ICAERUS

D1.5: Drone Standards, Regulations and Risks

Version A

WP1: Drone Landscape Analysis

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[1] *Deliverable type R: Document, report; DEM: Demonstrator, pilot, prototype, plan designs; DEC: Websites, patents filing, press & media actions, videos, etc.; DATA: Data sets, microdata, etc; DMP: Data management plan; ETHICS: Deliverables related to ethics issues; SECURITY: Deliverables related to security issues; OTHER: Software, technical diagram, algorithms, models, etc. Dissemination level: PU – Public, fully open, e.g. web (Deliverables flagged as public will be automatically published in CORDIS project's page); SEN – Sensitive, limited under the conditions of the Grant Agreement; Classified R-UE/EU-R – EU RESTRICTED under the Commission Decision No2015/444; Classified C-UE/EU-C – EU CONFIDENTIAL under the Commission Decision No2015/444; Classified S-UE/EU-S – EU SECRET under the Commission Decision No2015/444*

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RP1 General Project Review – Revision

Expert opinion on deliverable/ Comment	Steps towards addressing it (Partner)
Revised Executive Summary	Added (NSWR)
First sentence in the introduction - reference	Reference added: Scott E.T., Stiles, P., Debata, P., "Managing new technology: the combination of model risk and enterprise risk management", Working Paper 01/2022, Cambridge Judge Business School Link: https://www.jbs.cam.ac.uk/wp-content/uploads/2022/01/wp2201.pdf (NSWR)
Chapter 3, 4, 5 - maybe some editing could be done?	Bits of editing provided
Chapter 2 is too extensive	To reduce the size of chapter 2 parts of the following sections were moved to Appendices: section 2.2.1 CAP Strategic Plans; section 2.2.3 Farm to Fork; section 2.2.4 EU Biodiversity; section 2.2.5; Shaping EU Digital future; section 2.2.7 Aerodromes and Ground Handling. This reduces the chapter with up to 7-8 pages. (NSWR)
Cross linkages with D3.1 and the PESTEL analysis	Cross linking provided in Chapter 3 *Use Cases' PESTEL and SWOT analyses* with D3.1 (GS)
ISO 16119 / Standard 242 Aerial spraying - how is this standard relevant for drones?	The aforementioned ISO, as indicated by its title, does in fact focus on terrestrial machinery and not UAVs. However, as there are currently very limited standardised procedures, even at an experimentational level, for UAV spraying, it is a common practice to "borrow" and adjust engineering principles and scientific methodologies from conventional machinery measurements and operational steps. In a similar fashion, UC2 uses ISO 22866:2005 (Equipment for crop protection - Methods for field measurement of spray drift), an extensively implemented standard by the international scientific community, and has adjusted the documented operations, such as measurement requirements for environmental monitoring during spraying for each experimental iteration to be considered valid, or the data/sample acquisition (deployment, collection and retrieval/analysis). (AUA, GS)
Relation between D3.5 and D1.5	In general, both D3.5 and D1.5 present different dimensions of the Use Cases. In D3.5 the focus is on two studies - Life Cycle Assessment (LCA) and Life Cycle Costing (LCC), and a Technology adoption study. Their aim is to explore the effects and the socio-economic impact of the new technology in all five cases. This D3.5 presents the technological dimension of the adoption process. D1.5 presents the business and market dimension of the development of our use cases, particularly in terms of the external factors that will influence the business environment and any further

	market penetration, especially when the use cases reach large market shares. PESTEL and SWOT analyses create a broader understanding of the surroundings and establish a good foundation for making better business decisions. The relation between both D3.5 and D1.5 is that they present what needs to be done when the use cases are at a testing or deployment stage (D3.5) and then at a "reach the market" stage (D1.5). (GS, NSWR)

Executive Summary

This deliverable D1.5 *Drone Standards, Regulations and Risks* constitutes the first report of T1.4 *Standards, Regulations and Risks* of Work Package 1 *Drone Landscape Analysis*, aiming at providing needed information about the regulations, legislation, safety rules and standards as well as risk assessment with a detailed focus on the European policy, such as the Common Agricultural Policy and legislative documentation, that shapes the EU regulatory framework of UAS operations along with their impact upon the business environment of the ICAERUS use cases (UCs). Essentially, the conducted work under T1.4 in the first year of the project's duration adds sizable value to the results obtained from the market research analysis and stakeholders network analysis performed in T1.1 *Understanding the Drone Market.* Therefore, both deliverables D1.1 and D1.5 submitted in "year 1" provide an accomplished comprehension of the European drone industry's landscape.

The report offers a general PESTEL analysis that is centred around the external factors influencing the drone activities in Europe and ensuring their growth, safety, and security. With this background, each of the ICAERUS use cases is analysed both in terms of specific PESTEL for the case, SWOT analysis which results are integrated into the outputs of the PESTEL framework, and an examination of the risks affecting the overall activity of each case. This analysis complements the work conducted in T3.1 *Use Case Plan* and relevant links are provided in the document. The ultimate goal is to create a proper risk management planning and mitigation strategies for the UC leaders not only for the WP3 demonstrations under T3.4 *Demonstration activities and End-user Evaluation* but also for the UC operations beyond the project itself.

The result of all these processes in T1.4 adds to the information initiated in T1.1 and T3.1, and establishes the details of all use cases:

- ✓ **UC1 on Crop monitoring**: a commercial case in the viticulture segment of the vineyard industry in Tarragona (Spain) that aims to demonstrate the capacity of drones in disease and plant stress identification as well as weed detection in vineyards.
- ✓ **UC2 on Drone spraying**: an experimental optimisation B2B case in the agricultural sector that aims to test and assess spraying configurations for optimal drone applications in the university's open-field conditions in Attica (Greece).
- ✓ **UC3 on Livestock monitoring**: an experimental case in the livestock farming segment of the agricultural industry in South France that aims to evaluate drone solutions on monitoring different grazing cattle and sheep systems in order to reduce the case's labour intensity.
- ✓ **UC4 on Forestry and biodiversity monitoring**: an experimental business case that aims to monitor ecosystems and assess biodiversity and wildlife population in the forest terrains of Lithuania. It evaluates the capacity of drones to manage or prevent the expansion of infectious diseases affecting both feral and domestic animals.
- ✓ **UC5 on Rural logistics**: a both B2B and B2C case in the aerial supply chain industry that designs and offers an automatic "drone delivery fleet management system" to operate three different types of drones for delivering various payload parcels along different routes in rural settlements (North Macedonia).

The specific objectives for this deliverable are to:

- Provide an improved understanding of the relevant business environment for UAVs operations;
- Review and analyse policies, regulations and standards related to the use cases' activities;
- Define the framework for risk assessment of all five use cases' activities.

Thus the document is structured in five sections that constitute the intricate parts of a comprehensive analysis. The first section makes a prelude to the described work in following chapters in the context of the WP1 methodology. The **section 2** brings the results of a general PESTEL analysis covering external factors – political, economic, social, technological, environmental and legal – and how they affect the performance and success of project's use cases when they reach the market. The external factors identified in this document as a significant influence over the drone activities are as follows:

1. Political – Common Agricultural Policy; The Green Deal; White papers – Shaping Europe's digital Future; From Farm to Fork; Biodiversity; Urban Mobility Package; Drone Strategy; Horizon Europe; Innovation and Capacity Building.
2. Economic – Economic growth; The Green Deal Industrial Plan; E-Commerce and greening business; Drones as multi-purpose vehicles; Community services.
3. Social – Eco Awareness; Safety; Digital connected society; Urbanisation and ageing population.
4. Technological – 5G and satellite connections; Big Data, Open data, Smartphone apps; Next generation of automation (AI); Internet of Things (IoT).
5. Environmental – Decarbonisation; European strategy for low emission mobility (UC5) and Carbon footprint of farmers (UC1, 2, 3).
6. Legal – EU regulations; ISO standards; Voluntary standards; Acceptable means of Compliance

Combined all these six factors can have a profound impact on risks and opportunities for the project's use cases as the analysis has revealed. The PESTEL framework creates a broader understanding of the surroundings and establishes a good foundation for making better business decisions during both market penetration periods or launching of new market strategies. **Sections 3** and **4** continue further with both the PESTEL and SWOT analyses in a more specific use-case level as well as the risk assessment task conducted by the UC leaders in the first year of the project's duration. The analysis of section 3 is based on three pillars:

- Definition of the UC – presents the business principles of each Use Case
- PESTEL analysis – this part complements the general PESTEL analysis in chapter 2 with the specifics of each use case. Separately, the focus is on the political, economic, social, technological, environmental, and legal factors in a great deal of attention regarding solely the business and policy environment of the UCs' countries of origin (Spain, France, Greece, Lithuania and North Macedonia).
- SWOT analysis – this part evaluates the strengths, weaknesses, opportunities, and threats of the case. It gives additional information to the already collected pool of knowledge (factors) from the PESTEL strategic framework.

The final **section 4** describes the risk assessment performed by all UC leaders, which involves an identification of all potential risks or hazards associated with the use of drones, and evaluating the likelihood or potential impact of such hazards.

Summarising all the outcomes of T1.4 *Standards, regulations and risks* and if all use cases are fully deployed, and commercially operative beyond the project's timeframe (from 2026 onwards), potential benefits for the European member states and regions include, but are not limited to:

- *Environmental* – decarbonising the European industry via zero-emissions services using clean electric and hydrogen fuel cell technology in the future.
- *Public health and safety* – delivering medical supplies, blood, goods in emergency cases, humanitarian aids quickly to and between places; and assessing crop yields or tree health in agriculture and forestry safely and efficiently.

- *Rural development and improved life-style in remote areas* – rural transportation of goods to villages where the access by car or van is restricted; supporting the local communities in building a better life for their families; and attracting younger families to move to the rural areas.
- *Data-driven industry* – aerial crop yield evaluation, aerial with ground image acquisition, user-friendly dashboards as a decision support system, meteorological IoT stations, GPS collars, etc.

The outputs of this report will be used in:

- Task 4.2 /WP4 “Online Training Course” – ICAERUS Academy
- Task 5.6/WP5 “Inclusive Business and Governance Models”
- Task 6.1/WP6 “ICAERUS Platform design and specifications”

to complete the basis for future developments of European drone innovations in agriculture and logistics.

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Abbreviations

AESA – Spanish Aviation Authority
AI – Artificial Intelligence
AMC – Acceptable Means of Compliance
ARC – Air Risk Class
ART21 – ART21 UAB (Lithuania)

ASD-STAN – AeroSpace and Defence industries Association of Europe
ASTM International – American Society for Testing and Materials (International Standards Organisation)
AUA – Agricultural University of Athens
B2B – Business to Business
B2C – Business to Customer
BVLOS – Beyond Visual Line of Sight
CAA – Civil Aviation Authority
CAGs – Collaborative Analysis Groups
CAP – Common Agricultural Policy
CAT A – Category A (open)
CAT B – Category B (specific)
CEN – European Committee for Standardisation
CENELEC – European Committee for Electrotechnical Standardisation
CILs – Class Identification Labels
CISP – Common Information Service Provider
ConOps – Concept of Operations
DAA – Detect and Avoid
DL – Deep Learning
DoW – Description of Work
DRI – Direct Remote Identification
DSM – Digital Single Market
EAFRD – European Agricultural Fund for Rural Development
EAGF – European Agricultural Guarantee Fund
EASA – EU Aviation Safety Agency (Cologne)
EC – European Commission
EIP – European Innovation Partnership
EP – European Parliament
EPAS – European Plan for Aviation Safety
ERRF – European Recovery and Resilience Facility
ESG – Environmental, Societal and Governance
ESO – European Standards Organisation
ETS – Emissions Trading System
ETSI – European Telecommunication Standards Institute
ETSO – European Technical Standard Order
EU – European Union
EUR – the Euro
EUROCAE – European Organisation for Civil Aviation Equipment
EUSCG – European UAS Standards Coordination Group
eVTOL – electric vertical take-off and landing
FAA – Federal Aviation Administration
FP7 – Framework Programme 7, 2007 – 2013
F2F – Farm-to-Fork Strategy
GALLO – Guidance for Authorisation for Low-level Operation
GATT – General Agreement on Tariffs and Trade
GDP – Gross Domestic Product
GFAA – German Federal Aviation Authority
GM – Guidance Materials
GPS – Global Positioning System
GRC – Ground Risk Class
GS – GeoSense
H2FC – Hydrogen Fuel Cell (Drones)
ICAERUS – Innovation and capacity-building in Agricultural Environment and Rural UAV Services

IDELE – Institut Del' Élevage (Paris)
IEEE – Institute of Electrical and Electronics Engineers
IoT – Internet of Things
ISB – Industry and Stakeholder Body
ISO – International Standards Organisation
JARUS – Joint Authorities for Rulemaking on Unmanned Systems
LiDAR – Light Detection and Ranging
LUC – Light UAS operator Certificate
MTOM – Maximum Take-off Mass
NAA – National Aviation Authority
NoAs – Network of Aviation Safety Analysts
NCAs – National Coordination Authorities
NPA – Notice of Proposed Amendment
OSOs – Operational Safety Objectives
PBR – Performance-based regulation
PDRA – Predefined Risk Assessment
PESTEL – Political, economic, social, technological, environmental, and legal factor analysis
PTS – Prototype Technical Specifications
REPowerEU – Renewable Energy Power (EU)
RGB colour camera – "Red, Green and Blue" primary colours of light in a camera
RIA – Research and Innovation Action
RPAS – Remotely Piloted Aircraft System
SAIL – Specific Assurance and Integrity levels
SDGs – Sustainable Development Goals
SME – Small and Medium Enterprise
SORA – Specific Operations Risk Assessment
SRM – Safety Risk Management
STS – Standard Scenarios
SWOT – Strengths, Weaknesses, Opportunities, and Threats
TMPR – Tactical Mitigation Performance Requirements
UAM – Urban Air Mobility
UAV – Unmanned Aerial Vehicle
UAS – Unmanned Aircraft System
UC – Use Case
UNEP – UN Environment Programme
U-RDP – UAS Standardisation Rolling Development Plan
USD – the US Dollar
USSP – U-space Service Provider
UTM – Urban Traffic Management or UAS Traffic Management
VLOS – Visual Line of Sight
WEF – World Economic Forum
WG – Working Group
WP – Work Package
WTO – World Trade Organisation

1. Introduction

The wider application of models for risk management in firms and corporations have brought into focus the introduction of an efficient mathematical function to ensure the development and validation of high-quality models across the whole organisation – eventually beyond risk itself (Scott et al., 2022). With automation and digitisation, more models are being integrated into business processes, exposing institutions to greater risk and consequent operational losses. In general, the value of sophisticated risk modelling extends beyond the satisfaction and compliance with the regulatory regimes. Effective modelling can improve a company's earnings through cost reduction, loss avoidance, and capital improvement. Cost reduction and loss avoidance come mainly from increased operational and process efficiency while capital improvement comes from the reduction of undue capital buffers. More complex models have been created with advanced-analytics techniques, such as machine learning, to achieve higher performance standards.

Governance, business models and standards are also part of the modelling infrastructure. The governance can be set up on different levels to define and maintain standards in the organisation. It can also define stakeholder roles, including skills, responsibilities and tasks (Motoyama et al., 2016). The business model may have a more diverse understanding as various approaches have been proposed. For instance, Morris et al (2005) presented an interactive framework that includes three specific decision-making levels – rules, proprietary and foundation – with respect to six basic "decision areas", namely factors related to services and products, the market, internal capabilities, the competitive strategy, economics, and the growth or exit strategy. Lindgren et al (2010) stated that some authors took a narrow focus (technological or financial), while others adopted a more general view of the business model understanding. Some have embedded corporate strategy in their business model while others left it out. Nevertheless, with all these foundational elements in place, specifically, governance rules, standards, business processes and models, companies and SMEs can then build their own risk management modelling and programmes to create transparency for senior management, operational departments, and stakeholders.

Furthermore, innovation, whether in products, services, models or processes, is crucial to firms' competitiveness. This is especially true for the rise of service innovation, as manufacturing and service companies are now looking together for new service ideas (Al-Debei et al., 2013). In 2022, the EU manufacturer Airbus teamed up with Munich Airport (a ground infrastructure operator) to establish "Air Mobility Initiative" in Bavaria and run a series of research projects to define the principles of advanced air mobility service in Europe and globally[2]. The producer – Apple Inc. – announced in June 2022 that it will offer a new "buy now pay later" payment service where customers can select the "Apple pay later" option and Goldman Sachs (the bank) will pay for their credit card purchase immediately[3]. With this new service, Apple Inc. will enter the payment solutions market traditionally served by commercial banks. Both examples demonstrate how widespread the service innovation is nowadays no matter the sector and how much more complex the risk management planning appears to have become. The complexity is a common characteristic of the drone service operations involved in all use cases of the ICAERUS project.

For the purposes of the presented document, this prelude to the described work under *T1.4 Standards, regulations, and risks* aims to brief the reader with the background information of our understanding of risk management and planning as an overall framework of the incorporated analyses. Each section of the deliverable exposes an aspect of this issue.

1.1 Objectives and Structure of the document

The aim of Work Package 1 (WP1) is to conduct a thorough analysis of the drone landscape in Europe by achieving the four specified objectives below:

[2] https://www.airbus.com/en/newsroom/press-releases/2022-06-airbus-and-munich-airport-international-expand-their-partnership-to

[3] https://www.npr.org/2023/03/30/1166970047/apple-rolls-out-apple-pay-later-a-buy-now-pay-later-service

1) **Map, engage and understand** the needs and requirements of relevant stakeholders in the field of drone innovation in Europe.

2) **Identify and categorise** drone platforms and built-in technological components.

3) **Conduct** a comparative analysis of stakeholders' needs and technological solutions for drones.

4) **Review and analysis** of standards, regulations and risks related to the use of drones.

As seen by the objectives, WP1 is divided into four tasks to delineate the principal operational framework for the deployment of five use cases as it conducted both substantial market research analysis and detailed stakeholders network analysis, and defined the European drone market landscape, including drone technology categories in the first two tasks – *T1.1 Understanding the Drone Market* and *T1.2 Stock-taking of Drone Technologies* during the first ten months of the project's duration. Moreover, the WP1 will also address the external factors such as standards, safety rules, procedures and regulations that have an essential role in the assessment of any business environment of drone operations and risk management and will therefore conduct the PESTEL and SWOT analyses in collaboration under *T1.4 Standards, Regulations and Risks*. ICAERUS has adopted the "application-oriented" approach at a proposal level to explore the multi-purpose application potential of drones in agricultural production, forestry, livestock monitoring and rural logistics. Thus, for the purposes of the project and its embedded approach, 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, and 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.

These are the five industrial use cases from the Description of Work that have been proposed for consideration, representing various market segments of the agricultural and logistics industry, and in this deliverable D1.5 *Drone Standards, Regulations and Risks* they will be extensively explored in terms of the objectives that T1.4 aims to achieve:

UC1: Crop monitoring Use Case (Spain) – assessed as a B2B case in the viticulture sector;

UC2: Drone spraying Use Case (Greece) – assessed as a B2B case in the agricultural sector;

UC3: Livestock monitoring Use Case (France) – assessed as a B2B case in the livestock farming sector;

UC4: Forestry and biodiversity Use Case (Lithuania) – assessed as a B2B case in the forestry sector;

UC5: Rural logistics Use Case (Greece & North Macedonia) – assessed as a B2B & B2C case in the rural logistic sector.

Before proceeding with the more detailed analysis of T1.4, which focus is on the external factors that may affect the business environment of any of the project's use cases as well as the risk management, Fig. 1 presents the general methodological approach of the package, based on eight steps covered by all tasks:

Figure 1 Methodological Approach of WP1

The main goal of this T1.4 to be achieved is based on the last step 8 of the described methodology in Fig.1. It studies the regulatory framework and conducts risk assessment of the drone operations involved in the use cases. For this purpose, it analyses existing standards, safety rules and European regulations that support the potential for rapid growth in this sector and ensures drone operations are safe, secure, and environmentally friendly. It pays attention to the major EU policy documents that shape the directions towards which the EU economy is heading and takes into consideration the national legislation and regulations of the Member states involved. Risk assessment and management has been a crucial part of the performed work in this task by engaging the UCs leaders and stakeholders in the identification and assessment of the relevant risks. All this considerable work has been done in the first year of the project as the knowledge gathered will be utilised by later WPs such as “Business and Governance Models”, “ICAERUS Academy and Platform” as exhibited in Fig.2:

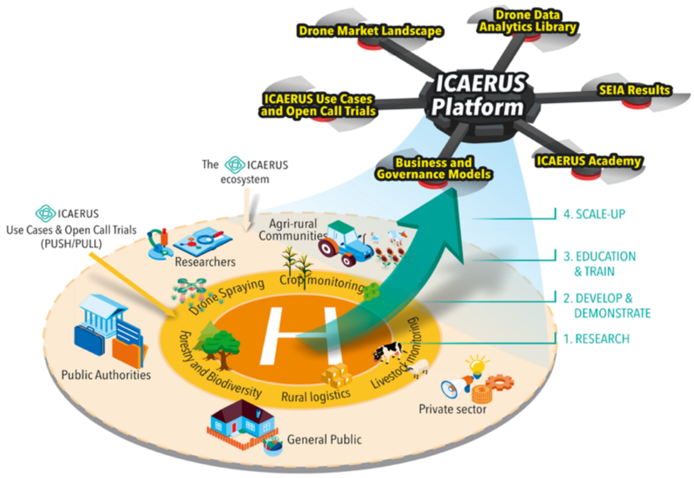

Figure 2 ICAERUS Ecosystem

The structure of this document is built on four major chapters, which includes a general PESTEL analysis to present all European political, economic, social, technological, environmental, and legal factors that play a significant role in the risk management planning, which is complemented with a more narrowly defined PESTEL and SWOT analyses associated with the business drone operations of any ICAERUS use case. This work is backed by contributions from T3.1, and WP3 in general. The last chapter 4 adds the risk identification and assessment of the drone operations by following the established methodology of the European Aviation Safety Agency (EASA).

2. General PESTEL analysis

PEST is an acronym for Political, Economic, Social and Technological factors that can be presented in a strategic framework to be used by senior management and boards in strategic planning and enterprise risk management. The PEST Analysis is a business measurement tool used to assess the market by determining how these external factors affect the performance and success of a business situation. It is commonly used by consultants to help their clients develop innovative product and market initiatives as well as within the financial community. Key points and conclusions from this analysis can be incorporated into other industry and firm-level frameworks such as SWOT analysis[4] or Porter's 5 competitive forces[5].

2.1 Review and analysis of external factors

The traditional PEST analysis will be extended to PESTEL, considering the Environmental and Legal factors of the drone market. Since the scope of all use cases is located within Europe, this section reviews and analyses the external factors of the drone business focusing on the European business, policy, and regulatory environment. Broadly speaking, Fig. 3 presents all factors that will be taken into consideration in the strategic planning and risk management of all project's use cases:

1. Political factors – those driven by government actions and policies.
2. Economic factors – those related to the macroeconomy and tend to be financial in nature.
3. Social factors – tend to be more qualitative, referring to major shifts in the society.
4. Technological factors – those that relate to the rapid changes of technology, and how they impact a company or an industry.
5. Environmental factors – those that relate to the physical environment and can present material risks and opportunities to the organisation.
6. Legal factors – those that emerge from changes to the regulatory environment, which affects certain industries or individual businesses.

PESTEL Analysis of ICAERUS Strategic and Risk management framework	
Political ● Common Agricultural Policy; The Green Deal ● White papers – Shaping Europe's digital Future; From Farm to Fork; Biodiversity ● Urban Mobility Package; Drone Strategy ● Horizon Europe: Innovations and Capacity building	**Economic** ● Economic growth ● The Green Deal industrial plan ● E-commerce and Greening business ● Drones as multi-purpose vehicle ● Community services
Social ● Urbanisation ● Safety ● Digital connected society ● Eco Awareness ● Ageing population	**Technological** ● 5G and satellite connections ● Big data, Open data ● Smart phone apps ● Next generation of automation (AI) ● Internet of Things (IoT)
Environmental ● European Strategy for low emission mobility (UC5)	**Legal** ● EU Regulations

[4] SWOT – strength, weakness, opportunity, threat – is a structured planning method that assesses these four elements in an organisation, project, or business. It involves defining the goal of the organisation or project and identifying the internal and external factors that are favourable or unfavourable to achieving that goal (Fred R. D., "Strategic Management: concepts and cases", 13th Edition, Pearson Education, Inc., 2011)

[5] Porter's five competitive forces – competition, suppliers, customers, threat of substitution, threat of new entry.

● Decarbonisation ● Carbon footprint of farmers (UC1, 2, 3)	● ISO standards, Voluntary standards ● Acceptable Means of Compliance

Figure 3 General PESTEL Analysis

Combined all these six factors can have a profound impact on risks and opportunities for the project's use cases. It is of necessity that all UC leaders recognise them and attempt to consider them in the risk assessment tools. Usually, companies conduct a PESTEL analysis first before incorporating new strategies into the business. It creates a broader understanding of the surroundings and establishes a good foundation for making better decisions. All external factors are explained in detail below associated with the drone business operations of the UCs.

2.1.1 Political factors

Politics plays a significant role in business and free markets are balanced with national and international systems of rules and procedures. In this section the attention will be given to policy actions originated by the European Commission (EC), European Parliament (EP) and the Council. From this perspective the **European Green Deal** is a comprehensive plan introduced by the EC in 2019 to make the European Union's economy sustainable and carbon-neutral by 2050. The EU aims to achieve this through a range of initiatives and policy proposals that will reduce greenhouse gas emissions, promote sustainable growth, and protect biodiversity. It supports the transformation of the EU into a fair and prosperous society with a modern and competitive economy.

One of the core principles of the Green Deal is the digitalisation of the economy, which includes the drone sector to help with the transition to a climate neutral economy by 2050. To guide these developments of the unmanned aircraft systems in Europe, the new **Drone Strategy 2.0** was announced at the end of 2022, which comes as a result of the intention to shape a comprehensive EU policy for the civil use of remotely piloted aircrafts. This strategy together with the **EU Plan for Aviation Safety**, 2022 – 2026, aim to foster further developments of the drone ecosystem in Europe by supporting member states' implementation of common operations[6].

Previously, in 2013, the EC created and published the **Urban Mobility Package** to reinforce the support of European cities for tackling urban mobility challenges by strengthening actions towards sustainable urban mobility and encouraging national governments to make better coordinated action[7]. These measures led to the development of the first drone strategy in 2014[8].

