. Public-private funding; 4. Skillful workforce to implement the business model; 5. Technical knowledge about drones and drone operations; 6. General knowledge (financial, economic, logistical);	Private cost structure	Private revenue stream	1. Improved delivery model of goods; 2. Access to wider market; 3. Final medical products offered	1. Traning of staff about drones in general, basics about the devices, about fliying, and the implementation environment; 2. Reporting on challenges for implementation of drone solutions for rural logistics in rural areas; 3. Financial elements of implementing drones in delivery of goods; 4. Technical specifications of the delivery process; 5. Determined investment model and required technical capacity	
Agricultural pharmacy (the town of Struga)	*User / middleman*	Provider of agricultural inputs (pesticides, seeds, fertilizers) in the region of Struga (TBD)	Future user of services from drone operators in function of delivering light weight goods, plant health, plant nutrition or agricultural operations in general	To understand how drone operation and processes can fit the model of delivery in the areas of their operation; What is the financial model of drones operation and processes in the context of the pharmacy business model; How the developed logistical model based on UAVs can improve their business model especially the delivery aspect	1. To improve their delivery model to less accessible areas of the market; 2. Drone services; 3. Public-private funding; 4. Skillful workforce to implement the business model; 5. Technical knowledge about drones and drone operations; 6. General knowledge (financial, economic, logistical); 7. Store space	Private cost structure	Private revenue stream	1. Improved delivery model of goods; 2. Access to wider market; 3. Final medical products offered	1. Traning of staff about drones in general, basics about the devices, about fliying, and the implementation environment; 2. Reporting on challenges for implementation of drone solutions for rural logistics in rural areas; 3. Financial elements of implementing drones in delivery of goods; 4. Technical specifications of the delivery process; 5. Determined investment model and required technical capacity	
Agricultural pharmacy (the village Kuklis, Strumica, North Macedonia)	*User / middleman*	One of the largest agricultural pharmacy in the South East of North Macedonia, Provider of agricultural inputs (pesticides, seeds, fertilizers) (no active web site)	Future user of services from drone operators in function of delivering light weight goods, plant health, plant nutrition or agricultural operations in general	To understand how drone operation and processes can fit the model of delivery in the areas of their operation; What is the financial model of drones operation and processes in the context of the pharmacy business model; How the developed logistical model based on UAVs can improve their business model especially the delivery aspect	1. To improve their delivery model to less accessible areas of the market; 2. Drone services; 3. Public-private funding; 4. Skillful workforce to implement the business model; 5. Technical knowledge about drones and drone operations; 6. General knowledge (financial, economic, logistical); 7. Store space	Private cost structure	Private revenue stream	1. Improved delivery model of goods; 2. Access to wider market; 3. Final medical products offered	1. Traning of staff about drones in general, basics about the devices, about fliying, and the implementation environment; 2. Reporting on challenges for implementation of drone solutions for rural logistics in rural areas; 3. Financial elements of implementing drones in delivery of goods; 4. Technical specifications of the delivery process; 5. Determined investment model and required technical capacity	TRUE

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