This project has received funding from the ECSEL Joint Undertaking under grant agreement No. 876019.
This Joint Undertaking receives support from the European Union's
Horizon 2020 research and innovation programme and the ECSEL member states.

ADACORSA

Deliverable	**D 1.2 Use cases and High-Level Requirements Reference**		
Involved SCs	SC7, SC8, SC9, SC10	**Deliverable type**	Public
Project	ADACORSA	**Grant Agreement Number**	876019
Deliverable File	D1.2	**Last Modified**	08.06.2021
Due Date	M11	**Actual Submission Date**	M14
Status	Final	**Version**	1.0
Contact Person	Lutfu AKCIL	**Organisation**	TAI
Phone	+90 3128111800	**E-Mail**	lutfu.akcil@tai.com.tr

Document history			
V	**Date**	**Author**	**Description**
0.1	25.08.2020	Ricardo Reis (EMBRT)	Initial Version
0.15	15.05.2021	Ricardo Reis (EMBRT), Onur Özçelik	SC7 and SC8 use cases. Full reformatting according to template.
0.2	08.06.2021	Lutfu Akcil	Executive Summary has entered Conops and Operational use cases defined
0.3	08.06.2021	Walter Decker	Clean up and HLR table reworked
0.35	18.06.2021	Ricardo Reis (EMBRT)	Reformatting and re-adding introduction and conclusion from ADACORSA template
0.4	23.06.2021	Vaishnavi Upadrasta	Stakeholder analysis contribution included as chapter 9
0.45	25.06.2021	Ricardo Reis (EMBRT), Walter Decker (IFAG)	Formating, revision, SC8 contribution update
0.9	28.06.2021	Raj (TUD), Petr (ESC)	Revision
1.0	30.06.2021	Ricardo Reis (EMBRT), Walter Decker (IFAG), Ulrike Glock (IFAG), Lutfu Akcil (TAI)	Final and reviewed Version

Table of contents

Executive summary

This document is intended to give an overview of use cases in different demonstrations and connections with High Level Requirements (HLR) baselines. Also, this document explains which demonstrations inputs comes from different supply chains and feeds which SC's with demonstration output.

There are 3 different scenarios addressing Forestry, Smart Construction and Logistics. Each starts by a general summary, scenario assumptions, detailed concept of operations with use cases and describes the validation matrix of HLR's.

For the Forestry scenario, the team starts with a manual controlled survey on the forest (without using GPS due to the tree's canopy height). They then analyze the flight data and using AI/ML algorithms, the drone might operate autonomously and performs the remaining operations at the forest.

For the Construction Site scenario, an autonomous cargo delivery performs with BVLOS from warehouse to construction site and construction site to warehouse; 5G coverage of the construction site by a tethered drone and using image processing algorithms loading and riding of an autonomous truck demonstration shall perform.

For the BVLOS Logistic service, a customer requests a package to be delivered by a service provider (Mission Service Provider). The package is placed on the drone by a Drone Operator, flies to the destination. Near the delivery area, due to local restrictions and context, the control is transferred from the Base Ground Station to the Mission Ground Station. After delivery, the drone returns. Some events are described, related to cooperative Detect and Avoid (DAA), drone authentication, communications, etc.

Each demonstration task includes a stakeholder analysis in the document. In this analysis, all the parties and their relations with the demonstration has described from different point of views. Stakeholders might be part of the demonstrations or may affect from now or future, so this analysis is an entry point for the future impact analysis.

ADACORSA projects aims to develop equipment, systems and integrate them to the drones consider with the EU regulations, so use cases and demonstration scenarios will perform under these regulations and report feedbacks to the authorities for continuous improvement. Supply Chain 10 in the project, takes the scenarios and use cases from point of regulators' in different perspectives, and analysis them as facilitators of future growth and development for drone technologies.

Publishable summary

Executive summary is the publishable summary of this document.

Non publishable information

There is no any non-publishable information on this document.

1. Introduction

ADACORSA project has large number of activities at different levels in engineering: component level, system level and platform level. After all these activities, partners will perform four different demonstrations on the forest, in a construction area and logistics. These demonstrations aim to use developed equipment, algorithms and platforms on unmanned operations.