Now Drone Strategy 2.0 issued in November 2022 with actions until 2030 builds a new foundation in the drone regulation framework upgrading the basics of Drone Strategy 1.0. The goal is to create a European drone ecosystem and a market for drone services that depends on the successful implementation of the already adopted regulation. It covers a wide range of topics such as:

- The facilitation of professional drone operations
- A regulatory framework for urban air mobility
- Scalability and financing of drone industry[9]

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[6] https://www.easa.europa.eu/en/document-library/general-publications/european-plan-aviation-safety-2022-2026

[7] EC Urban Mobility Package 2013, https://ec.europa.eu/transport/themes/urban/urban_mobility/ump_en

[8] See Drone Strategy 1.0; Aviation – EC is taking the European drone sector to new heights (2017) https://ec.europa.eu/commission/presscorner/detail/es/IP_17_1605

[9] See more in: The European Investment Bank guide to finance for drone projects (2022) https://www.eib.org/attachments/publications/eib_guide_to_finance_for_drone_projects_en.pdf

- Promotion of civil-military cooperation
- Counter-drone systems, and cybersecurity

From 2021 onwards, the new research and innovation programme **Horizon Europe** (2021-2027) reflects the European policy priorities of the Green Deal, digitalisation and decarbonisation of the economy and contributes to finding solutions with calls that are centred on the developments of low carbon technologies and smart systems in many industries such as agriculture and forestry, livestock farming, transportation or Intelligent Transport Systems, aviation and logistics. In support of this programme, there are many national and local initiatives provided as collaborative and social innovation activities.

On a sectoral level, in terms of the use of new drone technology, one of the most relevant policy areas to the UCs is the EU's **Common Agricultural Policy** (CAP). The CAP is a set of policies and regulations aimed at promoting sustainable agriculture and rural development in the EU. It provides funding for a range of initiatives, including the use of new technologies in agriculture. Although the CAP already includes sections for new technologies, it has been instrumental in driving the adoption of new drone applications in the agriculture. While it is not the same as the CAP, some of the goals of the Green Deal and the **Farm to Fork** (F2F) Strategy are aligned with the benefits of UAVs. For example, using drones for crop monitoring can help reduce the use of pesticides and fertilisers, leading to more sustainable agriculture.

2.1.2 Economic factors

From **macroeconomics perspective**, economic policies continue to support recovery from the COVID pandemic, accompanied by structural reforms to improve the efficiency of labour and product markets and increase growth potential under inflationary pressure all over the world. EU’s long-term budget coupled with Next Generation EU mechanism provided a total of 2.018 trillion in current prices to rebuild a post-COVID19 Europe.

Early and decisive action to reduce GHG emissions through predictable policies such as tax reforms, public investment programmes or research and development measures could help support short-term growth and improve the longer-term outlook.

In the past, the Council of the European Union published broad guidelines for the economic policies of the Member states and the EU stating:

“Delivering a strong energy Union should ensure affordability, secure and sustainable energy for businesses and households. A cost-effective implementation of the 2030 climate and energy framework and transition to a competitive, resource efficient low carbon economy should be pursued, including through both demand and supply side reforms, while promoting green jobs, green technologies, and innovative solutions”[10].

Over the last decade the European Union and its member states together provided a number of measures and support to the green transitioning of the economy. Since 2015, the EU have provided more than 170 billion euros per year in energy subsidies. In 2020, the European Recovery and Resilience Facility (ERRF)[11] committed about 525 billion euros of new investments, of which 40% were directed at climate and energy transition. In addition, local governments also supported this transition as part of the Green Deal through various national schemes. All these programmes were entangled with different initiatives such as the free trade mechanism and technological innovations.

[10] EU recommendations on board guidelines for the economic policies of the Member states and of the European Union, https://ec.europa.eu/europe2020/pdf/eu2020_20151407_economic_policies_pdf

[11] See more: https://commission.europa.eu/business-economy-euro/economic-recovery/recovery-and-resilience-facility_en

Furthermore, in January 2023, the Green Deal Industrial Plan was presented by the Commission to the Council to enable the EU member states to support their industries via loosening the State aid rules and enabling tax credits by individual states[12]. The Plan builds on previous initiatives and relies on the strengths of the single market, ongoing efforts under the EU Green Deal and REPowerEU[13].

It is based on four pillars:

- A predictable and simplified regulatory environment
- Speeding up access to finance
- Enhancing skills
- And open trade for resilient supply chain

This plan aims to support the competitiveness of the EU and continue leading on the path to climate neutrality by 2050.

As it is expected, because of the green transition (more green markets and businesses), between 35% - 40% of all jobs could be affected, which means that developing the skills needed for quality jobs will be a priority of the European Commission and the industrial plan. This leads to the next initiative to establish Net-Zero Industry Academies to roll-out up-skilling and re-skilling programmes. The aim is also to protect the single market from unfair trade in the clean tech sector and to use instruments to ensure that foreign subsidies do not distort internal competition.

On the other side, from an **industry perspective** or at a microeconomics level, the ICAERUS project focuses on drones as a multi-purpose vehicle that can achieve optimisation of resources and reduction of carbon emissions from agricultural activities as the various use cases demonstrate the economic and environmental impact. The economic impact of drone technology is significant as estimated that the global drone market will reach $43 billion by 2024. The use of drones in various industries has also led to *greater efficiency, lower costs, and increased safety*.

Finally, drone business models as a major business innovation are worth of discussion in this part of the deliverable. For smaller UAS, factors such as *pricing, customer base and regulations* may influence their economic viability. For larger UAS, *the scale* is of great importance. For instance, future air taxi service could be viable only in highly dense areas and could still cost up to $1,900 per trip[14]. Moreover, for this service to be competitive against the automotive sector, UAS taxis will have to fly with a high speed. The profit margins seem to be slim, and for safety reasons business models are tremendously susceptible to regulation. The protection of citizens is of course very important for policy-makers, but business models should also allow for the company's growth.

Summing it up, in later WPs of ICAERUS, the economic impact from these multi-purpose applications will be assessed in a great deal of detail, however, the explanation of the industry's economic factors such as *resource optimisation, increased productivity and efficiency, data-driven solutions* influence the business decisions of various data-demanding economic sectors nowadays.

2.1.3 Social factors

Social factors are also known as demographic factors, focusing on buying behaviour or customer needs that can affect the value of a product or service. The identified factors in this section relate strongly to the communities and potential customers of the UCs' operations.

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[12] https://ec.europa.eu/commission/presscorner/detail/en/ip_23_510

[13] REPowerEU – affordable, secure and sustainable energy for Europe, https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/repowereu-affordable-secure-and-sustainable-energy-europe_en

[14] WEF, Global Technology Governance Report 2021

- Eco-awareness

The eco-movement is a political and social movement that promotes goals such as environmental protection, sustainability, non-violence, and social justice, and has been observed all over the world. There are signs that eco-consciousness and green consumption are really catching on in Europe. The "best global brands" survey recently found that consumer interest in environmentally friendly products continues to grow and spans all categories: from personal care, food, and household products to automotive, energy and technology products[15]. For the first time in 2022, the survey incorporated quantitative environmental, societal and governance (ESG) data into their methodology to measure the real implications of global brand companies' leadership.

- Safety

Safety is an important social factor that influences the regulations in the European Union. As it is discussed in later sections, the majority of operational standards, rules, and regulations for UAS operations are driven by the most significant concern of public authorities, which is the protection of their citizens.

- Drone awareness

The communities need more drone awareness campaigns to understand the civilian benefits of UAS operations near their neighbourhoods without any fears of spying toolkits around. The perception of drones in the European society has some military connotation, which sometimes holds back the business and commercial activities, especially in cases where the local communities have to reach an agreement.

- Urbanisation

This is a well understood social phenomenon from the last century together with the other factor – ageing population. In 2007, and for the first time in the history, more than half of the world population lived in cities. By 2050, the percentage is expected to increase to 70% according to the UN Environment Programme[16] (UNEP). Cities need to meet the shared climate and sustainable development goals, including strengthening the food-supply-chain to offer a liveable and just future for its citizens as well as healthcare for the elderly.

2.1.4 Technological factors

Technological innovation contributes to a growing demand of new digital services (Yonatany, 2017). Digital technologies are one of the strongest drivers of this demand (Quah, 2002), allowing the exchange of data or messages between various actors, and thus make it possible to match demand and supply in real-time.

The civil aviation industry has a robust system of **air traffic management** that organises flight directions and provides safety measures for travellers and members of the public. This is an important technological factor that is less developed for UAS flights. To overcome this hurdle, the EU introduced the U-space system with multiple stakeholders. The purpose is to collect information on UAS operations – drone ID, flight data and cargo, among other data points – to provide an organised system for safe flight across modes at large scale. This data will need to be standardised between cities and countries.

Many of the technologies and innovations emerging in the aviation industry bear significant potential to further improve the level of safety, by improving the collection and analysis of operational data, better condition monitoring of aircraft for the purpose of preventive maintenance, improved accessibility and better quality of meteorological information, or others.

[15] https://interbrand.com/thinking/welcome-to-best-global-brands-2022
[16] UNEP – United Nations Environment Programme https://www.unep.org

As the **next generation of automation** in aviation systems will be using Artificial intelligence (AI), EASA is putting significant efforts into preparing for the future with the identification of dedicated resources to research and innovation (R&I), such as the Agency-wide AI implementation project team, the 'EASA Innovation Cell', increasing support to the development of EU aviation & aeronautics research programmes and projects. In addition, EASA has developed an AI Roadmap that aims at creating a consistent and risk-based 'AI trustworthiness' framework to enable the processing of AI/Machine learning applications in any of the core domains of EASA, from 2025 onwards.

In terms of technology, the European Commission has identified issues to be tackled at European level[17]:

- Security of communication – the transport system becomes more digitised and thus vulnerable to hacking and cyber-attacks. The cyber-security of communication is therefore critical and requires action at European level.
- Privacy and data protection – protection of personal data and privacy is a determining factor for the successful deployment of cooperative, connected, and automated vehicles.
- Communication technologies and radiofrequency – by combining complementary communication technologies the messages should be unaware of, and thus flexible about the communication technology used, easing the inclusion of future technologies (5G and satellite communication).
- Interoperability at all levels – transport systems need to be able to interact with each other, across borders and modes, at all levels: infrastructure, data, services, applications, and networks.

Communication between vehicles and with the infrastructure will increase the safety of automated vehicles. Cooperation, connectivity, and automation are technologies reinforcing each other and will likely merge in the near future.

Through the "**Digitising European Industry**" initiative[18] launched in 2016, EUR 3 billion EU investment were mobilised for the period of 2018 – 2020 for public-private partnerships that supported:

- 5G, the IoT, High Performance Computing, electronics and photonics components and systems, robotics, and data technologies.
- Developed and piloted at large scale digital industrial platforms for "smart" factories, hospitals, farming, and autonomous driving.

The initiative aimed to tackle some of the challenges of the "Digital Single Market", one of which was the differences in the level of digitalisation of industry across sectors, member states and regions.

Fast **evolving archetypes** that combine characteristics of any of the three – fixed wing, rotary wing, and lighter-than-air aircraft – such as electric vertical take-off and landing (eVTOL) do not fit into any category. Any UAS that carries passengers often uses this new eVTOL form, for which new airworthiness and safety standards will be needed. Infrastructure will also have to be built and certified using new standards and processes to accommodate new forms of aerial mobility.

More specifically, the drone technology has advanced rapidly in recent years with drones becoming smaller, more affordable, and easier to operate. Originally developed for military applications, drones are now used in a wide range of sectors, including agriculture, construction, infrastructure, delivery services and cinematography.

[17] Strategy towards cooperative, connected and automated mobility (https://ec.europa.eu/energy/sites/ener/files/documents/1_en_act_part1_v5.pdf)
[18] https://digital-strategy.ec.europa.eu/en/library/digitising-european-industry-initiative-nutshell

In agriculture, drones are a low-cost aerial camera platform equipped with an autopilot and using GPS and sensors to collect relevant data. They are comparable to a normal point-and-shoot camera for visible images, but a multispectral sensor expands the utility of the technology and allows farmers to see things that cannot be seen in the visible spectrum, crop health, stress levels and fruits[19]. These capabilities could help overcome the various limitations that hinder agricultural production. PwC estimates the potential market for drone-based solutions in agriculture at USD 32.4 billion[20]. The use of drones in agriculture opens the door to accessing real-time information on the farm. They can be used at various stages of the cultivation process: Soil and field analysis, planting, crop spraying, crop monitoring, irrigation, and health assessment. Another application in agriculture is spraying with drones. Here, drones can spray crops with pesticides, herbicides, and other chemicals more precisely and efficiently than traditional ground-based methods. This can lead to less use of chemicals, less environmental impact and greater safety for workers. Livestock monitoring is another area where drones can be used to monitor the health and welfare of animals and detect problems such as disease and injury, leading to early intervention and better outcome.

In forestry and biodiversity monitoring, drones can be used to assess tree health, monitor forest fires, and detect changes in biodiversity. This can lead to better management of forest resources, reduced fire risk and increased conservation efforts. Finally, drones can also be used in rural logistics to deliver vital goods to remote areas, transport crops and livestock, and help with disaster relief.

In conclusion, the new ways of applying drone technology in real economy's business cases present unseen challenges and market reactions[21]. For instance, UAS integration into urban traffic management systems, drone operator certification, legal and ethical concerns related to law enforcement's use of drones and ensuring that new UAS business models are accounted for within the existing business regulations all require careful consideration and explanation.

2.1.5 Environmental factors

These are also referred to as "ecological factors" that involve physical changes. Both consumers and public authorities penalise firms if their activities have an adverse effect on the environment. This is a rising concern and companies should not underestimate the public perception of the planet's health. A few important factors are identified here such as decarbonisation, climate change and low emissions.

- Decarbonisation

It includes a range of initiatives and proposals, such as protecting and restoring ecosystems, promoting sustainable agriculture and forestry, reducing pollution, and improving soil health, as well as enhancing the role of nature-based solutions in mitigating climate change. For instance, in the food system the EU policy aims to address the environmental, health, and social challenges that are currently faced, including climate change, biodiversity loss, food waste, and diet-related health problems.

- Climate change

The five Nordic countries – Denmark, Finland, Iceland, Norway, and Sweden – are key partners to UNEP in its efforts to deal with the crisis of climate change, nature and biodiversity loss, population, and waste. In 2022, these countries provided $21,3 million to the Environment Fund[22], UNEP's core financing mechanism. It is also well-understood the impact of the business community that can make on biodiversity

[19] For instance, spectral cameras are used to assess plant stress levels, while soil moisture can be studied by thermal cameras and soil sensors.
[20] PwC Drone Powered Solutions (2017), https://www.pwc.com/kz/en/services/drone-powered-solution.html
[21] See examples from other industries such as the emerging electric vehicles industry in Chao et al., (2014)
[22] https://www.unep.org/about-un-environment-programme/funding-and-partnerships/environment-fund

and nature protection. The Nordic countries encourage UNEP to intensify its cooperation with the financial sector. The UN system will support the implementation of the new biodiversity framework[23].

- European Strategy for Low-emission mobility

Low-emission mobility and agriculture is an essential component of the broader shift to the low-carbon, circular economy needed for Europe to stay competitive and be able to cater to the needs of people. The Strategy is a forward-looking and long-term policy approach aiming to ensure a regulatory and business environment for the transition to low-emission mobility[24].
Typical CO2 emissions of air transport are in the range of 30 to 110 grams per passenger/km, which are comparable to travelling by car or light truck. Incorporating the use of drones in the "last mile" of the supply chain may significantly reduce the emissions from the delivery services. This is particularly relevant for the project's UC5, and its quantitative environmental impact will be assessed in WP3.

2.1.6 Legal factors

The enormous market potential of the drone industry justifies the intensive regulatory and standardisation work of the EC and EASA, which has made Europe the region with the most advanced drone regulatory framework in the world.

With the first Drone Strategy (2014), the EC adopted the **EASA Basic Regulation** to give the Agency the competence to regulate all drones and drone operations regardless of their weight. Then, **Regulations 2019/945** and **2019/947** were adopted to define the technical requirements for manufacturing a drone and the operational conditions for flying it. In March 2020 EASA proposed a regulatory framework for the U-space to create and harmonise the necessary conditions for manned and unmanned aircraft to operate safely in the U-space airspace, to prevent collisions between aircraft and to mitigate the air and ground risks. This was published in April 2021. In fact, many countries in Europe have insufficient UAS operations to require the establishment of **U-space** airspaces. However, the U-space regulatory package for the European Union came into effect on 26th January 2023 and it consists of:

1. Implementing Regulation EU 2021/664
2. Implementing Regulation EU 2021/665
3. Implementing Regulation EU 2021/666

Implementing this new system requires states first to define and designate U-space airspaces. This will be volumes of airspace in which the mandatory U-space services will be provided to guarantee safe, efficient, and interoperable operations[25].

In the ICAERUS framework of legal factors – the regulations, decisions, and standards – are organised under the same structure as in the AW-Drones project, which activities support the EU drone regulatory process and contribute to the harmonisation of EU drone regulations and standards. Over the last three years, the AW-Drones project has collected technical standards, rules and procedures that are already in commercial use worldwide[26]. Its information portal aid UAS operators by identifying all standards applicable to every SORA requirement[27]. It determines which standards constitute Acceptable Means of Compliance to one or more mitigations. Overall, the portal provides information about the standards applicable to a given mitigation deriving from the SORA methodology.

The regulatory measures that will be discussed further in this deliverable in more details in chapter 3 regarding the legal requirements of each project's use case are as follows:

[23] https://unsceb.org/un-common-approach-biodiversity
[24] https://www.eea.europa.eu/policy-documents/a-european-strategy-for-low
[25] This legislation creates geographically U-space ecosystems in Europe, unlike the US, where integrated services are more accessible via partnerships at all levels.
[26] https://standards.aw-drones.eu/
[27] SORA – specific operations risk assessment

- European regulations:
  1. EU Regulation **2019/947 -** safe operation of drones in European airspace
  2. EU Regulation **2019/945 -** safe operation of drones in Europe
  3. Associated **guidance documents** (GD) and **acceptable means of compliance** (AMC)
  4. **U-Space** regulations - U-Space Traffic Information Service; U-Space Weather Information Service; U-Space Tracking Service; and others

- Drone standards relevant to ICAERUS, derived from the AW-Drones portal:
  5. Agriculture - Standard 120 □ precision-agriculture
  Standard 242 - > ISO16119 Aerial spraying systems (agricultural and forestry machinery).
  6. Rural logistics / transport of goods □ Standard 400 Payload Delivery (medical supplies, ammunition, leaflets) operations
  7. Forestry and biodiversity - ISO16119 Forestry Machinery
  8. Standard 261: Standard for Drone Applications Framework

- "Voluntary" industry standards published by EASA and FAA in their rulebooks:
  9. European Technical Standard Order (ETSO) for drone equipment.

This was the last step of the conducted general PESTEL analysis, and many legal issues may affect a business that do not act responsibly. Therefore, any start-ups should remain within the confines of established regulations. All factors reviewed and analysed in sections §2.1.1 to §2.1.6 demonstrate the variety of developments that can affect business decisions of companies, and the importance of understanding them for the risk management planning.

2.2 Overview of EU policies and strategies

This subsection aims to provide an overview of the existing policy documents that delineate the policy and business environment in which the project's use cases will be operating and strategic decisions are made. The focus will be on several EU policy packages that shape the current and future trends in the European markets and define the framework for the drone innovative operations on which the ICAERUS consortium has concentrated.

2.2.1 EU's Common Agricultural Policy

The CAP as a major driving force in European policy-making was established in 1962 as an attempt to devise a policy to cope with economies that have had varying levels of involvement in agriculture and food processing, a variety of historical developments and rural traditions, and which have displayed divergences in the structure of agriculture in terms of farm size, ownership patterns and commodities produced. Over the years, many mechanisms were established to cooperate with other policy areas and external pressures for change of CAP were observed too, for example, the General Agreement on Tariffs and Trade (GATT)[28], which pushed with the liberalisation of the agricultural trade, and later this work was continued by the World Trade Organisation (WTO). It led to a compulsory 36% cut in the average bound tariffs between 1995 and 2000 for the developed countries (2004 for the developing ones)[29], which in practice materialised in a limited cut in actual tariff protection of the agricultural sector (Bureau et al., 2017).

[28] The Uruguay Round ended in 1994 and the implementation period completed in 2004. See in: *World Trade Organisation,* (2004) Characteristics of the Uruguay Round Agreement on Agriculture
https://www.wto.org/english/tratop_e/dda_e/symp04_paper_hwang_e.doc
[29] *World Trade Organisation,* (2017) Legal texts – A summary of the Final Act of the Uruguay Round, 1986 – 1994.
https://www.wto.org/english/docs_e/legal_e/ursum_e.htm

Historically, the emergence of a modern, technologically oriented farmer, particularly in northern Europe, appeared in post-war times when innovations, profit maximisation and subsidised income stream that was invested in new buildings and machinery became an emphasis of the contemporary agriculture. As pointed out by many authors, banks and specialised agricultural credit institutions provided loans while government advisory services or field representatives from agrochemical companies offered advice to the farmer who was willing to experiment with new production techniques (Marsh et al., 1996). Further technological progress was largely influenced by discoveries in biotechnology such as transgenic plants resistant to viruses or insects, which reduced the dependence on certain chemicals[30]. Summing it up, the more sophisticated market demand globally and changing consumer needs locally tend to produce a more heterogeneous agro-food industry.

Technological and financial pressures later pushed farmers in the direction of higher levels of production and more intensive forms of farming, however, environmental regulations have become stricter, and farmers had to respond to changing public attitudes by engaging in more environmentally sensitive forms as discussed by Grant (1997).

CAP Strategic Plans

In general, the CAP has been through many reforms, and for instance, the reform in 2013 that covered the period 2014-2020, introduced “greening measures” that affected direct payments to farmers. A proportion of the payment (30%) was made conditional on the maintenance of permanent pastures, the diversification of crops, and the establishment of “ecological focus areas”. However, nearly 50% of the EU farmland and many farmers were exempted from deploying these measures, which tendency downgraded the importance of greening and reduced the benefit to biodiversity (Emmerson et al., 2016). Still the reform was much more focused on environmental and climate impacts mitigation than previous ones (Niza-Ribeiro, 2022)[31]. More details are provided in Annex 1.

CAP 2023-2027

CAP 2023-2027 is covered by three regulations that also apply since January 2023:

⇒ Regulation (EU) **2021/2115** on supporting the strategic plans;

⇒ Regulation (EU) **2021/2116** on financing, management, and monitoring of the CAP. It repealed Regulation (EU) 1306/2013;

⇒ Regulation (EU) **2021/2117**, which amended several regulations: Regulation (EU) 1308 /2013 on the common organisation of agricultural markets; Regulation (EU) 1151/2012 on quality schemes for agricultural products; Regulation (EU) 251/2014 on geographical indications for aromatised wine products; and Regulation (EU) 228/2013[32] on the agricultural measures in the outermost regions of the EU.

2.2.2 The Green Deal

The Green Deal is of high priority for the ICAERUS project because any new innovative development in the agricultural and logistic industries may encourage many more use cases to be experimented with and deployed that will strengthen the “green” markets in all sectors as well as the globally competitive role of Europe. The Deal outlines a range of initiatives to achieve its objectives, including increasing the share of renewable energy in the EU's energy mix, improving energy efficiency in buildings, promoting sustainable

[30] See more historical details in: Grant W., (1997), The Common Agricultural Policy, First Edition Hardcover, MacMillan Press Ltd, London

[31] The author explores the challenges of the growing need for food and water resources for an expanding human population accompanied by environmental degradation, increased habitat loss and interface with wildlife.

[32] See more details in: *https://agriculture.ec.europa.eu/common-agricultural-policy/cap-overview/cap-glance_en*

transport, and increasing circular economy practices to reduce waste and promote recycling[33]. To support these initiatives, the EU has also proposed the creation of a Just Transition Mechanism, which will provide funding to support the transition to a green economy and protect the rights of workers in industries that are likely to be affected by the shift away from fossil fuels.

The Green Deal is also closely tied to the EU's commitment to the Paris Agreement on climate change, and the EU has set an ambitious target of reducing its greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels[34]. The EU Emissions Trading System (ETS) proved to be effective in the sectors that it operates. It is expected a revision of the EU ETS rules for the aviation sector[35] to be included in the EC work plan and a review of the proposals to reduce free allowances allocated to the sector. The EU ETS is proposed to be extended to the maritime sector and, subject to impact assessment, to road transport.

Overall initiatives included in the Green Deal are:

Fit for 55

The 'Fit for 55' package aims to translate the ambitions of the Green Deal into law. The package is a set of proposals to revise climate-, energy- and transport-related legislation and put in place new legislative initiatives to align EU laws with the EU's climate goals.

European climate law

The European climate law regulation turns the political ambition of reaching climate neutrality by 2050 into a legal obligation for the EU. By adopting it, the EU and its member states committed to cutting net greenhouse gas emissions in the EU by at least 55% by 2030, compared to 1990 levels. This target is legally binding and based on an impact assessment carried out by the Commission.

EU strategy on adaptation to climate change

In June 2021, EU environment ministers approved conclusions endorsing the new EU strategy on adaptation to climate change. The strategy outlines a long-term vision for the EU to become a climate-resilient society that is fully adapted to the unavoidable impacts of climate change by 2050.

EU biodiversity strategy for 2030

The EU biodiversity strategy for 2030 aims to help recover Europe's biodiversity by 2030. This would bring benefits for people, the climate, and the planet.

Farm to Fork strategy

The Commission's Farm to Fork strategy aims to help the EU achieve climate neutrality by 2050, by shifting the current EU food system towards a sustainable model.

European industrial strategy

The EU relies on Europe's industry to lead the transitions towards climate neutrality. The aim of the EU's industrial strategy is to support the industry in its role as an accelerator and enabler of change, innovation and growth.

Circular economy action plan

Decoupling economic growth from resource use and shifting to circular systems in production and consumption is key to achieving EU climate neutrality by 2050. The action plan envisages over 30 action points on designing of sustainable products, circularity in production processes and empowering

[33] See more details in: *A European Green Deal*. (2021, July 14). European Commission. https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en

[34] In addition, the EU has a problem with climate catastrophe insurance – only 25% of losses from climate-related disasters are covered and to reduce the economic damage from such events, greater coverage is needed. See more in ECB Blog: What to do about Europe's climate insurance gap? https://www.ecb.europa.eu/press/blog/date/2023/html/ecb.blog.230424~4cdc3a38ba.en.html

[35] https://climate.ec.europa.eu/eu-action/transport-emissions/reducing-emissions-aviation_en

consumers and public buyers. It targets sectors such as electronics and ICT, batteries, packaging, plastics, textiles, construction and buildings, and food.

Batteries and waste batteries

The Commission has proposed to revise existing rules on batteries and adopt new mandatory requirements for all batteries (industrial, automotive, electric vehicle and portable) placed on the EU market. The new proposal aims to address the whole life cycle of batteries from the production process to design requirements as well as 'second life', recycling and incorporating recycled content into new ones.

A just transition

The EU Just Transition Mechanism will help regions which are highly dependent on fossil fuels and carbon intensive industries to embrace the transition to clean energy by providing financial and technical support to the regions most affected by the move towards a low-carbon economy.

Clean, affordable and secure energy

As 75% of EU greenhouse gas emissions come from energy use and production, the decarbonisation of the energy sector is a crucial step towards a climate-neutral EU. The EU is working at several levels to achieve these objectives: 1) the development and uptake of cleaner energy sources, such a renewable offshore energy and hydrogen; 2) fostering integration of energy systems throughout the EU; 3) developing interconnected energy infrastructure via EU energy corridors; 4) revising the current legislation on energy efficiency and renewable energy, including their 2030 targets.