This document intended to describe the use cases of demonstrations and high-level requirement relations of DEMO's.

Forestry scenario shall use the BVLOS capabilities and AI/ML based image processing algorithms. Environment will difficult and very challenging area for navigational conditions. Construction area demonstrations are also using BVLOS capabilities and high level of autonomy and it covers different supply chains outcomes. These capabilities are becoming more important in drone industry and unmanned market.

Smart Construction scenario area consist of 3 different sub-scenarios. In the first sub-scenario, an autonomous drone with BVLOS and drone will carry a package from warehouse to the construction area. In the second, a tethered drone will cover the area with seamless 5G network and connection. The third is connected with the second: using the seamless 5G networks established, control of autonomous trucks and assignment of vehicles tasks will be made.

BVLOS logistics scenario, a customer requests a package to be delivered by a service provider (Mission Service Provider). The package is placed on the drone by a Drone Operator, flies to the destination. Near the delivery area, due to local restrictions and context, the control is transferred from the Base Ground Station to the Mission Ground Station. After delivery, the drone returns. Some events are described, related to cooperative Detect and Avoid (DAA), drone authentication, communications, etc.

This document defines basic concept of operations for each of the scenarios, main operational capabilities and a stakeholder table was established. Each scenario has different inputs from different supply chains related with high level requirements.

From the stakeholder mapping of each scenario, SC9 did a stakeholder analysis using 3 methods: interviews, internal workshops and literature search, workshop with experts. Stakeholder analysis covers five different areas to understand possible benefits and concerns according to different groups:

- Development and production;
- Utilization;
- Operation;
- Regulation;
- Overflown communities.

Stakeholders analysis results towards drone use further provides a clear overview of industry experts' expectations and concerns. Outcomes of stakeholder analysis would aid drone market analysis and public acceptance of future services.

SC10 developed guidelines to translate the scenario operations, through the SORA analysis, into detailed requirements. This aligns the development with the developing reglementary landscape. This is presented in annex to this document.

Purpose and target group

This document provides HLR baseline for different demonstration activities in different Supply Chains. Demonstrator's use cases defines basic operational needs and functional capabilities, HLR document is describe its limits and KPI's considering the regulations, rules and stakeholders expectations.

The target groups are the project partners and those that need to understand how ADACORSA interacts with external context, namely regarding market, technology and regulation, especially regarding the on-going developments in U-Space pursued by SESAR. A first work on guidelines and process to derive low level requirements from operational knowledge and SORA methodology is provided.

Contributions of partners

Explanation of the partner involvement and their activities in their various sections:

Chapter	Partner	Contribution
1	EMBRT, INFINEON,TAI	Concept definition, review
2	**SC7:** FORDOTOSAN, TAI, TCELL, TB, KATAM, ROBONIK, SMART, AVU, CC **SC9:** ITML, IFAG, IFAT, FORDOTOSAN, TAI, ESC, HUA, HFC, ALTUS	Forestry scenario, Stakeholder
3	**SC7:** FORDOTOSAN, TAI, TCELL, TB, KATAM, ROBONIK, SMART, AVU, CC **SC9:** ITML, IFAG, IFAT, FORDOTOSAN, TAI, ESC, HUA, HFC, ALTUS	Smart construction, Stakeholder
4	**SC8:** EMBRT, ISEP, ESC, NLR, ANYWI, HUA **SC9:** ITML, IFAG, IFAT, FORDOTOSAN, TAI, ESC, HUA, HFC, ALTUS	BVLOS Logistics scenario, Stakeholder
5	ALL	High Level Requirements
6	**SC9:** ITML, IFAG, IFAT, FORDOTOSAN, TAI, ESC, HUA, HFC, ALTUS	
77	EMBRT, TAI	
Annex II	**SC10:** SYR, EMBRT, ANYWI, HUA	

TABLE 1: CONTRIBUTIONS

SC7 and SC8

Supply Chain 7 and 8 mostly focused on the platform level validations and demonstrations. In SC7, 4 different demonstrations have planned; forestry mission, Construction site activities (construction material transportation by an autonomous BVLOS drone, 5G coverage by a tethered drone and autonomous truck activities assisted by drone connectivity) and BVLOS logistics use cases. This activity uses HLRs and derivate sub system requirements and application specific requirements which flows to the other sub system and component level activities.