EU chemicals strategy for sustainability

Chemicals are essential to modern living standards and the economy. However, chemical substances can be harmful to people and the environment. The strategy sets out a long-term vision for the EU chemicals policy, wherein the EU and member states want to: 1) better protect human health; 2) strengthen the industry's competitiveness; 3) support a toxic-free environment.

Forest strategy and deforestation-free imports

As one of the flagship elements of the European Green Deal, the EU forest strategy for 2030, builds on the EU's biodiversity strategy and forms a key part of efforts to reduce greenhouse gas emissions by at least 55% by 2030. The proposed measures include:

1) promoting sustainable forest management

2) providing financial incentives for forest owners and managers to adopt environmentally friendly practices

3) improving the size and biodiversity of forests, including by planting 3 billion new trees by 2030.

2.2.3 Farm-to-Fork Strategy

This strategy is a comprehensive plan introduced by the EC in 2020 to transform the EU's food systems into more sustainable, healthy, and resilient ones. The strategy aims to address the environmental, health, and social challenges that currently face the food system, including climate change, biodiversity loss, food waste, and diet-related health problems. More details are provided in Annex 2.

2.2.4 EU Biodiversity Strategy

The European Union Biodiversity Strategy[36] for 2030 is a comprehensive and ambitious plan to protect nature and reverse the degradation of ecosystems in Europe and will work in tandem with the Farm-to-Fork strategy. More details are provided in Annex 3.

2.2.5 Shaping Europe's Digital Future

Shaping Europe's Digital Future is a strategy released by the EC in February 2020 that outlines its vision and plan for the development of digital technologies and services in the European Union. The strategy aims to ensure that digital transformation in Europe is human-centric, ethical, and respects European

[36] https://ec.europa.eu/environment/strategy/biodiversity-strategy-2030_en

values and fundamental rights. As part of the European Digital Strategy, the EC hopes to strengthen the tech sector across the continent and reduce its reliance on foreign technology while also building up its single market for digital services. It will support the design of new drone technology on the continent[37].

2.2.6 Drone Strategy 2.0

The first Drone strategy 1.0 established the safety basis for conducting drone operations in the EU as it focused mainly on the open category (low-risk drone activities). With Drone strategy 2.0, the EC recognises the complexity and challenges of the creation of an EU drone market in a harmonised way. Drones are already used in many sectors – agriculture, construction, filmmaking, surveillance, health-care, medical emergency, energy, environment, public safety and security. Typically, these are carried out with small drones. However, operators still need to apply for authorisation. Therefore, the new strategy develops new Standard Scenarios to reduce the administrative burdens. In the case of a pre-defined operation, operators only have to submit a declaration of compliance to the CAA, instead of applying for authorisation.

Furthermore, the strategy proposes the creation of test centres to promote drone operations and make drone services cheaper. It is expected for these centres to have a real impact on social acceptance and on the shaping of a competitive drone market across Europe. That's why, they should operate as real ecosystems where drone operations are facilitated, and drone services are provided to customers daily. Several European cities have already launched drone pilot projects and are experiencing with the centres.

The new Drone strategy 2.0 also encourages collaborations between military and civil drone capabilities, and Europe is leading the development and deployment of civil drone applications. To achieve its goal of being an important global actor, the EU needs to be stronger in security and defence, and of course this implies more synergies between civil, defence and space industries[38]. For instance, defence projects may benefit from innovative developments of start-ups with civil purposes such as designing drone technology for crop health assessment, or forest and biodiversity protection, or delivering cargo and vice versa the civil aeronautics may be driven further by developments in the defence or space industries.

Overall, the strategy contributes to the directions defined by the Urban Mobility Package in the transport sector and Shaping Europe's Digital Future document in the tech industry.

2.2.7 EU Aviation Safety Plan

It supports the further modernisation of the aviation system, in the areas of safety, efficiency, level playing field, and environmental protection. In the drone's domain, several concepts, platform architectures and practical demos continue to be developed at high pace across Europe. COVID-19 accelerated the development of certain use cases, such as for delivery of vital supplies to medical personnel, humanitarian aid, and emergency or disaster response.

2.2.7.1 Safe integration of new technologies and concepts

The European Plan for Aviation Safety (EPAS) 2022-2026 Vol. 1, chapter 3.1.3 focuses on the safe integration of new technologies, innovative solutions and operating concepts into the aviation system and facilitate the emergence of such new technologies and solutions. It highlights the need for a proactive approach to manage the risks associated with the introduction of new technologies and concepts, such as drones, UAVs, electric aircraft, and urban air mobility.

[37] More details are provided in Annex 4
[38] Action plan on synergies between civil, defence and space industries, February 2021, Brussels

The chapter describes several key actions that will be taken to ensure the safe integration of new technologies and concepts in aviation. These actions include the development of safety assessments and risk management plans, the establishment of a regulatory framework that promotes innovation while ensuring safety, and the implementation of effective communication and collaboration between stakeholders involved in the development and deployment of new technologies and concepts.

It focuses on ensuring the safe operation of UAS, also known as drones, and electric vertical takeoff and landing (eVTOL) aircraft, alongside manned aircraft. The chapter highlights the need for a comprehensive regulatory framework for the 'certified' UAS category to ensure safe and efficient integration of these aircraft in the aviation system. More details are provided in Annex 5.

2.2.7.2 Unmanned aircraft systems and manned eVTOL aircraft

Chapter 14 of the EPAS 2022-2026 Vol. 2 focuses on the safety challenges posed by UAS and eVTOL aircraft. The chapter provides an overview of the regulatory framework for UAS and eVTOL operations, the safety risks associated with these operations, and the actions that are relevant to ensure the safe integration into the aviation system.

The main objective is to create a level playing field in all EU Member States, using an operation-centric concept, which is proportionate and risk- and performance-based, so that all companies can make best use of UAS technologies to create jobs and growth. At the same time, to enable the safe integration of drones in the European airspace while maintaining a high and uniform level of safety. Measures taken to manage the safety risks associated with UAS and eVTOL operations include:

1. Introduction of a regulatory framework for the operation of drones: The EU is developing regulations for UAS which will be categorised into:
- 'Open' category: low-risk operation not requiring authorisation or declaration before flight
- 'Specific' category: medium-risk operation requiring authorisation or declaration before flight
- 'Certified' category: high-risk operation requiring certification process

2. Regular update of Regulations (EU) 2019/945 and 2019/947 (drones in the 'open' and 'specific' categories).
3. Regular update of the AMC & GM to Regulations (EU) 2019/945 and 2019/947 (drones in the 'open' and 'specific' categories.
4. European safety promotion of civil drones:
a) Promote safe operation of drones to the public; b) Promote the safe use of drones and an understanding of the drone rules to those undertaking commercial drone operations; c) Promote the design and certification aspects of drones; d) Promote activities to minimise the risk of drones impacting airspace.
5. Vulnerability of manned aircraft to drone strikes:
a) Assessment of the potential collision threats posed by drones to manned aircraft and evaluation of their estimated impacts; b) Establishment of a risk model to support regulatory and operational stances to be validated by means of a comprehensive set of simulated impact tests.
6. SESAR 2020 research projects aiming to safely integrate drones in the airspace.
7. SESAR exploratory projects on U-space.
8. UAS standards: the research will deliver the assessment of the technical content of the industrial standards. In addition, it shall assess the new standards that will be added by the EUSCG.
9. New air mobility: the purpose is to develop rules or amend existing ones, where necessary, to address new technologies and operational air transport concepts, with the objective of adapting the regulatory framework in line with performance-based regulation (PBR) principles. A general principle that will govern this action is that future requirements should be technology-neutral where possible, while ensuring legal certainty.

2.2.7.3 Aerodromes and ground handling

Chapter 19, Volume 3 provides an overview of how the safety risks associated with aerodromes and ground handling are analysed and the outcome of these analyses, with the purpose of providing readers with more insight on where the actions in the EPAS come from (see Annex 5 for more details).

Concluding the section, the risk factors for UAS are their operating mode in terms of line-of-sight (LOS), their weight and handling of payloads, their closeness to inhabitants, and the airspace routes. Typically, BVLOS operations require a certified pilot. Consequently, the development of the larger H2FC drones (hydrogen fuel cell) more suitable for BVLOS operations will be slower and entails a longer investment planning. Therefore, drone deliveries within denser urban areas are likely to occur at later stages of such developments (nearer to 2030). The involvement of local or cities authorities support the adaptation of drone technology, and since safety is a primary concern of all regulators and CAAs, the municipalities can form their own vision of the socially accepted drone applications.

2.3 Review of the EU legislation regarding UAS operations

Recently it has been observed numerous innovations in office work, collaboration, distribution, and service delivery, which shifted the behaviour of customers, habits, and expectations. Some of the emerging technologies of the Fourth Industrial Revolution – mobility (autonomous vehicles), artificial intelligence, drones, and the internet of things – have been at the centre of these innovations and will power applications that are themselves revolutionary. However, governing these new technologies requires new principles, rules, and protocols. Such governance is not only a matter of supervision and regulation from government but also encompasses a wide range of frameworks such as self-regulation, non-binding guidance standards, certifications, and operational authorisations. In this section, the aim is to outline the regulatory framework of the UAS operations governing the European airspace.

2.3.1 EU Regulations

The drone regulation which entered into force on 31st December 2020 in the European Union aims to capture all applications of UAS in the European airspace. It harmonises the different national legislatures on the operation of UAS, incorporating the knowledge accumulated in all member states and building upon the work done by JARUS Group[39]. JARUS provides guidance material to facilitate each authority to write their own requirements and avoid duplicated efforts. This EU regulation, possibly the largest aviation regulation in history in terms of scope was split up into two parts: 1) an implementing act (**EU 2019/947**) and a delegated act (**EU 2019/945**)[40] to construct a single European market for UAS and provide operators and manufacturers with the opportunity to bring new products to a larger consumer base.

Depending on the national legislation, the Open category may be more or less restrictive. The operators in this category are expecting the UAS with correct Class Identification Labels (CILs), allowing them to fly closer to uninvolved persons and within the populated areas. Commercially active operators will likely be considered in the Specific category soon due to the usage of UAS with higher MTOM near urban areas and the requirement of BVLOS operations. The risk-based, operation-centric approach that is building the principles of the Specific category enables a wide range of innovative applications of different UAS to reach the market but does not explore the commercial scalability. The issue of scales will be tackled by "standard scenarios" that take effect in 2024 and by publishing more "pre-defined risk assessment" (PDRA). To use

[39] JARUS – Joint Authorities for Rulemaking on Unmanned Systems (*http://jarus-rpas.org*). It represents the National Aviation Authorities of 63 countries plus EASA and EUROCONTROL.

[40] Commission Delegated Regulation (EU) 2020/1058 of 27th April 2020 amending Delegated Regulation (EU) 2019/945 as regards the introduction of two new unmanned aircraft systems classes; *https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32020R1058*

the standard scenarios STS-01 and STS-02, the UAS operator has to declare itself to the competent authority. And by doing so, the company does not need an operational authorisation to start its operations.

France is one of the member states that has been working on a UAS regulation from scratch since 2014. They classified operators into three categories: 1) “aeromodelling” category for recreational purposes; 2) the second category is for professional operations and 3) “experiments” category for specific needs or testing purposes. For the professional purposes, three scenarios were identified with specific operational and technical conditions and appropriate training consistent with the risk level associated to each scenario was offered. With the implementation of EU 2019/947, UAS operators can use non-CE-class marked drones during a transitional period (until 1st Jan. 2024) and fall under the Open category. For A1 and A3 Open subcategories France offers an e-learning platform allowing candidates to follow a dedicated course and take an online exam to obtain the necessary certificate. In-house A2 examination sessions are also available, and the possibility offered by EASA to set up online proctored exam sessions help to cover the increasing number of remote pilots willing to sit the exams.

The French standard scenarios S-1, S-2 and S-3 remain valid until 2024 and continue to act as the preferred alternative for these UAS operations that do not fall under the scope of the Open category. The European standard scenarios STS-01 and STS-02 theoretical examinations are under development and will be ready for implementation at the end of the transitional period by Jan. 2024. When the UAS operations are too complex to be covered by the standard scenarios, French operators can ask for an operational authorisation in accordance with one of the pre-defined risk assessments (PDRAs) or by performing a safety risk assessment using the SORA methodology of EASA. The PDRA is reasonably feasible for operators who have limited knowledge in safety risk management, while SORA requires more expertise in risk assessment and an appropriate course delivered by a competent trainer.

The EU 2019/947 allows a mutual recognition of remote pilot certificates – A1/A3, A2 and STS – and it is important to harmonise training courses in Europe. Without a common framework, it appears that training practices vary from one country to another, however the granted certificates and associated privileges are the same. Regarding practical assessments, which is more complicated in the Specific category according to operational authorisations (non-STS, and non-PDRA) since UAS operations are different by nature, common guidelines on how to evaluate pilot skills should be outlined on a European level.

In Germany, the competences in aviation and UAS training are divided between the federal government and the federal states. In the Open category, the Federal Aviation Authority is responsible for training and examinations nationwide. Courses can be completed on a web portal set up specifically for pilots training. In some cases, competences are outsourced to other authorities or entities. In the Specific category, competences are divided between the German Federal Aviation Authority (GFAA) and the state aviation authorities (almost 20 organisations). However, some federal states have partially relinquished competences to the GFAA, while others agreed on standardised procedures. As it is shown here, from differences in legal form, organisation, and structure, to the national allocation of competences, member state authorities have many responsibilities to handle and coordination with the EASA is not always easy.

Moreover, the national authorities are sometimes confronted with very specific areas of application, which must be assessed and approved within the framework of the highest possible level of standardisation. The EASA intends to facilitate these cases with instruments such as standard scenarios, but this has not been always successful in real practices.

Another major EU regulation that was adopted in April 2021 is “**the U-space package**” consisting of three components that define the conditions necessary for both drones and manned aircraft to operate safely in U-space airspace. EUROCONTROL contributes to the development of work programmes dealing with the airspace risk assessment, U-space flight authorisation, electronic communication and coordination with local authorities, the AMC and GM for U-space regulation, as well as conducting safety risk and impact assessments for UAS operations under the certified category[41].

U-space is a set of specific services and procedures designed to ensure safe and efficient access to airspace for many drones, which are based on high levels of digitalisation and automation. Implementing this new package requires member states first to define and designate U-space airspaces – these are the volumes of airspace in which the mandatory U-space services will be provided to guarantee safe, efficient, and interoperable operations. Four mandatory services will be established:

1. Network identification service – provides the identity of UAS operators and the location and trajectory of drones during operations.
2. Geo-awareness service – provides information on operational conditions, airspace limitations or existing time restrictions.
3. UAS flight authorisation service – ensures free of conflict operations with other UAS operating.
4. Traffic information service – alerts operators of air traffic that may be found near the aircraft.

There are two more services that are optional, but may be established as mandatory for certain U-space airspaces when so determined by the state:

5. Weather information service – supports the flight planning and execution phases.
6. Compliance monitoring service – warns of non-compliance with the granted flight clearance and informs operators of any deviation from it.

Furthermore, for the provision of these mandatory services, the deployment of U-space will require an integration of two new service providers:
1) the common information service provider (CISP) and 2) the U-space service provider (USSP).

The last aspect for the state to determine is the delivery model of all these services. It may be centralised, distributed, or mixed.

In this respect, European U-space providers need to find EUR 2 billion in investment until 2035 and drone operators a further EUR 0.7 billion to develop a European UTM system:

Table 1 Stakeholder investments in UTM technology in Europe

Number	Stakeholders	Investment (billions)
1.	U-space service provider	≈ EUR 2.0
2.	Drone operators	≈ EUR 0.7
3.	Air Navigation service providers	≈ EUR 0.7
4.	Telecom / satcom providers	≈ EUR 0.6
5.	Airports	≈ EUR 0.3
6.	Airspace users	≈ EUR 0.1
7.	Others	≈ EUR 0.2
	TOTAL	≈ EUR 4.5

[41] EUROCONTROL *https://www.eurocontrol.int* is a pan-European civil military organisation dedicated to supporting European aviation with a headquarter located in Brussels.

Source: The Market for UAV Traffic Management Services 2023-2027, Ed. 6.1 February 2023

The U-space service providers will invest to support the new services in the ecosystem, while the drone operators are required to ensure that the drones are properly equipped for these services. The scale of operations and growth in UAVs are expected to expand substantially, making the associated investment meaningful – the specific category fleet size will evolve from under 10 000 in 2015 to nearly 400 000 in 2050 (Butterworth-Hayes, 2023).

In legal terms, the U-space regulatory package consists of the Commission Implementing Regulation EU 2021 /664 of 22nd April 2021 on a regulatory framework for U-space, which regulates the technical and operational requirements for the U-space system. It was necessary to amend two implementing regulations to complement the regulatory regime on U-space. Second, it consists of Implementing Regulation EU 2021 /665, which amends EU 2017 /373, establishing common requirements for air traffic management and air navigation service providers to establish the coordination procedures and communication facilities between ATS units, U-space providers and UAS operators. Third, it consists of Implementing Regulation EU 2021 /666, which amends EU No. 923/2012 (SERA Regulation), establishing the common rules for effectively making the presence of manned aircraft operating in U-space airspace electronically conspicuous.

Among the most anticipated applications for the future use of U-space is UAM, which aims to address the mobility and pollution problems that large cities in Europe are faced with. That's why the EASA in Dec. 2022 published Terms of Reference RMT.0230 to introduce a regulatory framework for the operation of unmanned aircraft systems and for UAM in the EU aviation system.

Overall, the three major regulations described in this section establish the principles of the regulatory framework for UAS operations in Europe.

2.3.2 Standards

The European UAS Standards Coordination Group (EUSCG) was established with the main objective to ensure a coordinated and harmonised elaboration and implementation of UAS functionalities[42]. It is a joint and advisory group that streamlines standardisation activities across Europe based on EU regulations and EASA rulemaking initiatives. Its main task is to develop, monitor, and maintain an overarching European UAS Standardisation Rolling Development Plan (U-RDP), which is based on the standardisation roadmap that is developed by EASA and other organisations, and it includes input from all members. The Group is chaired by EASA, and EUROCAE provides the Secretariat role.

EUROCAE is an independent non-profit organisation with 60 years of experience in developing standards to suit the needs of the aviation industry while supporting European and global regulations[43]. The activities are organised by Working Groups (WGs), and currently they have 52 WGs. One of those groups is WG-105 Unmanned Aircraft Systems (UAS), which task is to design and develop necessary standards to enable safe integration of UAS into all classes of airspace[44]. It takes into consideration the emerging European regulatory proportionate risk-based approach, of the related categories of operations (open, specific and certified) and industry requirements. This WG is divided into six sub-groups and has published 20 standards since its inception in 2016.

Table 2 List of standards developed by EUROCAE WG-105

Number	Title	WGs

[42] EUSCG at www.euscg.eu
[43] EUROCAE is based in France, see more at https://www.eurocae.net
[44] https://www.eurocae.net/about-us/working-groups/

ED-251	Operational Services and Environment Definition for RPAS Automatic Taxiing	WG-105
ED-252	Operational Services and Environment Definition for RPAS Automatic Take-off and Landing	WG-105
ED-253	Operational Services and Environment Definition for Automation and Emergency Recovery	WG-105
ED-258	Operational Services and Environment Definition for Detect and Avoid [Traffic] in Class D-G Airspaces under VFR /IFR	WG-105
ED-266	Guidance on Spectrum Access, Use and Management for UAS	WG-105
ED-267	Operational Services and Environment Definition for Detect and Avoid for VLL	WG-105
ED-269	Minimum Operational Performance Standard for UAS Geo-Fencing	WG-105
ED-270	Minimum Operational Performance Standard for UAS Geo-Caging	WG-105
ED-272	Minimum Aviation System Performance Standard for Remote Pilot Stations Supporting IFR Operations in Non-segregated Airspace	WG-105
ED-279	Generic Functional Hazard Assessment for UAS and RPAS	WG-105
ED-280	Guidelines for UAS Safety Analysis for the Specific category with Low and Medium levels of Robustness	WG-105
ED-281	Minimum Aviation System Performance Standards for RPAS Automation and Emergency Recovery	WG-105
ED-282	Minimum Operational Performance Standard for Unmanned Aircraft System Electronic Reporting	WG-105
ED-283	Minimum Aviation System Performance Standards for RPAS Automatic Take-off and Landing (ATOL)	WG-105
ED-284	Minimum Aviation System Performance Standards for RPAS Automatic Taxiing	WG-105
ER-016	RPAS 5030-5091 MHz CNPC LOS and BLOS Compatibility Study	WG-105
ER-019	Inputs to RPAS AMC 1309	WG-105

Source: Compiled by the authors

Some of these published standards have been recognised as AMC or GM by EASA, and they can be used by applicants (drone operators or manufacturers) to demonstrate compliance to a certain section of a regulation.

Another body that provides provisional development of standards in the UAS domain is JARUS Group, which goal is to facilitate each authority in creating their own regulatory requirements by identifying common frameworks. Their activities are supported by the Industry and Stakeholder Body (ISB) to allow for the representation of industry and recognised stakeholder organisations worldwide. The Group's work is split up into four working groups (WGs) as each specialises in a different area. Their workplan addresses the most important challenges facing the UAS sector. Some of the recent publications that have been produced by WGs include:

- An updated Specific Operations Risk Assessment (SORA) complemented with Standard Scenarios (STS) and Pre-defined Risk Assessments (PDRA)[45] – the document was released in January 2019, and it consists of guidelines for a risk assessment methodology to be used to establish a sufficient level of confidence that a specific operation can be conducted safely.

- RPAS Operational Categorisation[46] - the document was released in September 2019, and consists of a thoroughly explained risk-based concept for performance-based regulations of UAS operations globally. It is intended to inform the rulemaking authorities on future regulation of UAS operations.

- UAS RPC CAT A & CAT B[47] - the document was released in October 2019, and consists of recommendations for competent authorities to use for their own national legislation, regarding remote pilot competency for operations in Category A (‘open”) and Category B (“specific”).

- Performance-based airworthiness requirements for CS-UAS[48] - the document was released in September 2019 and consists of recommendations for states to use for their own national legislation, concerning Certification Specification for UAS. It presents best practices and procedures used in prior UAS approvals and input from WG3 (Airworthiness).

- Guidance material to JARUS recommendation UAS RPC CAT A & CAT B[49] - the document was released in April 2020, and represents JARUS guidance material on the qualification of an entity that a competent authority may delegate as a provider of theoretical knowledge examination and practical skill assessment.

- In December 2022, JARUS published its latest SORA version 2.5 proposals, which were opened for comments to all European stakeholders until March 2023.

The third body that makes global standards based on “best practice” is the International Organisation for Standardisation (ISO)[50]. They develop UAS standards currently in several different fields. These include product manufacturing and maintenance, operations, and procedures, UAS Traffic Management (UTM), testing, evaluating and others. Most of the standards are founded on the need to provide air safety of the UAS and their usage, but also on acceptability of the product.

In 2015, the ISO established its technical subcommittee ISO/TC 20/SC 16, *Unmanned aircraft systems,* to develop the ISO 21384 series for UAS standards on safety and quality for product manufacture, operations, and unmanned traffic management. Moreover, the UTM systems will play a vital role and ISO 23629 for UAS traffic management helps to level the playing field globally. ISO 23629 designs standards that include functional structure and requirements for UTM services and service providers. They will complement operational procedure standards being developed within the ISO 21384 series and other standards supporting requirements for safe commercial UAS operations. These two series of quality standards for UAS will underpin the safe evolution of this fast-moving industry.

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[45] See more at: http://jarus-rpas.org/sites/jarus-rpas.org/files/jar_doc_06_jarus_sora_v2.0.pdf
[46] See more at: http://jarus-rpas.org/sites/jarus-rpas.org/files/jar_doc_09_uas_operational_categorization.pdf
[47] See more at: http://jarus-rpas.org/sites/jarus-rpas.org/files/jar_doc_15_uas_rpc_cat_a_b.pdf
[48] See more at: http://jarus-rpas.org/sites/jarus-rpas.org/files/jar_doc_16_cs_uas_edition1.0.pdf
[49] See more at: http://jarus-rpas.org/sites/jarus-rpas.org/files/jar_doc_17_gm_rae_uas_rpc_cat_a_and_cat_b_edition_1.0.pdf
[50] See more at: https://www.iso.org/home.html

The last organisation to be mentioned here is the European Standards Organisation[51] (ESO), consisting of CEN[52], CENELEC, ETSI[53] and its associated body ASD-STAN[54] that makes European Standards for the internal market of the union. ASD-STAN currently develops European standards that shape the UAS classes C0 to C6. These new standards are based on the European regulations 2019/945 and 2020/1058, which describe the demands for the UAS in different classes. For instance, 4709-002 deals with the “direct remote identification (DRI)” since EU 2019/945 requires DRI information to be broadcasted using an “open and documented protocol”. The standard addresses drone’s capability to be identified during the whole duration of the flight, in real time and with no specific connectivity or ground infrastructure link, by existing mobile devices when within the broadcasting range. It can be used by law enforcement people, critical infrastructure managers and public to get an instantaneous information on the flying drone around. Summing it up, the whole series 4709 from 001 to 008 recommend a way to fit the demands as part of the EU standardisation strategy.

Creating a legislative framework for UAS operations appears to be challenging for the authorities due to the nature of services, complexity of the business environment with multiple stakeholders and the rapid technological developments. Standards provide a set of rules based on which stakeholders can focus on where they can add value. Common standards also create a level playing field for international trade, and they ensure compatibility and interoperability. Therefore, standardisation plays an important role and promotes safety of products and services.

2.4 The UAS risk assessment model: SORA

In a historical timeframe, the GALLO – guidance for authorisation for low-level operation – was the initial implementation policy that the Swiss Civil Aviation Authority created to provide a framework for accessing airspace in lieu of system certification. It became the first standardised risk management framework to meet the needs of a CAA to ensure safety in 2015[55]. Later two unrelated projects led directly to the development of the SORA, which is now used in the EU and Switzerland. The first project was a new electric aircraft, Solar Impulse, that required the Swiss authority to assess the airworthiness of a system with advanced battery and propulsion systems, remote pilot back-up controls, and an intent to start flying in rural conditions and then over urban settings like Zurich and Abu Dhabi. The second project was ASCOS of Airbus that presented a new model of holistic risk evaluation to aviation safety. It looked at both sides of the model – threats, hazards, harms, and barriers. By imparting an evaluation of “robustness” or “reliability” for the harm barrier, a CAA could more easily trust the mitigation being employed and grant increased access to airspace. This risk model is now fundamental to the SORA.

Then, the European Commission via JARUS began to define unmanned aircraft classifications in a way that would enable operational risk management rather than strict certification. The three classifications were formulated – open, specific, and certified. The GALLO, which enabled operations beyond basic or low risk, was well suited to help approve the “specific” category. This is how the Swiss GALLO became the SORA. The SORA methodology was finalised by JARUS Working Group-6 for direct reference in EASA’s proposed regulation at the end of 2018, and guidelines were issued in 2019.

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[51] See more at: https://www.cencenelec.eu/european-standardization/

[52] CEN-CENELEC – European Committee for Standardisation and CENELEC – European Committee for Electrotechnical Standardisation (www.cencenelec.eu). These two bodies are business catalysts in Europe to remove trade barriers for EU industry and consumers.

[53]ETSI – European Telecommunications Standards Institute. The three committees CEN-CENELEC and ETSI are officially recognised as competent to develop voluntary technical standards.

[54] ASD-STAN – AeroSpace and Defence industries Association of Europe, www.asd-stan.org

[55] WEF, “Advanced Drone Operations Toolkit: Accelerating the Drone Revolution”, Dec. 2018, Geneva

Since then, the SORA has been updated a few times. The last version 2.5 was presented in November 2022 by EASA and additional workshops held for operators in February 2023. The SORA requires the operator to take measures to reduce the risk to an acceptable level. Until now, qualitative factors were used to assess air and ground risk. In the future to provide more accurate results, quantitative factors will be required to be used by applicants as part of the application process. Many small drone operators consider the last edition of SORA to be too weighted in favour of large drones.

2.4.1 The SORA methodology

The EASA's proposal for risk assessment called Specific Operations Risk Assessment (SORA) provides a methodology to guide both the applicant and the competent authority in determining whether an operation can be conducted in a safe manner. The SORA is a tailored guidebook that allows an operation to find a best fit mitigation means and hence reduce risk to an acceptable level. It does not provide prescriptive rules, but rather recommends safety objectives to be met at various levels of robustness associated with the risk. This new approach has given operators more freedom since the beginning of 2022, however it is complex in terms of implementation.

The methodology supports an application for authorisation to operate a UAS within the Specific category. It provides a consistent approach to assess the additional risks associated with the expanded and new operations not covered by the Open category. The methodology may be applied where the traditional approach to aircraft certification may not be appropriate due to an applicant's desire to operate a UAS in a limited or restricted manner. It may also support activities necessary to determine associated airworthiness requirements. This assumes that safety objectives derived from those relevant for the Certified category are consistent with the ones set out for the Specific category.

The methodology is based on the principles of the holistic system safety risk-based assessment model. It helps to evaluate the risks systemically and determine the boundaries required for a safe operation. This method allows the applicant to determine acceptable risk levels and to validate them. The competent authority may also apply this technique to be sure that the operator conducts the operation safely.

Privacy, financial and security aspects are excluded from the applicability of this methodology. However, the operator must also ensure compliance to all other regulatory requirements related to the operation that are not necessarily addressed by the SORA.

The methodology requires a consistent use of terms for all users during phases of operation, procedures, and operational volumes. It introduces the concept of robustness and proposes three different levels of robustness: low, medium, and high. It describes all actors that may interact in the phases of the processes. The main actors applicable to the SORA are operators, applicants, UAS manufacturers, component manufacturers, competent authorities, air navigation service providers, UTM /U-space service providers, pilots in command.

It introduces an understanding of risk and proposes a logical process to analyse it by following a 10-step approach. The SORA focuses on the assessment of ground and air risk. In addition to air and ground, a risk assessment of critical infrastructure has to be performed in cooperation with the organisation responsible for the infrastructure. The process of 10 steps follows below:

Step #1: Description of the concept of operations (ConOps)
Step #2: Determination of the intrinsic UAS ground risk class
Step #3: Determination of the final GRC

<u>Question</u>: Is GRC lower or equal to 7?

If **NO**, then apply other process or new application with a modified concept of operations.
If **YES**, then continue Step 4 Air Risk Assessment

Step #4: Determination of the initial Air Risk Class (ARC)
Step #5: Application of strategic mitigation to determine final ARC
Step #6: Levels of robustness and TMPR (Tactical mitigation performance requirements)
Step #7: Determination of the final SAIL (Specific assurance and integrity levels)
Step #8: Identification of operational safety objectives (OSOs)
Step #9: Adjacent area / airspace considerations
Step #10: Comprehensive safety portfolio

Outcome: UAS operation approval (with associated limitations)

Overall, the SORA methodology provides the applicant, the competent authority and the service provider with a well described process which includes a series of mitigations and safety objectives to be considered to ensure an adequate level of confidence that the operation can be safely conducted. In addition, the operator should address any other requirements not identified by the SORA process and identify the relevant stakeholders to coordinate with. The operator should also ensure consistency between the SORA safety case and actual operation conditions at time of flight.

2.4.2 Predefined risk assessment

As an alternative to the SORA risk assessment, it may be applied the PDRA method. It is an operational scenario for which EASA has already carried out the risk assessment and has been published as an acceptable means of compliance to the Article 11 of EU 2019/947.

In this case, operators still need to obtain an operational authorisation from the National Aviation Authority, however, the process is much simpler. If the operation is covered by one of the published PRDAs, the UAS operator can directly fill the table, prepare the manual, and submit the application to the national authority of registration. The PDRA table can be used as checklist of the evidences of compliance to demonstrate that the operation is safe. The already published PDRAs follow below:

- PDRA S-01 Agricultural works, short range cargo operations
- PDRA S-02 Surveillance, agricultural works, short range cargo operations
- PDRA G-01 Surveillance, long range cargo operations
- PDRA G-02 All range of operations PDRA G-03 – Linear inspections, agricultural works
- PDRA G-03 Linear inspections, agricultural works

The predefined risk assessment also makes it easier for the national authority to review all documentation and issue the authorisation.

3. Use Cases' PESTEL and SWOT analyses

This section is a continuation of the methodological techniques incorporated in T1.1 *Understanding the Drone Market*, and subsequently D1.1 *European Landscape of Drone Innovations and Technologies,* where both market and stakeholders network analyses were performed to thoroughly explore and describe the ICAERUS use cases. As it was observed, one of the most important characteristics of all project's use cases is their capability to create a network of stakeholders, which is a founding component for the development of future work in both this and later work packages, as well as the willingness of stakeholders to adopt innovative technologies, progress offered services to the market and utilise a business model in a shared manner that will be functioning within the EU regulatory framework of UAS operations.

Thus, the following two chapters 3 and 4 present both the PESTEL and SWOT analyses as well as the risk assessment task conducted by the UC Leaders in the first year of the project's duration. The work under T1.4 was organised in parallel with the heavy workloads that were done by WP1 partners under T1.1, and therefore both D1.1 and D1.5 create additional value to each other in terms of strategic management and business risk assessment. Furthermore, D1.5 is complemented by work conducted under T3.1 and this chapter 3 refers to D3.1 *Use Case Plan* from §3.2 onwards to build the needed links. Both WP1 and WP3 provide an improved understanding of business and technical analyses entangled within the strategic and risk management framework.

3.1 Framework for the research of ICAERUS industrial cases

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 – and the specific market segments of the drone technology that are associated with the use cases are listed in Table 3.

Table 3 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 demonstrate their business potential:

- **UC1**: is analysed as a B2B use case, which represents a commercial case of crop monitoring and vineyards disease detection in large terrains of vineyards in Catalonia, where there is a clear shift towards both more high-quality wine products and organic wine production.
- **UC2:** is analysed as a B2B use case that 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.
- **UC3:** is analysed as a B2B use case and has a large scope that aims to utilise drone monitoring of land, farming terrains and livestock in France. UC3 has the potential to expand to Scotland and Ireland.
- **UC4**: is analysed as a B2B use case that offers business solutions to land-owners and state agencies in charge of forest protection and biodiversity in Lithuania.

- **UC5**: is analysed as both B2B and B2C use case that offers drone services aiming to provide an overall improvement of the supply chain in goods, small packages, and medical products in rural conditions.

The analysis that is presented in the following sections from §3.2 – §3.6 shares the same approach and structure in all five UCs:

1. Definition of the UC – presents the basics of the UC, without the need to consult with other deliverables.

2. PESTEL analysis – this part complements the general PESTEL analysis in chapter 2 with the specifics of each use case. Separately, the focus is on the political, economic, social, technological, environmental, and legal factors in a great deal of attention regarding solely the business and policy environment of the UCs' countries of origin.

3. SWOT analysis – this part evaluates the strengths, weaknesses, opportunities, and threats of the case. It gives an additional information to the already collected pool of knowledge (factors) from the PESTEL strategic framework.

As part of the legal factors influencing the business environment of each case, the UC Leaders provided a detailed information about the regulations and standards that they will be complying with during the demonstrations. Table 4 presents:

1. The main EU regulations (1-4) that all UCs will comply with.

2. The U-space regulatory package (5-7) might be considered by UC2, UC3, UC4 and UC5. In the case of UC1 in Spain, they are well informed about it but do not need to take actions. It must be clear that the U-space package is not applicable yet and the services may not be guaranteed during the project's timeframe, however the regulations are mentioned for future references.

3. As for the technical standards (8-12) only UC4 and UC5 might consider some of them depending on the operations undertaken. Since some of the standards are under development, they are referenced here only for future activities, not applicable to the demonstrations in WP3.

Table 4 ICAERUS Use cases' applied Standards and Regulations

	Regulations & standards	Use Case	Comments
1.	**EU Regulation 2019/947 amended by:** Regulation (EU) 2020/639 Amendment 1 Regulation (EU) 2020/746 Amendment 2 Regulation (EU) 2021/1166 Amendment 3 Regulation (EU) 2022/425 Amendment 4	All	Safe drone operations in European airspace
2.	**EU Regulation 2019/945 amended by:** Delegated Regulation (EU) 2020/1058	All	Safe drone operations in European airspace
3.	**Commission Implementing Regulation (EU) 2022/425**	All	Postponing the transition dates for using certain UAS in the "open" category
4.	**EU Decision 2019/021/R** Issue 1 **EU Decision 2022/001/R** Issue 1, Amendment 1 **EU Decision 2022/002/R** Issue 1, Amendment 2	All	Amending EU Decision 2019/021/R on "geographical zones", operational authorization forms in the "specific" category, a procedure and forms for cross-border operations, training modules syllabus for remote pilots in the "specific" category, and a new predefined risk assessment

	U-Space package[56]	Use Case	
5.	**U-Space** traffic information service	UC2, UC3, UC4, UC5	This specification is intended to be a global specification providing components that may be used to satisfy requirements expected to be common to many UTM-related regulations
6.	**U-Space** tracking service	UC2, UC3, UC4, UC5	UAS Identification Report
7.	**U-Space** weather information service	UC3, UC4, UC5	Data model related to various spatial information for common use between the UAS operators and the UAS traffic management system
	Technical Standards[57]	Use Case	
8.	**Standard 120**	UC5	Specific operations risk assessment
9.	**Standard 242**	UC4, UC5	Part of **ISO 16119** specific requirements
10.	**Standard 261**	UC5	Support of drone applications
11.	**Standard 400**	UC5	Use case scenario for payload delivery
12.	**European Technical Standard Order (ETSO) for drone equipment**	UC4	Voluntary industry standards

In more details, explanations are provided for each regulation and standard:

1. EU Regulations 2019/947 and 2019/945

Regulation (EU) 2019/947[58] of 24th May 2019 lays down detailed provisions for the operation of unmanned aircraft systems as well as for personnel, including remote pilots and organisations involved. The term "operation of unmanned aircraft systems" does not include indoor UAS operations[59].

Delegated Regulation (EU) 2019/945 of 12th Marcg 2019 lays down the requirements for the design and manufacture of unmanned aircraft systems intended to be operated under the rules and conditions defined in implementing regulation (EU) 2019/947 and of remote identification add-ons. It also defines the type of UAS whose design, production and maintenance are subject to certification and establishes rules on making UAS and accessories kit and remote identification add-ons available in the Union. Finally, it lays down rules for third-country operators, conducting a UAS operation pursuant to implementing regulation (EU) 2019/947 in Europe.

2. Commission Implementing Regulation (EU) 2022/425

It is in regards of postponing the transition dates for the use of certain unmanned aircraft systems in the "open" category and the date of application for standard scenarios for operations executed in or beyond

[56] According to the U-space legislation and the status of the ICAERUS use cases now in Year 1, none of the project's cases falls under the U-space requirements that need to be satisfied.
[57] It must be clarified that the authorisation of any drone operation needs the approval of the National Aviation Authority in the respective EU Member state, depending on the readiness and adoption of EASA framework.
[58] https://www.easa.europa.eu/document-library/easy-access-rules/easy-access-rules-unmanned-aircraft-systems-regulation-eu
[59] The indoor operations occur in or into a building or, more generally, in or into a closed space such as a fuel tank, a silo, a cave or a mine where the likelihood of a UA escaping into the outside airspace is very low.

the visual line of sight. It amends Commission Implementing Regulation (EU) 2019/947[60] (Amendment 4). The postponement is until 1st January 2024.

3. EU Decision 2022/002/R

This "Decision" relates to the regular update of acceptable means of compliance (AMC) and guidance material (GM) to Regulation (EU) 2019/947 on the rules & procedures for the UAS operation. Both the amended and the new AMC and GM will maintain safety of UAS operations in the "open" and "specific" categories and increase the harmonisation of UAS operations across the EU by providing more clarity[61].

4. U-space traffic information service

This specification is intended to be a global specification providing components that may be used to satisfy requirements expected to be common to many UTM-related regulations. It is not intended to comprehensively address all aspects of any particular UTM-related regulation or concept of operations[62].

5. U-space tracking service

UAS Identification Report defines a message structure allowing transmitting the identification of a UAS as wellas the aircraft's current position. This data is required to establish the basic principles of UTM which enables the safe integration of UAS into non-segragated airspace[63].

6. U-space weather information service

To enable UAS to operate safely, there is a need to define the data model that is related to various spatial information for common use between the UAS operators and the UAS Traffic Management (UTM) system. Existing standards regarding spatial data for safely operating UAS including static data and dynamic data do not exist, whereas efforts are underway to establish related standards on the part of ASTM International[64] and EUROCAE[65].

7. Standard 120

Specific Operations Risk Assessment[66] (Standard scenarios) → it includes several SORA standards:

7.1 New Practice for general operations manual for professional operator of light unmanned aircraft systems: The standard defines the requirements for General Operations Manual for Professional Operator of Light Unmanned Aircraft Systems (UAS). It addresses the requirements and/or best practices for documentation and organisation of a professional operator. The intent is for this standard to support professional entities that will receive operator certification by a CAA and provide standards of practice for self- or third-party audit of operators of UAS (not all CAAs have operator certificates). This would provide a standard for operators and identify gaps that are not currently addressed as it relates to: (1) Individuals, who are currently remote pilots (i.e. FAA under Part 107) in jurisdictions that do not separately certify Operators, who want to voluntarily comply with a higher standard, and (2) Operators, who are seeking certification from a CAA for Light Unmanned Aircraft Systems, who want to voluntarily comply with an industry standard (3) Public agencies interested in developing unmanned aircraft systems programmes.

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60 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32022R0425

61 https://www.easa.europa.eu/en/downloads/135912/en

62 https://standards.aw-drones.eu/requirements/U-SPACE/34

63 https://standards.aw-drones.eu/requirements/U-SPACE/35

64 ASTM International (International Standards Organisation) – formerly known as American Society for Testing and Materials that develops and publishes voluntary consensus technical standards for a wide range of products, materials, systems, and services https://astm.org

65 https://standards.aw-drones.eu/requirements/U-SPACE/36

66 https://standards.aw-drones.eu/requirements/SORA/standard/120

7.2 Minimum Aviation Systems Performance Standard for RPAS Automatic Take-off and Landing

7.3 Minimum Aviation Systems Performance Standard for RPAS Automatic Taxiing

7.4 Minimum Aviation Systems Performance Standard for RPAS Automation & Emergency Recovery functions

7.5 Standard Practice for Independent Audit Programme for Unmanned Aircraft Operators 7.6 Flight beyond visual line of flight 7.7 Night operations 7.8 Precision agriculture 7.9 Bridge inspection 7.10 Train right-of-way's

8. Standard 242

This part of ISO 16119 specifies requirements and methods for design and performance of aerial fixed wing and rotary aircraft platforms for agriculture, forestry, and human health, with respect to minimising the risk of environmental contamination. It is intended to be used with ISO 16119-1, which gives general requirements common to all the sprayer types covered by ISO 16119. When requirements of this part of ISO 16119 are different from those which are stated in ISO 16119-1, the requirements of this part of ISO 16119 take precedence over the requirements of ISO 16119-1 for machines within the scope of this part. It does not cover safety aspects (see ISO 4254-6)[67]. Although ISO 16119 focuses on terrestrial machinery, not UAVs, currently there are limited standarised procedures even in an experimental level for UAV spraying. It is a common practice to "borrow" and adjust engineering principles and scientific methodologies from conventional machinery measurements and operational steps, and apply them. Therefore, in this document the standard 242 is cited for future applicable situations.

9. Standard 261

The standard establishes a framework for support of drone applications. It specifies drone application classes and application scenarios and the required application execution environments[68].

10. Standard 400

The "Classification" of UAS operations outlines use case scenario for payload delivery (Ammunition, Medical supply, Communication leaflets)[69]. This standard is relevant for the project's UC5.

11. List of current ETSOs

European Technical Standard Orders for drone equipment[70] - some of these voluntary standards will be utilised by UC4 in their risk assessment modelling.

In addition to these European regulations and standards, UC3, UC4 and UC5 have referenced the national rules that they will have to comply with too. The information is included in the UC's sections below.

3.2 Use Case 1: Crop monitoring in Spain

3.2.1 Definition

The 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. Automation will be implemented such as robotics 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

[67] https://standards.aw-drones.eu/requirements/SORA/standard/242
[68] https://standards.aw-drones.eu/requirements/SORA/standard/261
[69] https://standards.aw-drones.eu/requirements/SORA/standard/400
[70] https://www.easa.europa.eu/en/domains/aircraft-products/etso/list-of-current-etso

unmanned aerial vehicles for image analytics process, and a crop management dashboard to monitor and assess field data and operational field strategies.

3.2.2 PESTEL Analysis

	PESTEL Analysis
Political	Horizon Europe: Innovations and Capacity building Take-up of The European Green Deal, Conflict mitigation and management. Future; From Farm to Fork; Biodiversity National and Local initiatives in Spain
Economic	Pandemic recovery funds. E-commerce and digital infrastructure Market segments
Social	Digitally connected society Rural shrinkage and demographic change Gender and Generational gaps
Technological	Lock-in
Environmental	Natura 2000 Water Scarcity Desertification Gas emissions Organic certification
Legal	EU Regulation 2019/947 EU Regulation 2019/945 Commission Implementing Regulation (EU) 2022/425 EU Decision 2022/002/R U-space

Figure 4 UC1 PESTEL Factors

Political factors

Green Policy: Several political factors are influencing UC1: Include the application and understanding of policy at various levels and the lack of take-up. It is widely considered that **European scale and Regional Interpretation must do more to** reach farmers. **Innovation in Capacity Building will be achieved** through improved communication strategies, relaying investment opportunities in support of grassroots actions. Catalysing initiatives created by regional governance together with applied research programs and creative business sectors that are well attuned to the nuances of local issues and should be given more credence, financial support, and consideration.

Europe's Farm to Fork Strategy is an important opportunity with investment in product distribution in the area. Particularly in the absence of cooperatives which have begun to disband, farms are either closing or becoming subsidiaries of larger businesses, whose interests are often outside of the region. This strategy can be instrumental to supporting smallholders in local food systems and partnerships, a number of data procurement and management strategies to be considered, an important part of UC1 data management initiative.

Conflict between other neighbouring farmers and local rural agents who may not be informed or aware of the research deployments yet feel they should be involved. It may also raise issues about just or fair funding distribution. Regionally, the **VINQ**[71] initiative by the URV and the communiques by **IRTA**[72] are relevant for reaching farmers and end-users. The incorrect interpretation of legal authorities and community conflict arising from lack of understanding in this research case. A mitigating action will be in knowledge and information sharing actions with a multi-actor approach at key stages of engagement.

Economic factors

Economic Growth has been encouraged after the pandemic period through a multi-billion-euro investment programme. In Catalonia and in the region of Tarragona this has been divided through various rural and agricultural regeneration projects that align to and augment existing pre-pandemic regional policy. Subsidies for innovative farms, yet other resources and establishing new markets is difficult. An example is the MercaBarna fruit and vegetable market is now one of the largest in Europe and the only option for Catalan producers.

Diversity in markets is needed. **E-commerce** may provide a new pathway for producers to connect with consumers more directly and therefore providing competitive support and options for organic and small-scale producers. This should be explored further and is also an initiative of local governance included in Data tracking, value chains and product elaboration. For vineyards, access to foreign and international markets is important and this may also be supported by e-commerce and new value chains, supported by data driven certification strategies relating to drones. One of the stakeholders of UC1 - OpenVino - is considering these options.

Social factors

The lack of viable work opportunities and economic downturn in the rural agricultural sector in the region has led to a generational divide, as younger people tend to leave the rural Tarragona region in search of more profitable employment. This results in only a fraction of farmers in the region now under forty years of age. Concurrently, over a five-year period (2017 - 2023) farm worker minimum wage has increased to align with European standards[73], yet sales prices for crops have not risen correspondingly and remain the same. Together with environmental and economic factors, these issues outline some compounding pressures that farms and vineyards in the region face and are among the reasons for farm closures and rural population shrinkage.

Conversely a new demographic of land managers is entering the region, termed locally as ‘neo-rurals’ these young and often foreign families demonstrate a small yet significant reversal of rural shrinkage in the form of positive urban to rural migration. With the ability to work online, this demographic group is attracted by cheaper land and housing prices and a chance to enter the property ladder, gaining access to open green spaces. The influx has been compounded by the COVID 19 Pandemic lockdown period and acceptance of home working. Across the agricultural and regional development sectors there is increasing attention towards the “neo-rural” movement as an attractor of new talent, to promote rural revival new infrastructure is proposed to support a ‘Digital connected society’ (see below) yet it is recognised that this does not constitute nor solve the issue of farm closures.

Coinciding with a move to rural digital connectivity is a move towards organic farming practices, and certification schemes for high quality, environmentally friendly products. This is evidenced by a shift

[71] Forum developed by URV where the farmers can post and answer questions (a university’s initiative)
[72] Institute of Agri-food Research and Technology, Catalonia
[73] La Vanguardia Citation

towards eco-awareness is visible in the consumer market. In summary the neo-rural demographic is both digital and organic.

Technological factors

In demonstration of a technical response to the driving social, economic, and political factors outlined above, several key deployments are relevant to this use case. The Guify.net group has been working as a socially owned internet provider, installing a network of antennas to reach remote locations. This has also supported a LoRa network for IoT devices relevant to sensing and precision agriculture devices. This is currently being supplanted by a government backed 5G networks mobile IoT devices have been considered a necessary precursor to more complex data driven management systems, precision agriculture, both fundamental to the European Drive towards “The Agriculture 4.0” transition and to environmental monitoring.

In-field devices have gained in analytical abilities in recent years, and a new wave of field ready Artificial Intelligence enabled devices, or ‘Edge Computing’ technologies are being deployed. These new capabilities offer further support to the ‘Farm to Fork strategy’ as whole agricultural systems, tracking logistics that connect to new markets. Drone and aerial imaging analytics have also gained traction as their abilities become more accurate as agricultural analytical tools. Large scale governmental studies in the use case area have found the Sentinal 2 satellite imagery sufficient for their needs, yet drones are also now being taken up in conjunction with AI analytics for crop detection and monitoring in scientific research programmes.

It is notable that both farmers are reluctant to deploy nascent digital technologies in the use case region and small-scale suppliers of digital technology have found growth difficult. This ‘lack of uptake’ compared to other regions in Europe and globally has been in part to the small-scale nature of the farms and vineyards in question, with technologies not yet being demonstrated to afford sufficient benefits. Lock-in both technologically and economically has meant that farmers do not have the resources to change their methodology. A move towards organic farming is costly and takes time in years without profitable revenue generation. Again, the ‘VINQ program’ supported by the Catalan Government's Innovation department is working in the region to subsidise farms in this digital transition via microfinancing data collection.

Environmental factors

The use case area of the Priorat and Penedes, part of the ‘Camp de Tarragona regions’ can be described as a closely adjoining patchwork of differing uses, including agricultural, settlements and conservation area. In this case many agricultural zones directly join ‘Natura 2000’ protected conservation areas. This poses management challenges for farmers and new technology deployments. As permissions, legal frameworks, standards, and representative bodies may change markedly by close proximity.
The region of Camp de Tarragona, is also designated as a climate risk zone, already experiencing droughts, water scarcity and distribution issues as well as fire risk and seasonal weather extremes. These environmental factors are compounded to a further risk of desertification into the future.

The vineyards in the use case’s area are particularly prone to water scarcity and have in some cases successfully turned to organic methodologies to combat these issues. Related to this is the turn away from diesel powered farm machinery to lighter battery-operated tools. This trend is positive in its compliance with EU standards for gas emissions reductions and follows the transition towards digital tooling. Many studies are being conducted across the Priorat area to identify successful organic farming and land use techniques. It is the legal factors and organic certification frameworks that lead farmers to improve take-up and evidence-based technology deployments and data procurement. The region attempts to mitigate against fire risk with technologies relating to those of the Crop Monitoring Use Case.

Legal factors

Table 5 UC1 applied standards and regulations

	Regulations & standards	Use Case	Comments
1.	**EU Regulation 2019/947**	✓	Safe drone operations in European airspace
2.	**EU Regulation 2019/945**	✓	Safe drone operations in European airspace
3.	**Commission Implementing Regulation (EU) 2022/425**	✓	Postponing the transition dates for using certain UAS in the "open" category
4.	**EU Decision 2022/002/R**	✓	Amending EU Decision 2019/021/R on "geographical zones", operational authorization forms in the "specific" category, a procedure and forms for cross-border operations, training modules syllabus for remote pilots in the "specific" category, and a new predefined risk assessment

EU Regulation 2019/947 and EU Regulation 2019/945 apply to UC1 since these are the rules to fly drones in all the EU aerial space, and they will be acknowledged. The team members are also aware of the Commission Implementing Regulation (EU) 2022/425 to know which type of drones can be used now and in the future. For this purpose, the UC leader (Noumena) trained a team member to be a pilot and be able to operate in all the possible drones that will be needed for the UC1. In addition, the U-space package[74] is well understood by the team and acknowledged the new movements to manage drone safety although it will not directly apply to them. The other regulations do not apply to the UC1 operations. However, in Spain there is an additional regulation which makes it mandatory to have a civil liability insurance for the drone.

3.2.3 SWOT Analysis

Strengths:

- UAVs can cover large areas quickly and efficiently, making them well-suited for plant disease detection.
- UAVs can capture high-resolution images and video, which can be used to identify the presence and severity of plant diseases.
- UAVs can be equipped with various - sensors, such as thermal cameras, to detect plant diseases that may not be visible to the naked eye.