Supply chain 8 focused on the good delivery, detect and avoid (DAA) and communication handover capabilities based applications. Precise positioning and failsafe communication handover capabilities are the key point of planned demonstrations.

SC09

In order to investigate public acceptance of Drone usage successfully within the ADACORSA specified use cases, it is important to identify all possible individuals, groups or organizations i.e. stakeholders who will be affected by the new technology usage. The different stakeholder groups may have varying perspectives, attitudes and intentions towards drone usage that can reflect on their acceptance level. Thus within WP1 along with an extensive literature review, using stakeholder analysis approach will not only help in generating knowledge and understanding of each actor's perspective, but also help in attaining a complete picture of drone public acceptance.

As part of the stakeholder analysis, stakeholder identification templates were created and distributed among some consortium partners from SC7 and SC8. Their expert knowledge in the field would enable them to identify all stakeholders in the specified scenarios. The data collected from the experts would then be categorized using stakeholder mapping method. Any gaps and inconsistencies are planned to be addressed in a possible workshop/interviews.

SC10

SC10 developed guidelines to translate the scenario operations, through the SORA analysis, into detailed requirements. This aligns the development with the developing reglementary landscape. This is presented in annex to this document

Current and future regulatory framework by EASA

SC 10 is taking care on Regulations on national and European for Drones /UAV Systems. The target is to get overview of actual and future operational and regularly framework with special focus on flying BVOS and work out guidelines inside ADACORSA

Analysis of the future drone market with respect to regulatory frameworks

- Especially for example Farming, Industrial inspection, Security …
- Investigate benefits of safe drone operations for the public, society, economy

Guidelines, checklists and templates for drone development and operation:

- to establish acceptable means of compliance for unmanned system architectures and design,
- The development of equipment and components used in unmanned aircrafts,
- The verification of hardware, software and System implementation

SC 10 will also contribute to T 1.2 HLR, T 2.10 Development guidelines and processes, T 6.10 Validation and demonstration guidelines, T 7.3 Regulatory alignment, standardisation

Relation to other activities in the project

Explains the relations to other activities in the project:

Inputs:

- D 1.1 set-up the overarching framework and operational capabilities to be addressed
- In this document, SC7 and SC8 provided the use case scenarios for Forestry, Smart Construction and BVLOS logistics (objectives, specific HLR, operational description and stakeholder mapping)
- SC9 lead and managed the stakeholder mapping and discussion
- EMBRT lead the overall HLR process. All SC evaluated the HLR in order to link with detailed requirements in T1.3
- SC10 did an extensive work regarding how to link the regulatory environment, HLR and lower level requirements. This is added in Annex II.

Outputs: D 1.2 provides the operational understanding for deployment and integration of technologies developed by the SCs, linking to the operational capabilities resulting from the analysis in D1.1. The document also supports the traceability of the means for verification or validation (demos) to the HLR, which will then be further detailed into lower level requirements in D1.3. The document will serve as a reference to the other WP regarding the operational context and support WP6 regarding the verification and validation activities.

2. Forestry Survey Scenario

2.1 Summary description

One of the motivations in SC7 is the realization of BVLOS drone operation in smart forestry site. The demo 7.4 will show the proof of concept for BVLOS drone operation in smart forestry site by undertaking the mission "to provide mapping of forest lands and detecting individual tree parameters crucial for forestry decision-making".