Weaknesses:

- UAVs may be limited in their ability to access certain areas, such as densely forested or urban environments.
- UAVs may be affected by weather conditions, such as strong winds or heavy rain.
- UAVs may require specialised training and certification to operate, which can be a barrier to adoption.
- R & D intensity

Opportunities

- UAVs can enable early detection of plant diseases, which can help to reduce the spread of the disease and minimise crop damage.

[74] Spain's Ministry of Transport, Mobility, and the Urban Agenda (MITMA) set up a National Action Plan for the Deployment of U-space 2022-2025.

- UAVs can be used to monitor and track the progress of plant diseases over time, providing valuable insights for researchers and farmers.
- UAVs can be used to deliver targeted treatments to infected plants, reducing the need for broad-spectrum pesticides, and increasing the effectiveness of disease control measures.

Threats:

- UAVs may face regulatory hurdles, as there are strict laws and regulations governing the use of drones.
- UAVs may be vulnerable to physical damage or malfunctions, which can disrupt operations.
- UAVs may be perceived as a threat to privacy, which could be a barrier to adoption for farmers.
- Using UAVs for plant disease detection may be costly, particularly if the UAVs require specialised equipment or sensors. This could be a barrier to adoption for farmers or other organisations.
- Competition

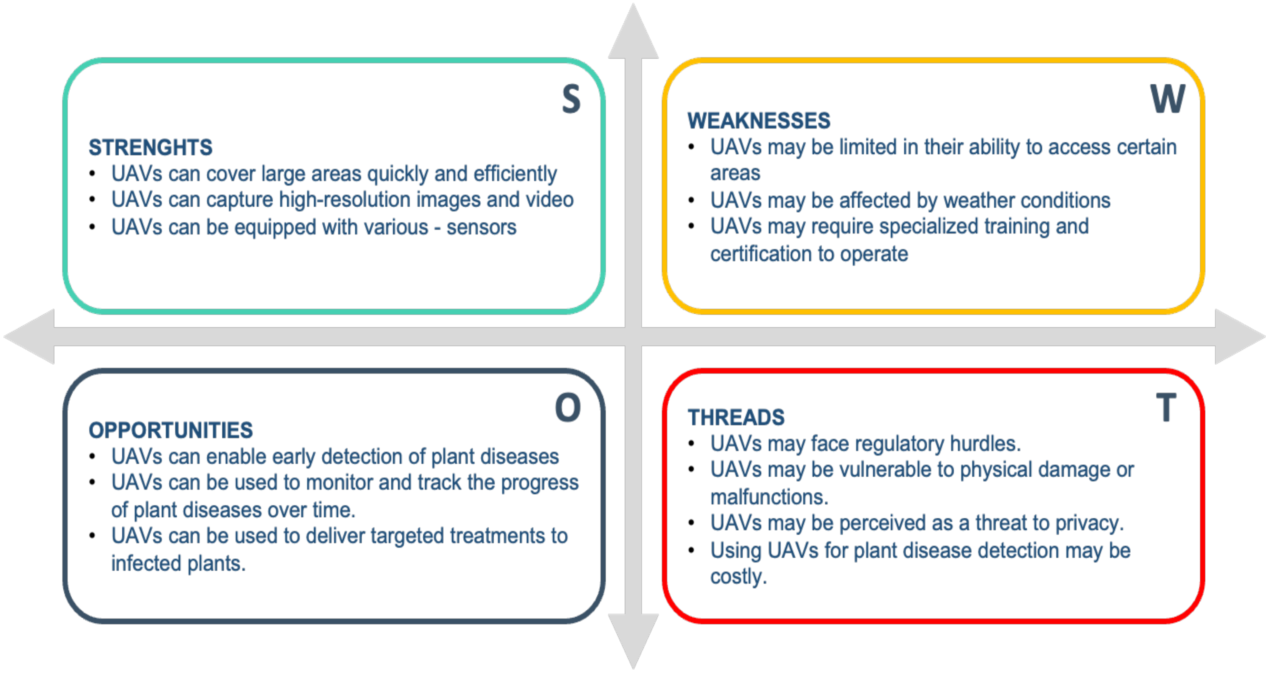

Figure 5 UC1 SWOT

3.3 Use Case 2: Drone spraying in Greece

3.3.1 Definition

The application of plant protection products, 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.

3.3.2 PESTEL Analysis

	PESTEL Analysis
Political	Existing prohibitions and restrictions Volatile legal framework Different views of various political parties Conflicting or overlapping regulations between EU countries
Economic	Purchase and operating costs Specialised training and expertise Increased operational and input efficiency Lower labour costs Independence from fossil fuels Government and private sector incentives or subsidies
Social	Public environmental awareness Concern about the environmental impact of traditional agriculture Accessibility of digital technologies in agriculture Public concern regarding spraying drones Purchase costs potentially not affordable by smallholder farmers
Technological	Availability and reliability of spraying drones Regulations or standards aligned with new technological components Available/accessible infrastructure
Environmental	Reduced use of agrochemicals Reduction or complete elimination of fossil fuel Inherent risks of agricultural spraying operations
Legal	Operational rules and licensing Standards and guidelines Environmental regulations Privacy laws Liability laws

Figure 6 UC2 PESTEL Factors

Political factors

Political factors have a significant impact on the use of spraying drones. One of the greatest challenges that the spraying drone sector faces across the EU is the prohibitions and restrictions that either hinder the widespread adoption of spraying drones or lead to workarounds and ad-hoc legal “windows” in order to perform the operations. Moreover, the entire legal framework is volatile, as government or policy public bodies may decide to adjust the regulations regarding the use of such drones. Political parties may also have different views on the use of spraying drones, which may influence the acceptance of this technology. In addition, the actions of other countries and international organisations may also affect the use of spraying drones in a particular country. Governments and regulatory bodies can also work to streamline or harmonise conflicting or overlapping regulations to avoid confusion and make it easier for users to comply with the law, which is currently a high-priority goal set by EASA.

Economic factors

Economic factors can also play a role in the use of spraying drones to meet the growing demand for environmentally friendly and sustainable practices in Europe. For example, the cost of acquiring and operating spraying drones may be a factor in their use. In addition, the potential benefits of using such drones, such as greater efficiency and lower labour costs, as well as lower labour and energy (especially the independence from fossil fuels) costs may also influence their use. However, spraying drones may require specialised training and expertise, and there may be logistical challenges associated with their use. Governments and companies may also provide incentives or subsidies for the use of spraying drones to encourage their use. Overall, the economic considerations for using spraying drones are likely to vary depending on context and circumstances. To meet growing demand in environmental and sustainable practices in Europe, UC_2 aims to initially provide evidence on the efficiency and effectiveness of spraying UAVs as a sustainable alternative to conventional spraying machinery and promote their adoption (while always taking into consideration the legal framework of each country).

Social factors

Social factors can influence the use of spraying drones in the agricultural or logistics sector. For example, public awareness and concern about the environmental impact of traditional agricultural methods could increase, leading to greater demand for more sustainable solutions such as spraying drones. In addition, the widespread use of digital technologies and data analytics in these sectors could drive the adoption of spraying drones, as these tools can improve efficiency and decision-making. In addition, the attitudes and opinions of key stakeholders such as farmers, consumers and regulators may also influence the use of spraying drones. There may be public concern or resistance to the use of spraying drones, which could affect their acceptance and use. Finally, as spraying drones can be expensive to purchase, the high upfront costs can be a barrier to their adoption, especially for small farmers or businesses. Overall, the social factors surrounding the use of spraying drones are likely to depend on the main needs and priorities of the stakeholders involved, as well as their financial status.

Technological factors

Technological factors are critical in the adoption and use of spraying drones. For example, the availability and reliability of spraying drones, as well as their capabilities and functions, may influence their adoption. In addition, advances in related technologies, such as navigation/positioning systems or services and data analytics, may also impact the use of spraying drones. Furthermore, the development of new regulations or standards for the use of spraying drones may also be linked to their technological attributes, as they should account for new advances following the technological components that are available on the market. Finally, the availability of adequate infrastructure, such as charging stations and maintenance facilities, may also be an environmental factor influencing the use of spraying drones. Overall, technological considerations for the use of spraying drones depend on the context and the goals and requirements of those who use them.

Environmental factors

Environmental factors are of major importance for any aspect of the agricultural sector, and therefore affect drone spraying operations. For instance, the potential environmental benefits of using spraying drones, such as reduced use of pesticides and other chemicals as well as the reduction or complete elimination of fossil fuel use heavily influences their "acceptance" from both the public and the end users alike. However, as spraying operations are directly linked to the environment, and especially natural resources health and biodiversity in different scales, the potential environmental risks of using spraying drones, such as the impact on wildlife and natural habitats, should always be considered, similarly to all conventional spraying machinery.

Legal factors

The main regulations and standards for the use of spraying drones vary between countries of the EU, as the legal considerations related to the use of spraying drones depend on the context and the laws and regulations that apply in a particular location. However, some potentially "common" legal considerations could be:

- Rules and regulations for the operation of drones, such as requirements for registration, licensing, and training of operators.
- Standards and guidelines for the use of pesticides or other chemicals in agriculture, including requirements for labelling, storage and disposal.
- Environmental regulations and protection, such as laws protecting natural habitats, wildlife, and water quality.
- Privacy laws and regulations, such as rules governing the use of data collected by drones and the protection of personal information.
- Liability laws, such as rules on liability for damage or injury caused by drones.

Legal obstacles or difficulties with the implementation of spraying drones can include:

- Lack of clear or consistent regulations or standards governing the use of spraying drones, making it difficult for users to comply with the law and creating confusion.
- Conflicting or overlapping regulations which make it difficult to determine which rules apply in each situation.
- Legal challenges or disputes which can lead to delays in the implementation of spraying drones.
- Similarly to most drones, there may be public concern or legal challenges related to the use of spraying drones, particularly regarding their potential impact on personal privacy or data protection, despite the majority of spraying drones only carries supportive vision systems / cameras to assist the operators in navigating the aircraft when required.

Table 6 UC2 applied standards and regulations

	Regulations & standards	Use Case	Comments
1.	**EU Regulation 2019/947**	✓	Safe drone operations in European airspace
2.	**EU Regulation 2019/945**	✓	Safe drone operations in European airspace
3.	**Commission Implementing Regulation (EU) 2022/425**	✓	Postponing the transition dates for using certain UAS in the "open" category
4.	**EU Decision 2022/002/R**	✓	Amending EU Decision 2019/021/R on "geographical zones", operational authorization forms in the "specific" category, a procedure and forms for cross-border operations, training modules syllabus for remote pilots in the "specific" category, and a new predefined risk assessment
5.	**U-Space** traffic information service[75]	✓	This specification is intended to be a global specification providing components that may be used to satisfy requirements expected to be common to many UTM-related regulations
6.	**U-Space** tracking service	✓	UAS Identification Report

[75] U-space services under number 5 and 6 in Table 6 are given only as references. UC2 does not have to comply with the U-space package now during the demonstrations in WP3.

3.3.3 SWOT Analysis

Strengths

- Spraying drones have the capacity to execute highly targeted applications based on the high-accuracy positioning systems that they have integrated. This reduces over-applications and eliminates negative parameters such as airborne spray drift and toxicities.
- Spraying drones perform ultra-low volume applications, which has the simultaneous benefit of reducing the total volume of agrochemical used (resulting in lower plant protection costs) while also eliminating displacement (droplet and vapour drift) or contamination (leaching and runoff), safeguarding the environment (e.g. water bodies, groundwater and soils) and local ecosystems and biodiversity.
- Spraying drones can operate in electricity, thus eliminating the need for fossil fuels and significantly decreasing operational costs.
- Human health is also protected, as the farmer/operator are far from the location where spraying takes place, while lower residue levels on the produce also safeguards consumers and public health.
- Spraying drones can easily access and operate in remote or “high-risk” areas where the deployment of conventional machinery is unsafe (i.e. due to tractor overturn or roll-over).

Weaknesses

- As several EU countries currently generally prohibit or heavily restrict the use of drones for spraying operations, the regulatory framework of each location is the most significant existing weakness.
- Although significantly more affordable than conventional sprayers, spraying drones are still high-cost investments that might be unaffordable by small farmers.
- Spraying drones require both exceptional knowledge and technical skills to ensure their safe deployment and this often requires the operator to acquire specific licence and certifications based on the operations of interest. To this end, operators must both follow and comply with the regulatory demands, both for law-abiding procedures but also their own safety. These regulations, however, are volatile, and in several cases, farmers have no knowledge regarding existing laws and requirements for UAV spraying.

Opportunities

- Coordination and cooperation can create updated frameworks that enable the safe adoption and use of spraying drones, especially when concrete evidence on their efficiency and safety exist.
- There is high demand in the market, both for direct adoption by farmers that want to purchase spraying drones, but also drone companies that want to offer drone spraying as a service.
- Spraying drones can play a major role in achieving sustainability and resilience goals in the European agricultural sector.
- Heavy-payload drones are a versatile tool that can assist farmers in numerous operations. For example, spraying drones could be used in precision agriculture, helping farmers optimise the use of water, fertiliser, and other resources.

Threats

- Currently, the existing regulatory framework in most EU countries does not sufficiently differentiate drone spraying with aerial spraying with larger aircrafts. Therefore, the greatest threat to the widespread adoption of spraying drones is the conservation of the existing outdated regulatory frameworks in several countries.
- Public opinion plays an important role in the adoption of novel digital tools, and to this end, spraying drones are inherently associated with two concepts that, in the eyes of the public, have negative consequences, namely the use of agrochemicals (mainly due to lack in agricultural knowledge) and drone privacy (mainly due to concerns of mounted imaging sensors / cameras in civil areas).

- As with any plant protection application, the use of agrochemicals can have an enormous impact on the environment and nearby ecosystems when performed recklessly and with no proper knowledge.
- Rivalry forces from larger aircrafts

Figure 7 UC2 SWOT

Within the scope of the present document and the SWOT analysis approach implemented, the most important elements for a spraying drone business case have been identified. As major advantages of spraying drones, their ability in safeguarding the environment and human health set them as a versatile tool that can help farmers become more resilient and efficient in their crop protection operations. The single most important weakness, as well as potential threat, is the outdated regulatory framework of many EU countries that render most UAV spraying applications illegal or very hard to acquire permission for. Therefore, obstacles that might not allow for a change and update in this framework is the most critical threat currently present within the sector. However, the apparent numerous opportunities that exist, and the strongly positive feedback and demand from farmers that want to incorporate spraying drones to their farms, as well as the multiple advantages they offer in combination with their capacity as multi-purpose tools in the agricultural and rural sector in general are expected to play a significant role in this endeavour, ultimately resulting in a more comprehensive framework and flexible regulations.

3.3.4 Summary of Use Case 1 and Use Case 2

The common feature of both cases is that they represent the agricultural sector, and both can offer aerial crop health assessment as drone services, although in ICAERUS – UC1 focuses on the viticulture segment while UC2 focuses on the open-field spraying. Performing the PESTEL and SWOT analyses collaboratively, actually give us a chance to pair the external factors with the internal weaknesses, and then this can highlight the most serious issues any use case faces. In UC1 and UC2 similarly there are some *restrictive external conditions* related to:

⇒ the regulatory environment, weather conditions and licensing as well as demographics and less opportunities for the younger people in rural areas.

Simultaneously, the *internal threats* of both cases (from SWOT diagrams) are associated with:

⇒ the UAVs malfunctions or misuse, high purchasing costs of the UAVs, and privacy concerns in terms of the collected data or visual imageries and community's perception of drone services.

Once these external and internal factors are well described and understood by the UC Leaders – Noumena and AUA, then they can decide whether it is most appropriate to mitigate the internal weaknesses or threats by assigning company / organisation resources to fix the problems, or to reduce the external restrictions identified by the PESTEL framework via abandoning the threatened services of the UAV operations and focusing on the operations that are less challenging.

The SWOT analysis provides a methodical and objective look of what each UC1 or UC2 have in place or what they can work with, and what the local markets in Spain and Greece are also offering, and thus, exploiting market opportunities. Based on all these results, UC Leaders will be able to prepare recommendations and strategies filled in with creative and innovative ideas for further business developments in the regions or communities where the drone services are expected to take place[76].

3.4 Use Case 3: Livestock monitoring in France

3.4.1 Definition

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.

3.4.2 PESTEL Analysis

	PESTEL Analysis
Political	The European Green Deal White papers – Shaping Europe's digital Future; From Farm to Fork; Biodiversity CAP and support to livestock farming
Economic	Factors influencing the revenue available: ● Public support ● International competitiveness ● Offer and Demand evolution.

[76] See more ideas in: Jones B., (1990). "Neighbourhood Planning: A Guide for Citizens and Planners", Routledge Taylor & Francis Group, UK https://www.routledge.com/Neighborhood-Planning-A-Guide-for-Citizens-and-Planners/Jones/p/book/9780918286673

Social	Demography crisis in Livestock Farming Relationship with the other rural stakeholders
Technological	Off the shelf technologies available with various payloads Affordability of the solution is decreasing with the new generation of drones
Environmental	Maintaining livestock systems with high environmental value Need for more sobriety
Legal	EU regulations & standards; French national legislation

Figure 8 UC3 PESTEL Factors

Political factors

Political factors are very strong in the UC3 because policies will influence all the other factors through regulations or economic support. The common agricultural policy in its new version 2023-2027 is a tool for supporting livestock farming that is able to reach the ambitions of the Green Deal and more precisely the “Farm to Fork” and “Biodiversity” strategies. Thus, regarding the direction of the CAP the pasture-based livestock farming systems (that are the object of UC3) can be impacted on legal, economic and social aspects. In the economic aspect:

- These systems benefit from specific support that are vital for them and affect their ability to invest: the sheep or beef direct support gives a subsidy for each eligible animal on the farm; the compensatory payment for natural handicaps that are given to farmers in specific territories (mountain and other disadvantaged areas). These payments can represent from 30 to 80% of the farmer's revenue. It is why the political arbitrage on the outlines of these payments are very impactful and are discussed regularly.
- Political arbitrage on trade agreements can affect very quickly the revenue of livestock farmers and their ability to invest in digital tools.
- Local politics can also support these farming systems by financing the adoption of new technologies to improve the attractivity of farming in these areas. More references on the use of drones might help localities to identify the technology as a tool to finance.

- In the regulatory aspect:
    - Politics can change the regulations regarding drones and specifically on the area where we can fly. To allow complex operations with autonomous drones, politicians might choose to prohibit the flights in open categories in those areas.

Economic factors

Economic factors are a complex matter to be discussed in UC3, because the use of economic indicators will not have a significant impact on technical and economic performances of the farm, especially because livestock farmers do not consider time spent on working in the farm as an economic factor. Farmers do not understand the meaning of “opportunity costs” to be able to see the benefits of economics. Thus, farmers improve their quality of work and life by investing when they have available money, mainly cash, to invest but do not think of net-return on investment. Therefore, every factor (public support, international competitiveness, offers or demand evolution in meat products) that decreases the revenues of livestock farmers threaten their ability to invest in the establishment of a drone system in their business.

Social factors

Social factors are the most important in UC3. On this topic, livestock farming faces major difficulties to attract the current and next generations of workforce, shepherds, and farm holders. Drones will be adopted by livestock farmers only if it facilitates their life while monitoring their herd. That is why the heart of the UC3 is to analyse the impact of using drones on the different dimensions of labour (time, organisational structure, drudgery, attractivity, human-animal relations, etc.). Social factors are not only at the human level. Pastures can be close to villages and their rural inhabitants and stakeholders. Pastoral areas are also multi-use areas with recreational uses (hiking, biking, etc.). The other users or stakeholders can be annoyed by a regular drone flight. That should always be taken into consideration in UC3. On the other hand, UC3 is based on pasture-based systems that are well accepted by the society for respecting nature and environment, maintaining biodiversity, landscapes, and local identity.

Technological factors

Technological factors are important in the adoption of drones as “eyes-in-the-sky” for monitoring herds. The noise has long been a barrier for adoption because of causing stress to animals. Today, the improvement of RGB image quality and the availability of powerful zooms allow the observation of animals from a long distance away (several hundred metres). In the same way thermal cameras are now available and relatively affordable. Technologies that can be fitted to UC3 are now available.

On the other hand, drone technologies should not be upgraded to the detriment of the availability of affordable solutions. For example, the low-end solutions from the market leader DJI have become 25% more expensive with the new generation of products. Should drone technologies continue to be affordable for livestock farmers in the next few years, it is an unknown variable to be considered.

Environmental factors

To meet growing demand in environmental and sustainable practices in Europe, UC3 will facilitate the work of farmers and thus the maintaining of livestock farming systems based on grasslands that have many benefits:

- Stocking carbon on the soil
- Maintaining high biodiversity on the grasslands
- Use very low inputs in the farming systems (especially chemical inputs)

On the other hand, using new complex electronic tools on these systems is not going for more sobriety. UC3 will investigate if the benefits for those livestock farming systems are sufficient to balance the use of these new electronic inputs in the systems.

Legal factors

The use of drones in the UC3 must comply with the European regulations summarised in table 7. Because European regulations give states some flexibility on the application of the rules, some law decrees clarify the application of drone regulations. The main clarifications or national exception are:

- Registering on a national platform is mandatory for all drones equipped with cameras or those >250 g.
- Night flights are forbidden in “open category” and very restricted in standard scenarios.
- Need of a remote identification for drone > 800 g.
- Flights inside public areas in an agglomeration are forbidden in open category or submitted to authorization in standard scenarios.
- Restrictions and prohibitions by areas are resumed here for open category: https://www.geoportail.gouv.fr/donnees/restrictions-uas-categorie-ouverte-et-aeromodelisme
- Restrictions and prohibitions by areas are resumed available on the French aviation system of information: https://www.sia.aviation-civile.gouv.fr/

Table 7 UC3 applied standards and regulations

	Regulations & standards	Use Case	Comments
1.	**EU Regulation 2019/947**	✓	Safe drone operations in European airspace
2.	**EU Regulation 2019/945**	✓	Safe drone operations in European airspace
3.	**Commission Implementing Regulation (EU) 2022/425**	✓	Postponing the transition dates for using certain UAS in the "open" category
4.	**EU Decision 2022/002/R**	✓	Amending EU Decision 2019/021/R on "geographical zones", operational authorization forms in the "specific" category, a procedure and forms for cross-border operations, training modules syllabus for remote pilots in the "specific" category, and a new predefined risk assessment
5.	**U-Space package:** traffic information service; tracking and weather information service	✓	This specification is intended to be a global specification; however, it is not applicable right now to UC3 and is given for future references.

3.4.3 SWOT Analysis

Strengths

- Drones can be used as eye-in-the-sky to easily monitor livestock. From the sky, herds and flock can be observed from a new perspective over vegetation and topography. Drones can also move very quickly. That allows farmers to observe animals in a very large area without moving an inch.
- Off-the-shelf drone and not "use-case-specific" technologies can be used as eyes-in-the-sky to monitor cattle via observations without strenuous walk over rangelands.
- A large part of the flights applied for monitoring cattle can be performed in open category. Thus, it allows farmers themselves to pilot without a time consuming and expensive certification.
- Various sensors (RGB, RGB + zoom, Thermal) are adapted to the large diversity of pastures and rangelands and their livestock farming systems.

Weaknesses

- Limited knowledge of the appropriate use of drones lead to farmers flying BVLOS or without taking care of the regulations and the characteristics of their drones.
- Around a quarter of the rangelands are used by the army as low-level training areas. Thus, flying in those areas is tougher. In open categories, the flight can be restricted to 50 m with the need to notify the army before the flight, or simply prohibited. In "specific category" an analysis of the on-going activation of military areas is necessary to fly and it is time consuming. Thus, time preparation of the flights in such circumstances might be overwhelming and not allowing for the actual flights to take place.
- Monitoring livestock supported by drones imply regular flights in rural areas where people love to enjoy the calm and peace. The inhabitants might be annoyed by regular flights above the pastures close to their residential houses.
- Not all the payloads and drone platforms are affordable by livestock farmers. The usefulness of drones and payloads seem to increase with the cost. Trade-offs should be found and adapted to the different livestock systems.

- Drones fitted for monitoring livestock are not all adapted to all weather conditions. Most of them cannot fly under rain or under strong wind. However, animals must be monitored daily even if drones will be only a supportive tool and not the core of a monitoring process.

Opportunities

- Many drones are affordable in the second-hand market. And the livestock farmers are used to purchasing equipment that way.
- For the most expensive drones and payloads, there is room for developing "drone-as-a-service" models. For example, in future cooperatives and advising companies might train certified pilots and invest with more expensive drones, like drones with thermal cameras, and sell services of animal counting for the large flock in the mountain or search and rescue services for lost animals in pastoral areas.
- Pioneering drone market segment

Figure 9 UC3 SWOT

Threats

- Regulations can change and create new issues for monitoring cattle with drones. For example, the development of U-Space might decrease the area accessible for our use case because it will be difficult for farmers to fly under U-Space conditions. Moreover, rangelands are perceived as empty areas and regulators easily prohibit the area for allowing the test of U-Space corridors or other risky operations.
- There is a rising awareness about sobriety in our society. Using drones for livestock monitoring is using more resources (especially electronic components).

- Drone technologies are an example of planned obsolescence with manufacturers releasing new models almost every year and choosing to stop producing the components of the previous generations of drones.

The business case of monitoring livestock with drones is based on off-the-shelf technology and relatively low-risk flight often compatible with the open category. This is the biggest strength because the business case can be easily deployed and multiplied but also the biggest weakness because livestock farmers with no knowledge of appropriate use of drones can easily misuse it regarding the legal and technological aspects. In the same way, the large variety of payloads that can be used to monitor animals is a strength but also a weakness since some of the payloads like the thermal camera are relatively unaffordable. The ability to find a trade-off between affordability and usefulness will be the key to the business model. In the future, complementary business models based on pay-as-a-service models might appear allowing a collective use of most expensive technologies by cooperatives or advising companies. On the other hand, regulations can change and thoroughly influence this use case, because it is in an experimental phase and yet not well perceived by the other stakeholders and regulators. Just as well as the need for more sobriety in our society might reject any use of more technologies in activities where they were unpopular.

3.5 Use Case 4: Forestry and biodiversity in Lithuania

3.5.1 Definition

UAVs are becoming an essential tool in forestry research and monitoring thanks to their capacity for early fire detection and control (Kinaneva et al., 2019), monitoring active forest fire and supporting firefighting teams on duty (Simões et al., 2020), forest insect pest and disease monitoring (Duarte et al., 2022), as well as classify species, quantify spatial gaps (Torresan et al., 2017). 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. The UC4 investigates the mentioned opportunities.

3.5.2 PESTEL Analysis

	PESTEL Analysis
Political	• The European Green Deal • White papers – Shaping Europe's Digital Future; From Farm to Fork; Biodiversity • Horizon Europe: Innovations and Capacity building • National Forest Agreement (Lithuania) • New EU Forest strategy for 2030.
Economic	• Economic growth • Public-Private partnership • Greening business and community services • Drones and related services start-ups
Social	• Rural Development • Reliance on technology • Digital connected society

	• Eco Awareness and Biodiversity • Ageing population
Technological	• Emergence of 5G • Hyperspectral data, Open data • Cloud computing • Internet of Things
Environmental	• Sustainable forest management • CO2 assessment
Legal	• Comply with national regulations • Comply with EU regulations

Figure 10 UC4 PESTEL Factors

Political factors

The new EU Forest Strategy[77] is one of the flagship initiatives of the European Green Deal[78] and builds on the EU biodiversity strategy for 2030[79]. The strategy will contribute to achieving the EU's biodiversity objectives and greenhouse gas emission reduction target of at least 55% by 2030 and climate neutrality by 2050. It recognises the central and multifunctional role of forests and the contribution of foresters and the entire forest-based value chain for achieving a sustainable and climate-neutral economy by 2050 and preserving lively and prosperous rural areas.

The strategy is accompanied by two staff working documents: Staff Working Document on the Stakeholder Consultation and Evidence Base and Staff Working Document on the 3 Billion Tree Planting Pledge for 2030[80].

The National Forest Agreement[81] is the first vision for the future of Lithuania's forests, based on partnership and open, systematic, and constructive dialogue, which provides a common vision for the future of Lithuania's forests agreed upon by stakeholders.

Economic factors

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**[82]. And this will ensure not just **Greening business** but also **Drones and related services start-ups** development and **Economic growth** in general. By developing **public-private partnerships** and **community services** we can increase economic sustainability.

Social factors

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[77] https://ec.europa.eu/info/files/communication-new-eu-forest-strategy-2030
[78] https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en
[79] https://ec.europa.eu/environment/strategy/biodiversity-strategy-2030_en
[80] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021SC0652&qid=1672909643093
[81] https://nacionalinismiskususitarimas.lt/
[82] https://www.weforum.org/press/2020/08/us-businesses-governments-and-non-profits-join-global-push-for-1-trillion-trees/

Development and implementation of forest monitoring by the purpose of using drone solutions which would reduce the burden of monitoring large areas of forests periodically. Reducing the workload and the time needed to detect potential risk areas at the same time while reducing the manpower needed for such tasks. In addition, the acceptance of the utilisation of drones and mathematical analysis systems for forest monitoring can be hindered by the view that new technologies cost too much and they will reduce job opportunities in the field. The socioeconomic benefits and improvements of such a system should be clearly addressed and channelled to the public.

Technological factors

Hyperspectral imaging and thermal imaging cameras will be successfully paired with UAVs for an inflow of valuable specific information analysis which will give a clear picture and insight of the current forest health and wildlife behaviour. Ensure optimal conditions (angle, vibration dampening, stability, etc.) for the hyperspectral and thermal data collection during the flight. Ensure sufficient flight time for data collection and monitoring.

Environmental factors

According to the EU forest strategy 2030, GHG emissions and removals from forests and forest products will play a key role in achieving the Union's ambitious target of absorbing 310 million tonnes of carbon dioxide equivalents. Sustainable forest management plays the leading role in this process, which approaches are based on a recognised and internationally agreed dynamic approach to the sustainable forest management concept.

Legal factors

Apart from the EU regulations that UC4 would take into consideration, there are three national orders of the Lithuanian Transport Competence Agency that the team would need to comply with (see table 8).

Mission planning and control will comply with local governmental regulations. Carried-out missions will not disturb everyday air traffic and will not include flying over protected or restricted spaces so as not to create any precedents.

Mission planning must be done carefully to comply with all laws and regulations and critical airspace would not be included in the flight path. Two-way communication with governmental institutions must be established for the purposes of the demonstration.

Table 8 UC4 *applied standards and regulations*

	Regulations & standards	Use Case	Comments
1.	**EU Regulation 2019/947**	✓	Safe drone operations in European airspace
2.	**EU Regulation 2019/945**	✓	Safe drone operations in European airspace
3.	**Commission Implementing Regulation (EU) 2022/425**	✓	Postponing the transition dates for using certain UAS in the “open” category
4.	**EU Decision 2022/002/R**	✓	Amending EU Decision 2019/021/R on “geographical zones”, operational authorization forms in the “specific” category, a procedure and forms for cross-border

			operations, training modules syllabus for remote pilots in the “specific” category, and a new predefined risk assessment
5.	**U-Space package:** traffic information service; tracking and weather information service	✓	This specification is intended to be a global specification; however, it is not applicable yet and is referenced here for future purposes.
6.	**ISO16119** Forestry Machinery	✓	Forestry and biodiversity
7.	**European Technical Standard Order (ETSO) for drone equipment**	✓	Voluntary industry standards
8.	No. 2-306 - Concerning the approval of the procedures for issuing a lightweight unmanned aircraft system user certificate	✓	National orders of the director of the Public Transport Competence Agency. From 2021 January 11: 1) All drone users whose devices weigh more than 250g or have a sensor capable of capturing personal data must register with the Transport Competence Agency (TCA) online system. 2) The registrant receives an authentic drone user registration number with which he must tag all the drones he owns. 3) Drone users, depending on the drone subcategory they have, must: - take a theory course; - pass an online exam in the TCA system; - or prepare for the theory exam and pass it in the TCA exam class. There are three categories of drone flights, with different rules and requirements for flights: open, special, and certified.
9.	No. 2-307 -Approval of the procedural description of the certificate confirming his registration issued to the user of the unmanned aircraft system	✓	
10.	No. 2-308 - On the approval of the procedure for the documents proving the qualification of the remote pilot of the unmanned aircraft system	✓	

3.5.3 SWOT Analysis

Strengths

- High spatial resolution
- No negative impact due to cloud cover
- Cost-effectiveness
- Enhanced monitoring

- Assist ground surveys
- Safer work environment
- Efficient data collection
- Consistent data
- Greater access to inaccessible areas

Weaknesses

- Small payload
- Adversely affected by weather conditions
- Limited flight endurance
- Safety issues - distance to people and aircraft
- R & D intensity and high-quality resources with mathematical degrees required
- Affordability – it could become expensive

Opportunities

- Environmentally friendly process
- Growing market
- Reduction of workload
- Precise health assessment of forest and biodiversity
- Pioneering use case

Threats

- Policies and regulations
- Visual line of sight
- Certification
- Rivalry forces from the satellite services
- Competition

Figure 11 UC4 SWOT

UAVs are becoming a great asset to foresters. They provide regularity of data, which allows forest owners to make informed and accurate decisions based on the species composition and health of the forest. UAVs can be used to monitor tree health, forest fires, and wildlife and can aid in compliance monitoring reporting. They are a cost-effective tool that can be used in various aspects of forestry. However, with the increasing rules and regulations being implemented, constraints are arising with the constant visual line of sight and certifications required to operate. UAVs are a continually growing market that provides numerous opportunities for the industry while enhancing the safety of the workers.

3.6 Use Case 5: Rural logistics, North Macedonia

3.6.1 Definition

The scope 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.

3.6.2 PESTEL Analysis

PEST Analysis

Political	Volatile legal framework Unauthorised autonomous UAV flights Not widespread solution for logistics
Economic	Purchase, maintenance, and operating costs Specialized training and expertise Requirement of a backup transport solution Increased operational efficiency Independence from fossil fuels
Social	Public resistance to new technologies Invasion of privacy Risk of accidents in urban implementations Negative public conception of military drones
Technological	Detect And Avoid (DAA) technology not fully mature yet Challenging UAV communication in some environments Dependency on many other technologies
Environmental	UAV operations are strongly affected from weather conditions Reduction of fossil fuel Reduction of toxic pollutants
Legal	Operational rules and licensing Standards and guidelines Unclear designation of responsibilities

Figure 12 UC5 PESTEL Factors

Political factors

Political factors may strongly affect the UAVs services and operations in all modern countries. Although the establishment of the European Aviation Safety Agency (EASA) in 2002 set a regulatory framework to ensure the safety of EU citizens and the environmental protection, there are still several legal aspects that remain unclear. For instance, autonomous flights of UAVs are not currently authorized and probably several years will be required for the emergence of its solution. These aspects typically hinder the implementation of UAVs, particularly in applications that are not widespread and commonly used yet, such as drone logistics. Nevertheless, in most EU countries there is an ongoing process of digitalisation and innovation in almost every governmental sector. This fact is promising for the embracement of drone technology and the adjustment of current or future regulations for legitimate implementations of drones in a variety of topics. Especially for North Macedonia (which is one of the selected demonstration sites within the UC5 of the ICAERUS project), the ambition and effort of the country to become an EU member is profound in the legislation scheme, aiming to comply with the EU standards.

Economic factors

The UAVs systems are becoming a potential alternative for logistics activities (Raj et al., 2019), apparently with a significant economic impact on global societies. In fact, many companies are involved in UAV development for transportation and deliveries (i.e., Amazon, DHL, Google, etc.), dramatically increasing the sector’s demand for the employment of human resources. However, several economic factors, such as inflation, may impede the process of adopting UAV concepts, technologies, and equipment as a valuable service in logistics, particularly in rural or remote areas. In addition, the difficulty to evaluate and predict maintenance costs of UAVs (Chapman, 2017), as well as the cost redundancy linked with the requirement of a backup transport solution (i.e., to ensure service in all weather conditions), are contributing to the global market's hesitation for the development of an integrated drone logistics dependence plan. Nevertheless, the recent pandemic of COVID-19 highlighted the need for a reliable transportation option, mainly for lightweight products of importance (i.e., documents, medicine, etc.) during lockdowns or to inaccessible areas. It is worth mentioning that since UAV logistics is still an emerging method, the implementation cost is expected to be quite higher in the initial stages of industry development than other types of conventional logistics services.

Social factors

The acceptance of UAV logistics services among the inhabitants of a country depends on the degree of their engagement in new technologies. Typically, elderly people are more hesitant to change or replace their routine with recently introduced technologies, even if they realize the potential benefits that technological products have to offer. However, the post-pandemic awareness of the population about the contribution of drones to several hazardous situations and emergencies (i.e., saving lives), affected the public's opinion, making them more eager to utilize new technologies. On the contrary, there are two main concerns of the population with a sociocultural impact: a) concerns about the invasion of privacy (Turner, 2015) and, b) concerns about the risk of accidents in urban use (Clothier et al., 2015). In addition, there is generally a negative conception among the inhabitants for the implementation of military drones, particularly in urban areas. For the UC5 pilot sites, the demographic profile of the population, especially in the region of Strumica (North Macedonia) which is mainly an agricultural area, is ideal for the embracement of drone logistics services, due to the high demand for fast and reliable delivery of small weight agricultural inputs (parts, fertilisers, pesticides, etc.).

Technological factors

The presence of many leading companies in Europe which are investing in the drone logistics sector, enhance their technological growth. For example, many research projects receive European financial support, which provides a favourable breeding ground for the development of this sector (Dhote et al., 2020). Thus, a wide range of technological solutions are available and can be implemented in a variety of different cases. Despite that, there are still some technological issues regarding the use of drones in delivery operations. For instance, the detect and avoid (DAA) principle, which is vital for drones and public safety, is not yet fully mature and the communication (frequency bands) of the operator with the drone could be a very complex problem in some environments. In general, the main drawback of drone deployment is the dependency on many other technologies, such as aviation, autonomy, surveillance, communication, manufacturing. In UC5 there will be an effort to provide sufficient information about the readiness of the UAV technologies and the UAV market in order to be implemented as a standard procedure for serving people in rural areas. Additionally, insights about the technological infrastructure capacities for utilising the UAVs to improve rural logistics in the target countries of the demonstration (Greece and North Macedonia).

Environmental factors

The deployment of drones in transportations and goods delivery has a low environmental impact (Goodchild et al., 2018), although they are strongly affected by the weather conditions (Watkins et al., 2020). The UC5 will serve as an example for the improvement of the environment conditions with the usage of vehicles that will not directly emit GHG and other toxic pollutants in comparison with the conventional transportation activities (fuel powered vehicles).

Legal factors

There is ongoing legislative work at the European level (i.e., EASA), although there are still remaining issues needing clarification. For instance, there must be a clear designation of responsibilities (drone manufacturer, operator, pilot) for drone operations. In addition, on a national level in North Macedonia, there is a regulation on the conditions under which an aircraft without a crew can fly in the air space (Official Gazette of Republic of North Macedonia no.14/06, 24/07, 103/08 67/10, 24/12, 80/12, 155/12, 42/14, 97/15, 152/15, 27/16, 31/16) which is not a complete regulation of UAV operations. The new legislative framework for UAV operations in the country will be announced on 01.07.2023 or at the beginning of 2024 and is expected to be identical with the EU UAV legislation.

Table 9 UC5 applied standards and regulations

	Regulations & standards	Use Case	Comments
1.	**EU Regulation 2019/947**	✓	Safe drone operations in European airspace
2.	**EU Regulation 2019/945**	✓	Safe drone operations in European airspace
3.	**Commission Implementing Regulation (EU) 2022/425**	✓	Postponing the transition dates for using certain UAS in the "open" category
4.	**EU Decision 2022/002/R**	✓	Amending EU Decision 2019/021/R on "geographical zones", operational authorization forms in the "specific" category, a procedure and forms for cross-border operations, training modules syllabus for remote pilots in the "specific" category, and a new predefined risk assessment
5.	**U-Space package:** traffic information service; tracking and weather information service	✓	This package is not applicable yet, however it is given for future references.
6.	**Standard 120**	✓	Specific operations risk assessment
7.	**Standard 242**	✓	Part of **ISO 16119** specific requirements
8.	**Standard 261**	✓	Support of drone applications
9.	**Standard 400**	(See § Legal factors)	Use case scenario for payload delivery

3.6.3 SWOT Analysis

Strengths

- Increased speed to transport urgent medical products.
- Easy access to remote areas.
- Flexibility of transport planning.
- Increase delivery efficiency.
- Improving the responsiveness of transport services.
- Reduced delivery costs.
- Reduced carbon footprint.

Weaknesses

- Limited operating ranges.
- Limited payload (size and mass).
- Sensitivity to weather conditions.

- Need for better regulation in the aviation sector.
- High Research & Development (R&D) costs of systems equipping and supporting the UAVs.
- Difficulties regarding the reliability (many models are prototypes).

Opportunities

- Reduction of public sector healthcare and elderly care costs.
- Improvement of the quality of medical transport.
- New applications.
- Innovation for new services/options.
- Transport service to remote areas.
- New emerging market.
- Increased operating range (charging stations and solar panels).

Threats

- Safety issues.
- Restrictive regulatory framework.
- Risk or rejection by the public (privacy, security).
- Failure rate.
- Reorganization/adaptation of the traditional road sector.
- Rivalry forces from the other transport modes.
- Competition

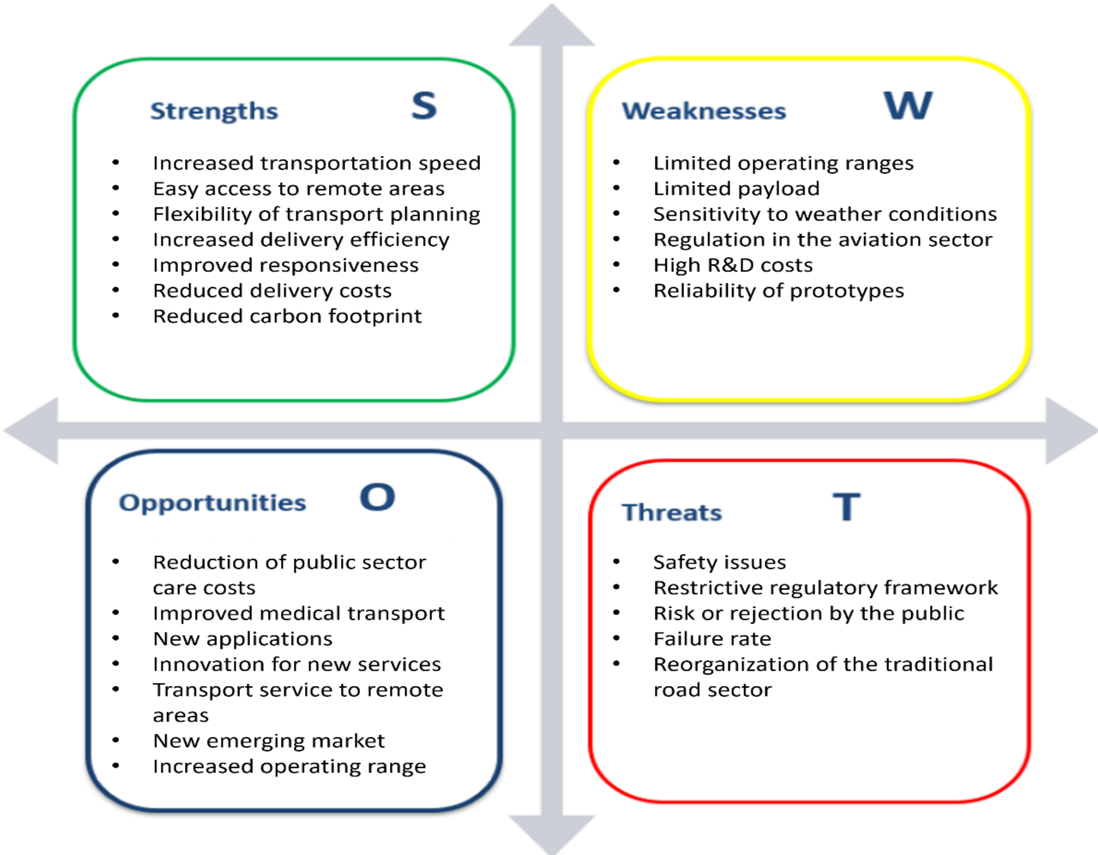

Figure 13 UC5 SWOT

Within the scope of the present document and the SWOT analysis approach implemented, the most important elements for drone logistics operations have been identified. The main advantages of drone deployment for transportations are the fast delivery of important parcels containing either documents or medical supplies, as well as the access to remote areas and the reduction of delivery costs. The most significant weaknesses of the drone logistics operation are the limited range and payload, combined with the high sensitivity to weather conditions. In addition, the main threats following the deployment of drones are the safety of the equipment and public, the restrictive and not yet fully clarified regulatory framework and issues related with the privacy or security of the people. Nevertheless, there is a plethora of opportunities that arise with the implementation of drones in the logistics sector, which can potentially improve the inhabitants' lives, especially in remote and rural areas.

3.6.4 Summary of Use Case 3, Use Case 4 and Use Case 5

Consistent business analysis and strategic planning is the most appropriate way of managing new growth opportunities, strengths, and operational risks[83]. The last three use cases in this deliverable represent different industries – agriculture and logistics – and both they can offer various segments monitoring as drone services and improve environmental credentials of the end-users. In ICAERUS – UC3 focuses on the livestock segment, UC4 focuses on forestry & biodiversity and UC5 – rural logistics, and while there are divergences among three of them as the analysis in section §3.4, §3.5 and §3.6 shows they have common features too. Performing the PESTEL and SWOT analyses in tandem, give us a chance to pair the external factors with the internal weaknesses, and then this can highlight the most serious issues any use case faces.

In UC3, UC4 and UC5, there are some *restrictive external conditions* related to:

⇒ the regulatory environment,
⇒ sensitive to weather conditions and certification
⇒ demographics of local areas,
⇒ and safety & security issues.

Simultaneously, the *internal threats* of the cases (from SWOT diagrams) are associated with:

⇒ high R&D costs, software development uncertainty,
⇒ unresolved scientific and theoretical questions,
⇒ payloads limitation, affordability of the technology is doubtful,
⇒ privacy concerns about the collected data,
⇒ competition from alternative services,
⇒ and community's perception of drone services.

Once these external and internal factors are well described and understood by the UC Leaders – IDELE, ART and GeoSense – they can decide whether and how to mitigate the internal weaknesses or threats by assigning company resources to fix the problems, or to reduce the external restrictive factors identified by the PESTEL framework via abandoning the threatened services of the UAV operations and focusing on the operations that are less challenging. In case this is unlikely then they will have to decide how to manage the existing internal threats.

Finally, the SWOT can be combined with other business analysis to obtain a full understanding of market conditions. The SWOT analysis, *per se*, provides a methodical and objective picture of what each UC3, UC4 or UC5 have in place or what they can work with, and what the local markets in France, Lithuania or Greece /North Macedonia are also offering, and thus, exploiting all market opportunities. Based on the results from both analyses in this report, UC Leaders may be in a position to prepare recommendations and strategies filled in with novel and innovative ideas for further business developments in their respective market segments.

[83] See practical examples in: Hussey E. D., (1998) "Strategic Management: From Theory to Implementation", 4th Edition, Butterworth-Heinemann, Oxford, Reed Educational and Professional Publishing Ltd., United Kingdom

4. Use Cases' Risk Assessment of Operations

This chapter focuses on the risk assessment process of all project's use cases. By regulatory requirements in the European Union, safety risk assessment in the drone industry is conducted in a four-phase model (UAS Regulation, EU 2019/947)[84]:

Phase I - Safety Hazard Identification: incidents such as near misses or latent conditions that have led or could have led to a degradation of the safety of drone operations are identified.
Phase II - Safety Risk Assessment: All identified hazards are assessed for severity and likelihood of operational risk.
Phase III - Safety Risk Mitigation: Risk mitigation measures are identified depending on the level of acceptance of the operational risk.
Phase IV - Safety Documentation: Not only the results, but also the entire process of UAS security risk assessment should be documented to ensure continuous security.

Potential safety risks associated with drone operations are listed below:

- High altitude loss
- Loss of control
- Loss of transmission
- Collision with manned or unmanned aircraft or buildings, power lines
- Partial failure or loss of navigation systems
- Severe weather or climatic events
- Pilot is unfamiliar with the area
- Take-off and landing incidents such as undershooting or overshooting

In the case of ICAERUS' use cases, depending on the UAS operations and constructed risk assessment model, either SORA methodology or PDRAs will be applied. Both forms were explained in section 2.3 of this document. Here it will be mentioned only the PDRA G-03 "Linear inspections, agricultural works" in terms of the second amendment of the EU Decision 2019/021/R amended by EU Decision 2022/002/R. For the operators that intend to perform the UAS operations under this PDRA G-03, a 10-step process has been defined in accordance with the EU Decision 2022/002/R[85]:

Step 1: Description of the concept of operations

Step 2: Determination of the intrinsic UAS ground risk class

Step 3: Determination of the final ground risk class

Step 4 to 6: Air risk assessment

Step 7: Determination of the final SAIL

Step 8: Identification of operational safety objectives

Step 9: Adjacent area / airspace considerations

Step 10: Comprehensive safety portfolio

Finally, to identify the risks in each of the UCs, their leaders used a risk matrix, which is usually applied in risk management and assessment to define the level of risk and uncertainty, considering the likelihood versus severity of consequences in each area of operations. This increases transparency of the process and supports the decision-making of each organisation.

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[84] See more details about Regulation (EU) 2019/947 in Section 3.1. Additional information at: https://mydroneguide.com/drone-risk-assessment/

[85] *https://www.easa.europa.eu/en/downloads/135912/en*

4.1 Use Case 1

Risk matrix - identification of risks related to UC1 crop monitoring activities

Risk management and assessment is based on different levels that could compromise the correct operation end to end for crop monitoring data collection. This means that the following risk assessment will include technical risks during scheduled flights and risks related to the software during data processing.

The following UC1 trained a team member with engineering background to fly a drone during the data collection process in the school "Aerocamaras", to obtain the official AESA (the Spanish Aviation Authority) titles for open and specific category as well as for a radio operator.

4.1.1.1 Safety Risk Assessment Model

Risk assessment is a systemic process to frame possible risks related to crop monitoring flight operations. This process mentions potential hazards or vulnerabilities that would compromise the operations. During this process, it is also evaluated how frequently these hazards could eventually happen and impact size of mentioned risks or hazards.

- **Identify the hazards/risks:** Identify potential risks associated with drones and crop monitoring operations this process includes the technicality in which the drone will be operating, materials to be included during flight operations and finally the weather conditions.

- **Evaluate the risks:** The following step will include how many times the potential risk is occurring during crop monitoring flight operation and examine the severity of the potential hazards caused.

- **Develop control measures:** After measuring the risks which had been identified during the step before. The following step is to understand how these risks could be mitigated. This process involves checking and maintaining the hardware and components that will be used during the flight operation. Check for the necessary updates (software, regulations, new standards, etc.) to have adequate performance during crop monitoring.

- **Implement the control measures:** Before the last step is to understand and check all the workflow involved in test flights made to explore the risk assessment process. During this step the main idea is fine tuning all the workflow to detect and how all risks will have the right intervention to continue the crop monitoring flight operations.

- **Review and update the assessment:** The final step is to review the steps mentioned before to refine details and improve the intervention needed in potential risks.

4.1.1.2 Risk assessment steps in UC1 and explanation

SORA is a risk assessment method that is used to evaluate the risks associated with specific UAS operations. It is a systematic process for identifying, assessing, and mitigating risks associated with UAS operations. The assessment considers the operational environment, the aircraft, and the crew, as well as the procedures and processes used during the operation. The goal of SORA is to ensure that the operation can be conducted safely and in compliance with regulations. Here are some potential safety risks related to drones and crop monitoring (see Table 10 for more details)

1.) <u>Inaccurate data gathering:</u> wrong data collected is one of the most crucial risks to mitigate to avoid feed trained models with incorrect data.

2.) Incorrect data processing practices: this item referred to avoid running incorrect processes to extract data from crop monitoring operations.
3.) Run out of battery: control the flight operation with the right amount of the power supply.
4.) Equipment contamination: any damage to the hardware used for crop monitoring flight operation.
5.) Crop safety: the following risk means any crop damage that could represent financial loss for farmer owners or stakeholders.
6.) Data security: ensure that the information collected will be stored with the necessary security protocols in order to protect farmers', vineyard owners' or stakeholders' information.
7.) Low bandwidth: check and set the right setup to perform with high quality.

When conducting a Specific Operations Risk Assessment (SORA) for a drone operation that is considered to be of low risk level, the process may be less detailed and formal than for a higher risk operation. However, it's important to follow a systematic process to ensure that all potential hazards have been identified and risks have been assessed. The steps for a low-risk operation are like those for a higher risk operation, but they may be simplified or streamlined.

Identify the hazards: This step involves identifying all the potential hazards associated with the drone operation, such as collision with other aircraft, loss of control, and failure of equipment.

Assess the risks: Once the hazards have been identified, the next step is to assess the risks associated with each hazard. This step involves evaluating the likelihood and severity of each hazard occurring, and determining the potential impact on people, property, and the environment.

Implement risk mitigation measures: After the risks have been assessed, the next step is to implement measures to mitigate those risks. This may include developing and implementing procedures to prevent the hazards from occurring, or procedures to limit the impact of a hazard if it does occur.

Evaluate the effectiveness of risk mitigation measures: After the risk mitigation measures have been implemented, the next step is to evaluate their effectiveness. This step involves monitoring and reviewing the operation to ensure that the measures are adequate, and that the operation is being conducted safely.

Continuously monitor and review: The SORA process should be continuously monitored and reviewed, and adjustments should be made as necessary. This step involves monitoring the operation to identify any new hazards or changes in the risks associated with the operation and updating the SORA as necessary.

It is important to note that since we do not expect to fly over people or inhabitants, not participating in the UC1, and we will always have the drone on VLOS all the operations will be of low risk. For this reason, the UC1 is not required to fill any written documentation about risk assessment but however, the team is well informed of how to proceed in unusual situations by thoroughly studying the drone manual.

Table 10 UC1 Risk Identification

Risk ID	Risk Description incl. Cause	Impact / Consequence	Likelihood (1...4)	Severity (1...4)	Risk Owner	Proposed Risk Mitigation measures	Treatment Action	Status
1	Safety hazard identification failure caused by error in object identification through artificial inteligence.	Near misses to workers, objects and crop damage,	2	4	UC1	Improved image recognition to include wildlife and human / worker identification.	- Periodic reporting on state-of-the-art analysis. - Integrate and design-in protocols for human / worker detection in-field with integration for improved artificial intelligence algorithms. - Alignment with policy.	Open
2	Safety risk assesment errors caused by inacurate data	Inacurate datasets resulting in physical damages	2	4	UC1	Analytics and revision and backup protocols	- Second and third safety check protocols implemented. - Virtual or dry run real world flight tests and checks.	Open
3	Safety risk mitigation failure caused by failure in adjustments to percieved risks.	Flight failure or inacurate datasets and results	2	3	UC1	Group and third party assesments to align risk observations	- Second opinions and prediction analyses conducted. - Preflight check protocols established	Open
4	Safety risk documentation failure caused by inacurate data, communication or failed reporting	Increased risk of malpractise and flight failure.	2	3	UC1	Improved data structuring and reporting measures	- Synthesising and aligning dataset sharing protocols - Reporting and analytics and checks communicated	Open
5	Flight Time	Run time of battery limit operational flight	1	2	UC1	Consider evaluate distribution for operational flight	- Consider evaluate area distribution for operational flight	Open

6	Equipment contamination	Sensors contaminated by propelled sprayers	2	2	UC1	Equipement review	- Effective cleaning monitoring system and set a check list for equiment conditions each flight. - ICAERUS training program for best practices to clean equipment.	Open
7	Data security and privacy caused by poor data infrastructure	Data breaches or theft	2	2	UC1	Improved data security	- Implementing relevant data security measures. - Deploying security software. - Periodic assessments and tests. - Updating to state of the art - ICAERUS partners will schedule security training protocols in case is needed.	Open
8	Crop Safety	Drift into Adjacent Cropped Areas	4	1	UC1	Drift Assessment	Estimate possible sources which would cause drift and evaluate if could be compensated or if drift is caused by weather conditions	Open

4.2 Use Case 2

Risk matrix - identification of risks related to UC2 drone spraying activities

As drone spraying is an open-field operation, numerous parameters can intervene with the experimental iterations of UC2, and it is therefore critical that potential risks should be carefully considered and mitigation steps are taken in a timely and robust manner, e.g., by creating and implementing a detailed risk management plan and by following all existing safety guidelines.

In the case of drone spraying activities, the process of risk assessment involves identifying the potential risks or hazards associated with the use of drones for spraying and evaluating the likelihood and potential impact of those hazards.

4.2.1.1 Safety Risk Assessment Model

A safety risk assessment model for spraying drones involves assessing the potential risks associated with the physical use of drones for spraying applications and implementing mitigation measures. This could include factors such as the safety of the operation based on environmental conditions and field terrain, the possibility of the drone malfunctioning before take-off or during the flight, and the possibility of the drone losing control and crashing. Moreover, logistic risks are also considered, given the current volatile situation of the supply chain in the EU. The aim of the model would be to identify and address potential hazards to prevent accidents and ensure the safe operation of the spraying drone.

There are several steps that can be taken in a risk assessment for the use of spraying drones:

- **Identify the hazards/risks**: The first step is to identify the potential hazards associated with using drones for spraying applications. This could include spraying operations, the drone itself, technological components or experimental materials and the environmental conditions in which the drone will be operating.
- **Evaluate the risks**: The next step is to evaluate the risks associated with each identified risk. This could involve considering the likelihood of the risk occurring, as well as its potential impact in case it manifests.
- **Develop control measures**: Once the risks have been identified and evaluated, the next step is to develop control measures to mitigate those risks. This could include implementing safety protocols for flights and spraying operations, conducting regular maintenance on the drones, purchase all consumables while the logistics chain is operating normally (considering that this does not include chemicals or other substances that potentially expire or degrade with time) and the operators stay updated on the most recent regulatory updates and guidelines on how to safely use spraying drones.
- **Implement the control measures**: The final step is to integrate all devised control measures into the experimental pipeline. This could involve implementing safety procedures and regular inspections and maintenance, while also considering various micro-optimisations in case a risk occurs (e.g. the spare drone is located near the experimental site, so in case of a crash of the primary UAV, the secondary aircraft can be deployed in a few hours).
- **Review and update the assessment**: It is important to regularly review and update the risk management plan to ensure that it remains effective and addresses any new or changing risks/hazards. This is achieved by conducting regular research checks and frequently consulting with other experts and stakeholders of the sector.

4.2.1.2 Risk assessment steps in UC2 and explanation

Within UC2, a total of eight (8) primary existing risks have been identified, which will exist throughout the duration of the experimental procedures as inherent drone spraying experiment parameters. By evaluating each of these risks, a secondary arbitrary classification can be done, setting the first two (2) risks on the list as "*Primary*", and the remaining six (6) as "*Secondary*", not only based on their severity and/or likelihood, but also considering the level which the implemented mitigation measures have eliminated its occurrence possibility or impact. The risks are the following:

1. Deployed drone crush, resulting in a delay of experimental iterations and the timeline of UC2 is affected. The main mitigation measure is to have an additional spraying drone ready to be deployed in case the primary aircraft cannot perform the experimental flights.
2. Extended period of extreme environmental conditions that do not allow for experimental spraying measurements. This is the parameter which we can have the least control over, and the main mitigation measure is to start the experimental iterations from very early each cultivation season, to ensure that adequate iterations can take place successfully every year.

3. Disease-infestation outbreaks cause damage to the canopy of the experimental vineyard, not allowing for reliable measurements. The main treatment action is to identify multiple experimental locations and then move to another one if the conditions are not optimal in the initial location.
4. Malfunction of spraying components (e.g., nozzles, pumps, and flowmeters) and/or experimental equipment (meteorological sensors) are damaged and the timeline of UC2 is affected. To eliminate this risk, spare components have been acquired for all experimental equipment.
5. Inability to purchase experimental consumables due to a disruption of the logistics chain resulting in limited access to necessary materials (e.g., spraying tracer, collectors), thus affecting the experimental iterations. The mitigation strategy for this risk is to purchase all experimental consumables upfront, at quantities to suffice for the entire duration of the experiment.
6. UAV Battery life decreases over time due to wear off thus limiting the time of experimental flights. Naturally, to eliminate this risk, the strategy is to purchase multiple spare batteries for the aircrafts (both primary and secondary drones; in case they are different models and therefore operate with different battery models).
7. Connectivity and coverage issues, poor signal reception and/or interference in the experimental area result in difficulties in communication and positioning accuracy of the aircraft. This risk can be mitigated by using multiple telecommunication service providers or by moving to other experimental locations in case connectivity issues originate from the location itself.
8. The use of spraying drones by inexperienced pilots drastically increases the risk of injury, and or equipment damage. To eliminate this risk, all UAV operators within UC2 are highly experienced certified pilots.

Each individual aforementioned risk has been carefully considered within the scope of the UC2 risk register, along with its respective risk-related metrics (likelihood and severity) and selected treatment actions (presented in Table 11).

Table 11 UC2 Risk Identification

Risk ID	Risk Description incl. Cause	Impact / Consequence	Likelihood (1...4)	Severity (1...4)	Risk Owner	Proposed Risk Mitigation Measures	Treatment Action	Status
1	Deployed drone crush	Experimental iterations are delayed and the timeline of the UC is affected	2	2	UC2	An additional UAV system will remain stand by in case a technical error prevents the original UAV system from executing the experimental flights	Deployment of the spare spraying UAV	Open
2	Extreme environmental conditions	Extended period of extreme environmental conditions that do not allow for experimental spraying measurements	4	3	UC2	The experimental design of UC2 has forecasted this scenario, and has thus started the experimental period from very early, to ensure that adequate iterations can take place successfully, even in	Extend the duration of the experimental season	Open

						the occurence of such extreme events for long periods of time during the summer.		
3	Damages in experimental crops	Disease-infestation outbreaks caused damage to the canopy of the experimental vineyard not allowing measurements	2	1	UC2	Multiple experimental locations have been identified within the vineyards	Move the experiment to another identified location	Open
4	Malfunction of spraying components	Spraying components (e.g. nozzles, pumps, flowmeters) and/or experimental equipment (meteorological sensors) are damaged and the timeline of the UC is affected	2	2	UC2	Spare components have been acquired for all experimental equipment.	Deploy/use the backup components	Open
5	Inability to purchase experimental consumable	Disruption of the logistics chain results in limited access to consumables (e.g. spraying tracer, collectors), thus affecting the experimental iterations	1	2	UC2	All experimental consumables have been purchased upfront, at quantities to suffice for the entire duration of the experiment		Open
6	UAV battery wear off	UAV Battery life decreases over time due to wear off thus limiting the time of experimental flights	2	1	UC2	Multiple spare batteries have been purchased	Proper use of multiple batteries to avoid wear off and battery life decrease	Open
7	Connectivity and	Poor signal reception and/or	3	2	UC2	Interferences can be mitigated through moving to a different		Open

	Coverage Issues	interference in the experimental area result in difficulties in communication and positioning accuracy of the aircraft				experimental location on days that conditions do not allow for safe flights. Poor signal can be mitigated through the use of multiple telecommunication service providers.		
8	Drone Education, Knowledge, and Skill	The use of spraying drone by inexperienced pilot drastically increases the risk of injury, and or equipment damage	1	4	UC2	The operators of the spraying UAVs are highly experienced certified pilots	Exclusive usage of the UC spraying drones by highly trained and experienced operators	Open

4.3 Use Case 3

Risk matrix - identification of risks related to UC3 livestock monitoring by drone

As monitoring livestock with drones is an open UAS operation, numerous parameters can intervene with its iterations on the grasslands, and it is therefore critical that potential risks should be carefully considered and mitigation steps are taken in a timely and robust manner, e.g., by creating and implementing a detailed risk management plan and by following all existing European and French safety guidelines. This UC3 is experimenting with the drone activity in livestock farming, and therefore there is no “best practice” examples that can be followed, and guidelines adopted. It is important for the UC leader (IDELE) to establish a robust risk assessment process that could be adopted by farms across Europe.

In the case of livestock monitoring activities performed by drones, the process of risk assessment involves identifying the potential risks or hazards associated with the physical use of drones and evaluating the likelihood and potential impact of those hazards in accordance with the regulatory requirements.

4.3.1.1 Safety Risk Assessment Model

A safety risk assessment model for drones used for monitoring livestock involves assessing the potential risks associated with the use of drones and implementing mitigation measures. This could include factors such as the safety of the operation based on environmental or weather conditions and grassland terrain, the possibility of the drone malfunctioning before take-off or during the flight, and the possibility of the drone losing control and crashing in a terrain near the Alps. The aim of the model would be to identify and address potential hazards to prevent accidents and ensure the safe operation of the UAV.

There are several steps that can be taken in a risk assessment for the use of drones in livestock monitoring:

- **Identify the hazards/risks**: The first step is to identify the potential hazards associated with using drones in the grasslands. This could include livestock monitoring operations, for instance, keeping an eye on a resting herd, the drone itself, technological components, or the weather conditions (a windy day near the Alps) in which the drone will be operating.
- **Evaluate the risks**: This step could involve considering the likelihood (1 to 4 in table 12) of the risk occurring, as well as its potential impact in case it manifests.
- **Develop control measures**: this step is to develop control measures to mitigate the identified risks. This could include implementing safety protocols for flights and livestock operations,

conducting regular maintenance on the drones, purchase all consumables while the supply chain is operating normally, and the operators stay updated on the most recent regulatory updates and guidelines on how to safely use drones.

- **Implement the control measures**: The final step is to integrate all devised control measures into the use case's model of risk assessment. This could involve implementing safety procedures in the farm and regular inspections and maintenance of the vehicle, while also considering various micro-optimisations in case a risk occurs (e.g., a spare drone is purchased and available).
- **Review and update the assessment**: It is important to regularly review and update the risk management plan to ensure that it remains effective and addresses any new or changing risks/hazards. This is achieved by conducting regular research checks.

4.3.1.2 Risk assessment steps in UC3 and explanation

Within UC3, a total of six risks have been identified, which will exist throughout the duration of the experimental procedures as inherent drone use parameters. It is important to note that most of the use of drones will be performed under open category and are then categorised at low risk. BVLOS flight would be performed only after intensive training by certified pilots and on the lands very well-known of the farms that are enclosed. Thus, the risk of BVLOS is much lower. Enclosed pastures will ensure to not fly over people that are not part of the mission.

These are the six risks associated with the use of drones for monitoring livestock (see Table12):

- A drone crashes due to obstacles such as trees, power lines, relay antennas, or even birds. The crash affects the timeline of UC3. The mitigation measures are to have an extensive appropriation of the flight areas (rangelands from the pilot farms) by the pilots and to have a spare drone to replace the crashed one and continue the activities as planned.

- Loss of connectivity during a flight with consequences on the drones and thus on the activities of UC3. The mitigation measures are to have high performance connectivity protocols between the drone and the remote and to have a spare drone in case of a crash.

- Incident or accident with military manned aircraft. Carmejane pilot farm is inside a low-level military training area where helicopters and fighter jet flights regularly occur. In this situation drones must comply with the rule "see and avoid". The mitigation measures are to have an extensive training of the pilots involved in this experimental farm and to comply with all regulations and specifically to notify all flights to the air force.

- Incident or accident with other manned aircraft. In the rangelands, drones can encounter other manned aircraft in low-level like rescue helicopters or gliders. The mitigation measures are to have an extensive training of the pilots and to avoid BVLOS flights when the visibility of such aircraft is not ensured in the BVLOS flight area.

- Incident or accident with animals, flying close to animals for monitoring them can create stress for them and thus many incidents. The mitigation measures are to have an extensive training of the pilots and an evaluation of drone impact of animal behaviours for producing guidelines.

- Conflict with neighbours or other users of the rangelands (hikers in the mountain rangelands for example) annoyed by flights. Especially because the flights will be regular. The mitigation measures are to comply with the 1/1 ratio (altitude/distance to neighbour) rule and to avoid flying less than 50 m away from the closest neighbour and to communicate with the neighbourhood.

Table 12 UC3 Risk Identification

Risk ID	Risk Description incl. Cause	Impact / Consequence	Likelihood (1...4)	Severity (1...4)	Risk Owner	Proposed Risk Mitigation measures	Treatment Action	Status
1	Deployed drone crush due to obstacles	Experimental iterations are delayed and the timeline of the UC is affected	2	3	UC3	The mitigation measures are to have an extensive appropriation of the flight areas (rangelands from the pilot farms) by the pilots and to have a spare drone to replace the crashed one and continue the activities as planned	Deployment of the spare UAV	Open
2	Deployed drone crush due to lost of connectivity	Experimental iterations are delayed and the timeline of the UC is affected	2	3	UC3	The mitigation measures are to have high performance connectivity protocols between the drone and the remote and to have a spare drone in case of a crash	Deployment of the spare UAV	Open
3	Incident or accident with other manned aircraft	Risk of suspension of drone operation license and affectation of timeline of the UC	1	4	UC3	The mitigation measures are to have an extensive training of the pilots involved in this pilot farm and to comply with all regulations and specifically to notify all flights to the air force.		Open
4	Incident or accident with other manned aircraft	Risk of suspension of drone operation license and affectation of timeline of the UC	1	4	UC3	The mitigation measures are to have an extensive training of the pilots and to avoid BVLOS flights when the visibility of such aircraft is not ensured in the BVLOS flight area	Idele will have other trained pilots to cover the time another one is trained	Open
5	Incident or accident with animals	animal hurt	2	3	UC3	The mitigation measures are to have an extensive training of the pilots and an evaluation of drone impact of animal behaviours for producing guidelines.	Review of the guidelines and protocols of flight	Open

6	Social conflicts with the neighbourhoods of the farm regarding regular drones' flight	Use of drones is paused due to social conflicht with neighbours the data acquisition stops	3	3	UC3	The mitigation measures are to comply with the 1/1 ratio (altitude/distance to neighbour) rule and to avoid flying less than 50 m away from the closest neighbour and to communicate with the neighbourhood	Communication between the pilot farms and the complainants. Eventually to build a new strategy to avoid or decrease annoyances	Open
7	Trained pilots quit their jobs in the pilot farms.	Use of drones is paused and the data acquisition stops	2	4	UC3	Farm staff that will be trained as pilot are selected regarding their long-term projects	Idele will have other trained pilots to cover the time another one is trained	Open

4.4 Use Case 4

Risk matrix - identification of risks related to UC4 forest and biodiversity

In the case of forest and biodiversity monitoring, following the national standards and regulations of Lithuania, the process of risk assessment involves an identification of potential risks or hazards associated with the use of drones for monitoring; and evaluating the likelihood and potential impact of those hazards.

4.4.1.1 Safety Risk Assessment Model

An air operation must be preceded by an analysis of potential hazards that could lead to an air accident. There are five sources of potential hazards that, if activated, may cause a loss of control over the UAV, which may result in a UAV striking a person or object on the ground or even another flying an unmanned or manned aircraft. The categories of hazard sources, as well as their respective contributing factors, are:

1. Failure to comply with procedures
2. Human error
    - Communication errors
    - Routine errors
    - Inappropriate or insufficient training of personnel;
    - Distraction resulting from disruption, confusion, or chaos, etc.
    - Lack of team cooperation;
    - Fatigue caused by excessive working hours;
    - Lack of appropriate tool to perform the task;
    - Stress caused by inadequate preparation for flight;
    - Carelessness, incorrect assessment of the situation;
3. UAV failure
    - High loss of altitude
    - Loss of control
    - Loss of transmission
    - Deterioration in the performance of systems used in steering or navigation, such as GPS.
4. Collision with manned, unmanned aircraft or trees
5. Rapid deterioration of weather conditions during the flight.

4.4.1.2 Risk assessment steps in UC4 and explanation

The nature of the organisation and the goal UC4 aims to achieve are factors that determine the choice of a risk management method. Within the framework of the **classic risk management method**, which the authors modelled and will be followed, their components can be distinguished.

There are two components in the risk assessment phase:

- Risk analysis, which is the systematic use of all available information in the indicated area of analysis, to
    - Identify threats—this is a process of systematic procedure to identify threats, which, because of their activation, may cause losses in the indicated area of analysis,
    - Estimate and prioritise the risks identified in the analysis area—defining the value of the risk measure and assigning it to one of the risk levels of the model used.
- Risk evaluation.

As part of the risk assessment phase, the UAV operator should analyse the risk by characterising the area and identifying potential hazard sources. Next, they should assess the level of risk for the air operation by selecting the appropriate model and measures.

The choice of risk models and measures depends on the degree of complexity, detail, and amount of information required and used. There are five particular risk areas that have been identified in UC4:

1. Equipment order delay
2. Drone education, knowledge, and skills (certified)
3. Environmental and biodiversity conditions
4. Extreme weather conditions
5. Safety risk - loss of control over the UAV, which may result in damaging a person or object on the ground.

The likelihood, severity and proposed mitigation actions for each risk area are explained in Table 13.

Table 13 UC4 Risk Identification

Risk ID	Risk Description incl. Cause	Impact / Consequence	Likelihood (1...4)	Severity (1...4)	Risk Owner	Proposed Risk Mitigation Measures	Treatment Action	Status
1	Equipment (UAV - fixed wing and thermal camera) order delay. The order delay due the currently supply chain trigger influenced by today's geopolitical situation	The ordered equipment delay will direct impact the monitoring plan and extend the mission starts.	3	2	UC4	The active and advance communication with suppliers let to plan and asses the possible delays during the use case plan preparation and before the mission starts.	For the extended delays remains, the option to order a service or rent the equipment.	Open
2	Drone Education, Knowledge, and Skill	The use of drone by inexperienced pilot drastically increases the	1	4	UC4	The operators of the UAVs will be experience and trained. Exclusive usage of the	Educational courses will be developed by the project ICAERUS and the courses	Open

		risk of injury, and or equipment damage				drones by the certified pilots. Training will continue on year 1 of the UC to be ready for the trials.	platform will be supported by the Open University (UK)	
3	Environmental and biodiversity conditions	Environmental and biodiversity conditions that do not allow the wild boars monitoirng.	2	3	UC4	The experimental design of UC4 has forecasted this scenario, and has thus plan experimental periods on the main part of the non-growing seasons (autumn-winter).	Life Cycle Cost Analysis that will be provided by the project should assess the environmental costs and related risks	Open
4	Extreme environmental conditions	Extended period of extreme environmental conditions that do not allow the forest drones monitoring.	2	3	UC4	The experimental design of UC4 forecast this scenario and thus plan experimental periods for the main part of the warm season (from spring to autumn). Otherwise, extreme weather - the rainy season, affects the reduced aridity of forests. In addition, there will be analyses of the historical Satellite data to identify the potential areas before the drone mission starts. The tree health monitoring is less dependent on extreme environmental conditions, except for weather	LCC analysis to assess and advise	Open

						conditions which directly cause drone operation.		
5	Safety Risk	May cause a loss of control over the UAV, which may result in a UAV striking a person or object on the ground or even another flying an unmanned or manned aircraft	2	2	UC4	Identify threats—this is a process of systematic procedure to identify threats, which, as a result of their activation, may cause losses in the indicated area of analysis, Estimate and prioritize the risks identified in the analysis area—defining the value of the risk measure and assigning it to one of the risk levels of the model used	As part of the risk assessment phase, the UAV operator should analyze the risk by characterizing the area and identifying potential hazard sources	Open

4.5 Use Case 5

Risk matrix - identification of risks related to UC5 drone logistics activities

Drone logistics is an open-field operation; hence a plethora of parameters could potentially intervene with the experimental implementations of UC5. Thus, it is critical to identify these potential risks and to consider several mitigation steps, such as to develop a detailed risk management plan and follow existing European and national safety guidelines. In the case of UC5, the drone logistics will cover two countries – Greece and North Macedonia. The latter as a non-EU country and has not adopted the EU regulations on UAS operations yet, hence it has its own national regulatory framework.

In the case of drone logistics activities, the process of risk assessment involves identifying the potential risks or hazards associated with the use of drones for transportations of small parcels in remote areas, as well as the evaluation of their impact upon drone operations.

4.5.1.1 Safety Risk Assessment Model

A safety risk assessment model for drone logistics in remote or rural areas involves several factors, such as the safety of the drone operations in relation with the environmental conditions and field terrain, the possible drone malfunctioning before take-off or during the flight, and the possibility to lose control of the drone, leading to a crash. For this reason, the European Union is seeking to harmonise drone regulation and to develop a common regulatory frame, which addresses operations in an operation-centric and risk-based approach. Following this approach, operations can be divided into three categories with increasing levels of risk: open, specific, and certified. In fact, the EASA is tasked with the development of associated guidance material and Acceptable Means of Compliance regarding these processes. In general, the aim of the safety risk assessment model is to identify and address potential hazards to prevent accidents and ensure the safe operation of drones. Typically, the steps that are followed for the risk assessment are:

- **Identify the hazards/risks**: The first step is to identify the potential hazards associated with the drone logistics activities such as transportation of small parcels, including the drone itself as a vehicle, the packaging of the goods, technological components or transported materials and the weather conditions in which the drone will be operating (dispersed rural areas).
- **Evaluate the risks**: This step could involve considering the likelihood of the risk occurring, as well as its potential impact in case it manifests.
- **Develop control measures**: Once the risks have been identified and evaluated, the next step is to develop control measures to mitigate those risks – implementing safety protocols for flights, conducting regular maintenance on the drones, purchasing all consumables and the operators stay updated on the most recent regulatory schemes and guidelines.
- **Implement the control measures**: The final step is to integrate all devised control measures into the UC5's experimental routes over Greece and North Macedonia – implementing safety procedures and regular inspections and maintenance, while also considering various micro-optimisations in case a risk occurs (e.g., the spare drone is located near the experimental site, so in case of a crash of the primary UAV, the secondary aircraft can be deployed quickly).
- **Review and update the assessment**: It is important to regularly review and update the risk management plan to ensure that it remains effective and addresses any new or changing risks/hazards.

4.5.1.2 Risk assessment steps in UC5 and explanation

Inside the EU regulatory frame, delivery operations lie in "specific category", as they need to be performed outside Visual Line Of Sight (VLOS) conditions to enable enough range for the benefits to be significant. Operations outside VLOS conditions are performed in either Beyond Visual Line Of Sight (BVLOS) or in Extended Visual Line Of Sight (EVLOS), the latter employing visual observers who must keep track of the drone. The BVLOS operations, lacking visual contact with the drone, require the use of detect and avoid (DAA) systems to avoid collisions with obstacles or other aircraft. Furthermore, specific operations are subject to a risk assessment using a dedicated methodology, such as the Specific Operations Risk Assessment (SORA) or using a Predefined Risk Assessment (PDRA). Both risk assessment procedures must represent a predefined, standardized Concept of Operations (ConOps) or alternatively be submitted for approval to the civil aviation authority of the corresponding country. Alternately, EASA through National Aviation Authority (NAA) can accredit organisations with Light UAS operator Certificate (LUC) that allow the organisation to self-authorise operations without applying for authorisation. Nevertheless, the main risks associated with drone logistics activities in the experimental activities of UC5 are listed below:

1. Drone crashes. The main mitigation measure is to deploy an additional operational-ready drone.
2. Extended period of extreme weather conditions.
3. Malfunction of various drone components (e.g., rotors) and/or payloads (e.g., sensors). To eliminate this risk, the purchase of spare components is required.
4. Decrease of UAV battery life over time. For the elimination of this risk, the strategy is to purchase multiple spare batteries for the aircrafts (both for primary and secondary drones).
5. Poor signal reception. This risk can be mitigated by using multiple telecommunication service providers.
6. Drone operations by inexperienced pilots. To eliminate this risk, all UAV operators within UC5 are highly experienced certified pilots.

Each individual risk has been carefully considered within the scope of the UC5 risk register, along with its respective risk-related metrics (likelihood and severity) and selected treatment actions (see Table 14).

Table 14 UC5 Risk Identification

Risk ID	Risk Description incl. Cause	Cause	Impact / Consequence	Likelihood (1…4)	Severity (1…4)	Risk Owner	Proposed Risk Mitigation Measures	Treatment Action	Status
1	Temporary Short-Time GNSS Loss during flight	Interference, going through a tunnel, going through high buildings, solar activity	Temporary loss of navigation control, unstable UAV, small deviation from planned path	2	2	UC5	Use high-quality GNSS devices and antennas Avoid flying under canopies Avoid lose proximity to obstacles and objects that block satellite reception Check Kp index before flying Set a Return to home failsafe policy	Put the drone on-hold waiting for the loss to go Engage Return to home failsafe	Open
2	Permanent Loss of GNSS during flight	Defect of GNSS device, Loss of GNSS signal	Control loss, collision with UAS, crashing to the ground, UAVs can lead to injuries to people if flight is on top of populated zone, UAV damage	1	4	UC5	Use high-quality GNSS devices Have on-board redundancy available in real time	Have an emergency landing procedure engaged	Open
3	Degraded Communication Quality	Unstable Connection, Network Congestion, Flying beyond telemetry range, Signal interfearence	Temporary or permanent loss of comand and control, occasional command losses, collision with obstacles, trajectory deviation, damage to UAV	3	1	UC5	Use a primary communication network and if possible, a secondary too Implement failsafe mechanisms when connection is lost Verification and prototyping through extensive	Put the drone on-hold waiting for the loss to go Try both primary and secondary communication network (if exists) Position your antennas in a way that	Open

							network simulations Monitor the communication quality in real time Inspect Log files	you maximise the radio-link perforce Engage Return to home failsafe	
4	Permanent Loss of Communication with Ground Control Station	Control system failure, environmental condition, power loss, software verification error and EMI.	Crash into building, obstacle, injuries to people, vehicle damage, undesired flight trajectory, uncontrolled maneuvers, loss of vehicle control	1	4	UC5	Use a primary communication network and if possible, a secondary too Implement failsafe mechanisms when connection is lost Verification and prototyping through extensive network simulations Monitor the communication quality in real time Inspect Log files	Position your antennas in a way that you maximise the radio-link perforce Check both primary and secondary communication channels and if they both fail engage the Return to home failsafe	
5	Security attack on the drone	Communication protocol insecure	Drone control loss, criminal attacks using the drone, drone hijack	1	4	UC5	Secure the communication protocols between the drone, cloud and GCS (Ground Control Station) Upload a horizontal and vertical geofence to the drone autopilot to restrict drone getting out of those geographical limits	Try to regain command and control both on primary and secondary communication network Position your antennas in a way that you maximise the radio-link perforce	
6	Loss of UAV electrical power	Faulty battery cell, faulty charge, inappropriate	Degraded flight, harm to people, crash	1	4	UC5	Check battery in pre-flight checks Check battery	Make sure you keep a very detailed	Open

		charge cycle, manufacturing defect, vibration					in postflight checks Check battery during charging Check battery during storage Keep a record of charging cycles for each battery Use a parachute as a failsafe Flying above non populated areas Real time battery information	record of each battery Try to use smart batteries with integrated electronic circuit on board that monitors each cell separately Monitor battery performance Avoid putting batteries under cold, thermal or deep discharge stress	
7	Autopilot controller module failure	Timing errors, memory corruption, incorrect specification, incorrect implementation, inaccurate/ incorrect assumptions.	Loss of flight	1	3	UC5	Use triple redundancy autopilot systems with double redundancy power supply Failsafe autopilot intervenes when failure of autopilot detected	Switch to the redundant circuit	Open
8	Cabling failure	Brocken cables and cable connections, wrong cable sizing	drone failure/crash, collision with property, harm people	1	4	UC5	Pre-flight checks Postflight checks Regular in-house check Use high quality silicon DC cables Use high quality soldering station make sure that your cables can supply the requested	Perform extended cable inspectons every 50h of flight time	Open

							maximum amperage		Open
9	Pilot (human) error	Human factor	Pilot not familiar with the area, pilot unfamiliar with equipment, inexperienced pilots, lack of training	2	3	UC5	Use a well trained drone pilot Make the drone pilot familiar with the operations field and airspace Keep a flight log of each drone pilot Check his attitude and physical conditions before mission Make sure he is not under medicine, drags or alcohol effect	Assign a second pilot in command Assess your drone pilot's skills and performance Train your pilot with emphasis in his weak spots (ICAERUS project will be offering some educational courses)	Open
10	Weather effects on UAV	Weather conditions beyond drone's technical specifications and performance (temperature, humidity, wind speed, rainfall)	Pure performance, drone malfuction and crash	2	4	UC5	Know drone's specifications regarding weather resistance Check weather forecast Verify weather conditions in field Check drone's warnings	Try to fly away from the bad weather lower your speed and altitude If you cannot reach your departure or destination point, perform an emergency landing	Open
11	Payload failure	Payload out of specifications, or is characterized as "dangerous goods"	Waste of time and money, general risk of damage and injury	1	3	UC5	Thorough inspection of the package to be delivered Secure the payload in the cargo bay Strong identification of sender and recipient	Do not start a delivery mission with a non suitable payload. Emergency return to land if the payload gets beyond accepted behaviour	Open

12	Collision with other drones flying on the same track	Human error, incorrect flight routing planning	Collision with other drones, vehicle damage	1	4	UC5	Accurate flight routing design Accurate geographical relief, cartographic background (high-definition 3D maps)	Specify a collision avoidance set of manoeuvre s Engage Collision avoidance protocol	Open

5. Conclusions

The multi-purpose drone applications that can be utilised in various market segments of the agricultural and forestry industry as well as the logistics is a still evolving space with regulatory and legislative challenges, new technological developments, and a dynamic set of numerous potential opportunities, stakeholders, and values. If the full benefits are to be materialised and distributed among the member-states and business communities in Europe, it will be necessary to foster extensive public-private partnerships, aligning with the investment, convergence and cohesion efforts of the EU regions and their economic, social, and sustainable vision. Moreover, the presence of potential beneficiary sectors such as agricultural engineering, biotech, cleantech, urban air mobility, health sciences and other frontier technologies that can support the design and development of drone innovations is a promising sign for the future deployment of European applications in the agricultural and logistic sectors.

The European drone market is moving forward rapidly and massively, affected by several inherent factors along with other external factors in close relation with the landscape. Topics like climate change, renewable energy, eco-awareness, and a digital single market are changing the parameters of our surroundings and are shaping the near future into a brand-new world (see chapter 2). Thus, the EC produced few policy packages to delineate the greening of European markets as an overall framework, where the economic, environmental, and social benefits can be equally maximised:

- ⇒ The Green Deal
- ⇒ The CAP Strategic Plans
- ⇒ EU Biodiversity Strategy
- ⇒ Farm-to-Fork Strategy
- ⇒ Shaping Europe's Digital Future

Furthermore, the European Union has taken several initiatives to tackle the fast evolution of drone technology, industrial use cases and synergies between smart services by issuing a more technical policy documents to define the direction of the EU industry's development:

- ⇒ Urban Mobility Package
- ⇒ Drone Strategy 2.0
- ⇒ European Plan for Aviation Safety

In addition, the EU agencies and professional community are developing new regulations, operational standards, and action plans to facilitate and accelerate the deployment of drone innovations in a safe and secure manner in the European sky as described in chapter 2 in general and in chapter 3 per UC.

The ICAERUS project also faces this challenge, aiming to provide a deep understanding of the rapid technological development of drone innovations and drone collaborations between different industries, analysing the current trends, initiatives, and policy framework as external factors to establish the foundation for the potential business and governance models in T5.6.

The ICAERUS use cases have been carefully selected and validated as representative of this innovative drone ecosystem, covering several market segments – viticulture, crop monitoring and drone spraying, livestock farming, forestry health assessment and rural logistics – and two main industries (agriculture and logistics) and are good candidates for the project final purposes. The results of conducted risk assessment work in T1.4 could be summarised per use case as follows below and presented in detail in chapter 4:

- o **UC1** is an emerging commercial case offering digital and drone solutions to vineyard owners and managers assessing drones as a 3D canopy reconstruction tool, using aerial (top) with ground (side) image acquisition. It is a low-risk operation with no written formalisation of risk management documentation. The UC1 Leader – Noumena – has trained a certified pilot to take control of the

UAV during the demonstrations and mitigate any adverse effects. In addition, there is one Spanish requirement for the drone as a vehicle to be insured during the operational processes.

- **UC2** is an experimental optimisation use case offering drone spraying solutions to landowners and crop-field producers exploring the capabilities of drones in performing spraying applications as an alternative to conventional terrestrial machinery. It is an open-field operation, for which the UC2 Leader – Athens University of Agriculture – has identified two “primary” risks and six “secondary” risks based on the level of severity and likelihood, plus mitigation actions have been planned for the upcoming demonstrations.

- **UC3** is an experimental case with the involvement of various research organisations offering digital and drone solutions to monitor grazing cattle and sheep systems. The open-field operation is performed under the open category at a low risk level as identified by the UC3 Leader - IDELE. BVLOS flight will be performed only after intensive training by certified pilots. All activities will take place on the land terrains that are very well-known to the farmers. Thus, the risk of BVLOS is much lower and people that are not part of the mission will not be present.

- **UC4** is an experimental business case offering drone solutions as a B2B case to forestry owners to support forest and biodiversity monitoring. Fire risk prevention will be targeted by utilising meteorological data and drone image analysis to detect the presence of materials that can spark wildfires. Also, tree health assessment will be provided by using satellite imagery for large areas to dictate specific critical areas to be inspected by drones. The UC4 Leader – ART21 – will follow the classic risk management method and have identified five relevant risks for their operations with the appropriate mitigation actions. In addition to the EU regulations, there are Lithuanian legal requirements that drone operators must comply with.

- **UC5** is a both B2B and B2C use case offering drone deliveries in rural conditions and implementing Drone as a Service model. The operations of drone delivery will be performed in the “specific category” as they have to be outside Visual Line of Sight (VLOS) conditions to enable enough range for the benefits to be significant. The UC5 Leader – GeoSense – follows the EASA methodology named SORA for the risk assessment and have identified 6 risks and adequate mitigation actions. Since the demonstrations will take place in North Macedonia, there are additional local regulations (non-EU rules) that the operator needs to comply with.

If all use cases are fully deployed and commercially operative beyond the project’s timeframe, potential benefits for the European member states and regions include, but are not limited to:

- *Environmental* – decarbonising the European industry via zero-emissions services using clean electric and hydrogen fuel cell technology in the future.
- *Public health and safety* – delivering medical supplies, blood, goods in emergency cases, humanitarian aids quickly to and between places; and assessing crop yields or tree health in agriculture and forestry safely and efficiently.
- *Rural development and improved life-style in remote areas* – rural transportation of goods to villages where the access by car or van is restricted; supporting the local communities in building a better life for their families; and attracting younger families to move to the rural areas.
- *Data-driven industry* – aerial crop yield evaluation, aerial with ground image acquisition, user-friendly dashboards as a decision support system, meteorological IoT stations, GPS collars, etc.

This accumulated pool of information about the use cases and the factors influencing their business environment constitute the perfect basis for the development of business and governance models in WP5 as well as tasks of other project WPs.

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Annexes

Annex I

Common Agricultural Policy (CAP) Strategic Plans

In recent days, to modernise and simplify the EU's CAP, the EC made a proposal in 2018 for a results-based approach with ten objectives to be accomplished between 2023 – 2027. After negotiations with the EP, the Council and the EC, the new CAP Strategic Plans entered into force on 1st January 2023[86]. What is expected from these plans is that:

- EU member-states use instruments of CAP 2023-2027 to support farmers in the transition towards increased sustainability of the food systems;
- Each Plan includes a strategy explaining how the country will use CAP instruments to achieve the embedded objectives in alignment with the Green Deal ambitions.

The EC's approval of the strategic plans was based on criteria defined in Regulation (EU) 2021/2115[87], which established rules on support for strategic plans to be drawn up by Member states under the CAP and financed by the European Agricultural Guarantee Fund (EAGF) and by the European Agricultural Fund for Rural Development (EAFRD). It repealed Regulations 1305 /2013 and 1307 /2013. Furthermore, article (6) states that synergies between EAFRD and Horizon Europe (established by Regulation (EU) 2021 /695) should encourage the Fund to apply research and innovation results, stemming from projects funded by Horizon Europe and the European Innovation Partnership (EIP) for agricultural sustainability, leading to innovations in the farming and rural areas.

The focus of the Strategic Plans is on quantified EU level targets in terms of use and risk of pesticides, sales of antimicrobials, nutrient loss, area under organic farming, high diversity landscape features, and access to fast broadband internet.

[86] https://agriculture.ec.europa.eu/cap-my-country/cap-strategic-plans_en
[87] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32021R2115

Annex II

Farm-to-Fork Strategy

The Farm to Fork Strategy[88] includes a range of initiatives and proposals, such as reducing the use of pesticides and fertilisers, increasing the use of organic farming practices, promoting sustainable and innovative food production systems, reducing food waste, and improving food labelling and consumer information. It also aims to improve the health and well-being of EU citizens by promoting healthy and sustainable diets, reducing the consumption of processed and high-calorie foods, make healthy and sustainable food more economically and physically accessible to everyone and improving food safety and traceability. Finally, companies will need to take measures to reduce their environmental footprint and reformulate their food products in line with guidelines for healthy, sustainable diets. It proposes to spend EUR 10 billion on research and innovation on food, bio-economy, natural resources, agriculture, fisheries, aquaculture and the environment, as well as digital technologies and nature-based solutions for agri-food funded by Horizon Europe. To achieve these objectives, the Strategy will involve collaboration between various stakeholders in the food system, including farmers, food processors, retailers, consumers, and policymakers. In addition, it must enable the transition through investments in research, innovation, advisory services, data, skills, and knowledge sharing. The main objectives of this strategy are:

- ✓ Ensuring sustainable food production;
- ✓ Ensuring food security;
- ✓ Stimulating sustainable food processing, wholesale, retail, hospitality, and food services practices;
- ✓ Promoting sustainable food consumption and facilitating the shift to healthy, sustainable diets;
- ✓ Reducing food loss and waste;
- ✓ Combating food fraud along the food supply chain.

Some flagship targets, which are considered essential to reach the objectives and some of which are also reflected in Biodiversity Strategy, are:

- a reduction by 50% of the use and risk of chemical pesticides, and the use of more hazardous pesticides by 50% by 2030,
- a reduction of nutrient losses by at least 50% while ensuring that there is no deterioration in soil fertility. This will reduce the use of fertilizers by at least 20% by 2030,
- a reduction of overall EU sales of antimicrobials for farmed animals and aquaculture of 50% by 2030,
- reaching 25% of agricultural land under organic farming by 2030.

The F2F strategy stands in line with the Sustainable Development Goals (SDGs)[89] of the UN, and further aims at raising standards globally, through international cooperation and trade policies so that its ecological transition is not offset by the externalisation of unsustainable practices in other regions.

Separately, the EC proposed a strategy to reduce methane emissions in 2020. Reducing these emissions requires a cross sectoral approach: the agriculture emits 53% of anthropogenic methane emissions; 26% come from waste and 19% from energy. At a global level, reducing methane emissions associated with human activity by 50% over the next 30 years may reduce temperature change by 0.18 degrees Celsius by 2050[90]. The strategy focuses on adequate reporting and specific measures in the energy, agriculture, and waste sectors[91].

[88] https://food.ec.europa.eu/horizontal-topics/farm-fork-strategy_en

[89] https://sdgs.un.org

[90] Climate and Clean Air Coalition Scientific Advisory Panel (2020)

[91] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, and the Committee of the Regions on an EU strategy to reduce methane emissions: https://energy.ec.europa.eu/system/files/2020-10/eu_methane_strategy_0.pdf

Annex III

EU Biodiversity Strategy

The strategy has four main goals:

1. To protect ecosystems and species: The EU aims to ensure that by 2030, all habitats and species of EU importance have favourable conservation status and are protected or restored. It plans to protect at least 30% of EU land and sea areas, with a third of these areas strictly protected.
2. To promote the sustainable use of land and sea: The EU aims to reduce the pressure on land and sea ecosystems by promoting sustainable land and sea use, and by addressing the main drivers of biodiversity loss including the use of pesticides and fertilizers, overfishing, and the spread of invasive alien species.
3. To support green infrastructure and restoration: The EU aims to improve the quality, connectivity, and resilience of ecosystems through the creation and restoration of degraded ecosystems, including 25,000 km of rivers.
4. To increase EU's contribution to global biodiversity: The EU aims to play a leading role in global biodiversity conservation, and to ensure that its actions contribute to the achievement of international biodiversity goals.

To achieve these goals, the EU Biodiversity Strategy will involve collaboration between various stakeholders, including policymakers, businesses, civil society, and citizens. It also includes several key actions, such as:

a) Developing a network of green infrastructure.
b) Promoting the use of nature-based solutions.
c) Investing in research and innovation.
d) Promoting sustainable agriculture and forestry practices.
e) Supporting biodiversity-friendly investments, including through the EU's Common Agricultural Policy and the European Green Deal.
f) Strengthening biodiversity governance and monitoring and promoting citizen engagement in biodiversity conservation.
g) Promoting biodiversity and sustainable development globally, and work with partners to combat the illegal trade in wildlife.

Overall, the strategy aims to increase the EU's contribution to global biodiversity conservation, by supporting international efforts to protect and restore biodiversity, promoting sustainable trade and development, and tackling the drivers of biodiversity loss. The EC is expected to propose a new biodiversity governance framework to address the existing legislative gaps. It will introduce legally binding nature-restoration targets to support the degraded ecosystems, to be achieved by fully implementing the EU Pollinators initiative and the Habitats Directive[92] as well as via the CAP.

The EC estimates that about EUR 20 billion annually will be necessary to fund the biodiversity strategy. This means that a combination of public and private funding on a national and EU level will be used together with the EU budget's funds. The EU financial system should also contribute to these actions.

[92] https://environment.ec.europa.eu/topics/nature-and-biodiversity/habitats-directive_en#:~:text=The%20Habitats%20Directive%20(Council%20Directive,and%20outside%20Natura%202000%20sites

Annex IV

Shaping Europe’s Digital Future

Digital solutions are also key to fighting climate change and achieving the green transition. These digital solutions will open new opportunities for businesses, encourage the development of trustworthy technology, foster an open and democratic society, enable a vibrant and sustainable economy, help fight climate change and achieve the green transition. To achieve these goals, the strategy proposes a range of initiatives and actions, including investments in digital infrastructure, research, and innovation; the creation of a single market for data; the development of common EU standards and regulations for digital technologies; and the promotion of digital skills and literacy among citizens.

The EU approach is based on three main pillars to ensure that Europe seizes the opportunity and gives its citizens, businesses, and governments control over the digital transformation as explained below:

Technology that works for the people

The EU's digital strategy will invest in digital skills for all Europeans protect people from cyber threats (hacking, ransomware, identity theft) ensure Artificial Intelligence is developed in ways that respect people’s rights and earn their trust accelerate the roll-out of ultra-fast broadband for homes, schools and hospitals throughout the EU expand Europe’s super-computing capacity to develop innovative solutions for medicine, transport and the environment. Key actions:

1. White Paper on Artificial Intelligence 2. Building and deploying cutting-edge joint digital capacities.
3. Accelerating investments in Europe’s Gigabit Connectivity 4. Establishment of a joint Cybersecurity Unit.
5. A Digital Education Action Plan 6. A reinforced Skills Agenda and Youth Guarantee.
7. Initiative to improve labour conditions of platform workers
8. A reinforced EU governments interoperability strategy.

A fair and competitive digital economy

The EU's digital strategy will enable a vibrant community of innovative and fast growing start-ups and small businesses to access finance and to expand strengthen the responsibility of online platforms by proposing a Digital Services Act and clarifying rules for online service make sure that EU rules are fit for the digital economy ensure fair competition of all companies in Europe increase access to high-quality data while ensuring that personal and sensitive data is safeguarded. Key Actions include:

1. A European Data Strategy 2. Ongoing evaluation and review of the fitness of EU competition rules for the digital age and launch of a sector inquiry 3. Exploration of ex ante rules 4. An Industrial Strategy Package 5. A framework to enable convenient, competitive, and secure Digital Finance 6. Communication on Business Taxation for the 21st century 7. A new Consumer Agenda.

An open, democratic, and sustainable society

The EU’s digital strategy will use technology to help Europe become climate-neutral by 2050 reduce the digital sector’s carbon emissions give citizens more control and protection of their data create a "European health data space" to foster targeted research, diagnosis, and treatment fight disinformation online and foster diverse and reliable media content. Key actions include:

• New and revised rules to deepen the Internal Market for Digital Services.
• Revision of eIDAS Regulation • Media and audio-visual Action Plan • European Democracy Action Plan
• Destination Earth - a high precision digital model of Earth • A circular electronics initiative • Initiatives to achieve climate-neutral, highly energy efficient and sustainable data centres, and transparency measures for telecoms operators on their environmental footprint • The promotion of electronic health records.

The strategy also emphasizes the importance of international cooperation and partnerships to ensure that Europe can benefit from and contribute to the development of digital technologies on a global scale, while also maintaining its values and sovereignty. Overall, "Shaping Europe's Digital Future" seeks to ensure that Europe can harness the potential of digital technologies to drive economic growth, social progress, and innovation, while also addressing the challenges and risks that come with digital transformation.

Annex V

EU Aviation Safety Plan

Safe integration of new technologies and concepts

It begins by outlining the current state of UAS operations in Europe, which has seen a rapid increase in recent years, leading to concerns regarding safety and security. In February 2019, Europe got one step closer to harmonised rules for safe drone operations as the EASA Committee voted unanimously to approve the EC’s proposal for an implementing act to regulate the operations of UAS in Europe including rules on registration, certification, and pilot training. With the above regulations the proposed EASA general concept establishing three categories of UAS operations (‘open’, ‘specific’ and ‘certified’ — with different safety requirements proportionate to the risk) is adopted at European level and will be implemented. Key actions include:

- ⇒ The Notice of Proposed Amendment (NPA) 2021-09 amending the AMC & GM[93] to address the definition of geographical zones, the standard scenarios, and the syllabus for training modules for remote pilots operating in the ‘specific’ category.
- ⇒ An NPA to cover operations of manned VTOL aircraft carrying passengers or cargo in congested (urban) and non-congested (non-urban) environments, as well as UAS operations in the ‘specific’ high-risk categories.
- ⇒ An NPA including the necessary AMC/GM in support of the implementation of the U-space regulations. EASA continues to assess the need for action in the field of UAS, in relation to the harmonised implementation of the adopted regulations for the ‘open’ and ‘specific’ categories, the development of the necessary regulations for the ‘certified’ category and the safe and harmonised development and deployment of U-space across the EU.

Next, what concerns the project’s UC5, the chapter discusses the development of eVTOL aircraft, which are expected to play a significant role in future urban mobility. These aircraft have unique operational characteristics, including vertical take-off and landing, and electric propulsion systems, which require specific safety considerations. The chapter stresses the need for a robust regulatory framework for the safe operation of eVTOL aircraft and the development of standards and guidance for their certification and maintenance. For their operations VTOL-capable aircraft will use aerodromes, heliports and the so-called vertiports. At the first stage, EASA is developing Prototype Technical Specifications (PTS) for the design and operations of VFR vertiports. At the second stage, it will develop a full package of regulations for the design and operations of vertiports, including requirements for the authority, vertiport operators and operation of vertiports, along with the certification specifications for the design and certification.

Finally, the analysis of the events in Gatwick in December 2018 identified the need to support aerodrome operators, ATS providers and aircraft operators in preventing and managing incidents of unauthorised drone operations in the surroundings of aerodromes, while at the same time keeping operational disruptions at a minimum. To avoid a diversity of national measures, EASA had proposed to act as the European coordinator of an action plan containing five objectives and to collaborate with the affected

[93] https://www.easa.europa.eu/en/document-library/general-publications/european-plan-aviation-safety-2022-2026

stakeholders, namely the Member States (including NCAs and law enforcement authorities), aerodrome operators, aircraft operators, ANSPs, EUROCONTROL and the EC.

The Action Plan is articulated around five objectives:

1- Educate the public to prevent and reduce misuse of drones around aerodromes.
2- Prepare aerodromes to mitigate risks from unauthorised drone use.
3- Support the assessment of the safety risk of drones to manned aircraft.
4- Ensure that C-UAS measures are swiftly considered and implemented from a global safety perspective.
5- Support adequate occurrence reporting

Aerodromes and Ground Handling

Assess - Elevated priority index

Facilitates Step 2: *Assessment of safety issue*

Baggage and cargo loading in passenger aircraft (SI-1004)
Ground staff movement around aircraft (SI-1019)
Unreported events (SI-1038)
Serviceability of runways/taxiways (SI-1032N
Coordination and control of turnarounds (SI-1010)
Parking and positioning of aircraft (SI-1026)
Condition and serviceability of the aerodrome operating environment (SI-1007)
Bird/wildlife control (SI-1005)

Assess - Normal-to-low priority index

Facilitates Step 2: *Assessment of safety issue*

Operation of vehicles (and other motorised GSE) (SI-1025) (Amended)
Worker fatigue leading to human error (SI-1039)
Runway/taxiway design d layout (SI-1029)
Aircraft movement under its own power (SI-1001)
Design of ground equipment (non-motorised) (SI-1013)
Load sheets and other documentation/systems (SI-1022)
Serviceability of ground support equipment (non-motorised) (SI-1033)
Design of vehicles (motorised GSE) (SI-1014)
Serviceability of vehicles (motorised GSE) (SI-1034)
Apron/stand design and layout (SI-1003)

Figure 14 Safety issues per category / priority

The main safety risks and corresponding mitigating actions feeding the EPAS are developed through the European Safety Risk Management (SRM) process. This comprises a set of processes that aim at identifying the safety issues and their mitigations. It involves analysis of data from different sources and collaboration with safety partners from national aviation authorities and the industry (through the Collaborative Analysis Groups (CAGs) and the Network of aviation safety Analysts (NoAs).

The SRM process follows five specific steps:

1- Identification of safety issues.
2- Assessment of safety issues.
3- Definition and programming of safety actions.
4- Implementation and follow-up.
5- Safety performance measurement.

Identified safety issues per category / priority associated with aerodromes and ground handling are presented in Fig. 14 and Fig. 15.

Control of passengers on the apron (SI-1009)
Ground operations in extreme temperatures (SI-1044)
Positioning and securing of ground support equipment (SI-1027)
Operation of ground support equipment (non-motorised) (SI-1024) (Amended)
Control of airside works (SI-1008)
Pushback operations (SI-1028)

Mitigate - define

***Facilitates Step 3:** Definition and programming of safety actions*

NIL

Assess - Normal-to-low priority index

***Facilitates Step 4:** Implementation and follow-up of safety actions*

Operation of air bridges/passenger boarding bridges (PBBs) (SI-1023)

Assess - Normal-to-low priority index

***Facilitates Step 5:** Safety performance measurement*

Fuelling operations (SI-1017)
Dangerous goods handling and lithium batteries (SI-1011)
Aircraft towing (SI-1002)
Jet blast (SI-1021)
Ground operations in high winds, rain, thunderstorms (SI-1042)
Serviceability of apron/stand (SI-1031)
Ground operations in low visibility conditions (SI-1018)
Cargo loading in cargo aircraft (SI-1006)
Ground operations in snow/ice conditions (SI-1043)
Emergency/abnormal operations (SI-1015)
Terminal design and layout (SI-1035)

Figure 15 Safety actions

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