This will be demonstrated with 3 use cases;

- **UC1:** Forestry Aerial Survey and Mapping (Flight above tree canopy)
- **UC2:** Forestry Analysis (Flight above tree canopy)
- **UC3:** Terrestrial forest inventory by autonomous flying drone (Flight above and through tree canopy)

The forestry drone will detect the trees' position and height to create a tree map based on recorded image data in **UC1**. This process will advantageously be done as much as possible during the field operations. An end user will then, within the mapped area, mark a sub-area that is to be measured in detail both at ground level and over the tree canopy (**UC2 & UC3**). Then, optimal paths of several drones moving back and forth inside the forest stock will be calculated. The drones will record all the terrain and trees. Orientation will be completely or partially independent from GPS support due to poor satellite reception under dense tree canopy. An adaptive crash avoidance against handle trees, branches and vegetation will be performed with taking the frequency of branches into account. In addition, a safety function will be demonstrated to detect and handle the situation if a person comes close to the drone.

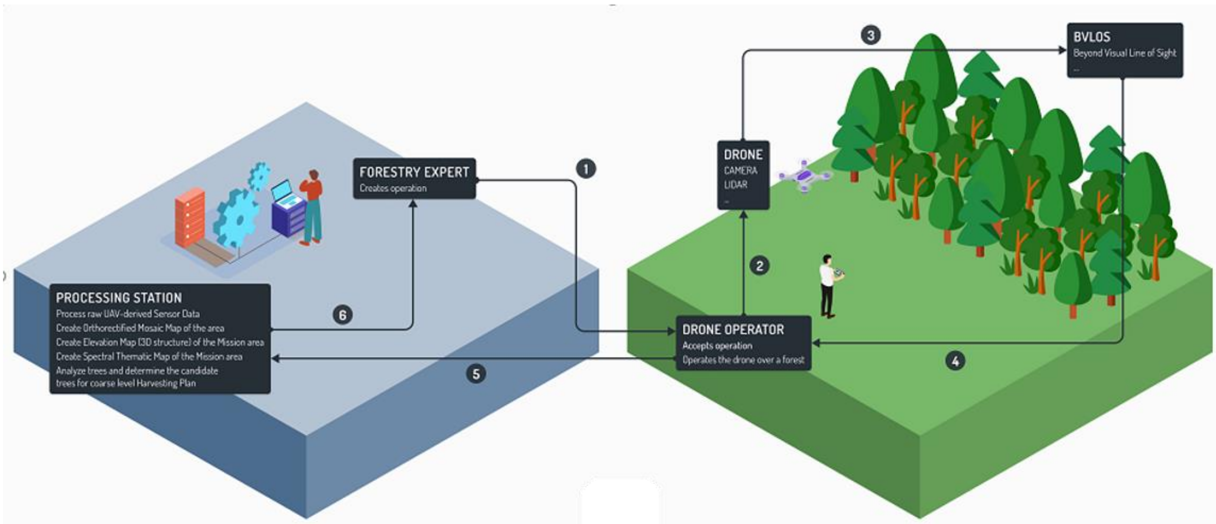

FIGURE 1: DEMO 7.4 USE CASE 1, 2 AND 3

This is scenario represents several common features of drone logistics operations.

Forestry Survey Scenario Summary Table	
Enabled Markets	Forestry management by drones
Key Operational Capabilities	tracking; detect and avoid;
Involved Supply Chains	SC2; SC3; SC10
EASA Drone class	C4: Drone up to 25Kg MTOW
Volume	U-space volumes X
Area	Forest
Mission	Mapping of forest lands and detecting individual tree parameters
Payload	RGB and Spectral imaging instruments, Computation Platform
EASA Operation type	Specific
Operation type	BVLOS
Entities in Scenario	Drone, Drone Operator, Forestry Expert, Processing Station/Computer

TABLE 2: FORESTRY SURVEY SCENARIO SUMMARY TABLE

2.2 Main Scenario Assumptions

- Offline operation: no mobile network available in forest
- Poor GNSS coverage below tree canopies
- RGB and Spectral imaging instruments are loaded on the drone
- Drone can fly with heavy payload
- Drone has high-precision geo-referencing feature
- Drone flight duration is more than 30 minutes

- Drone is highly automated and reliable
- Drone has an onboard storage for sensor data
- Processing will be done offline (on a ground station / PC)
- The drone will fly in X U-space volumes.

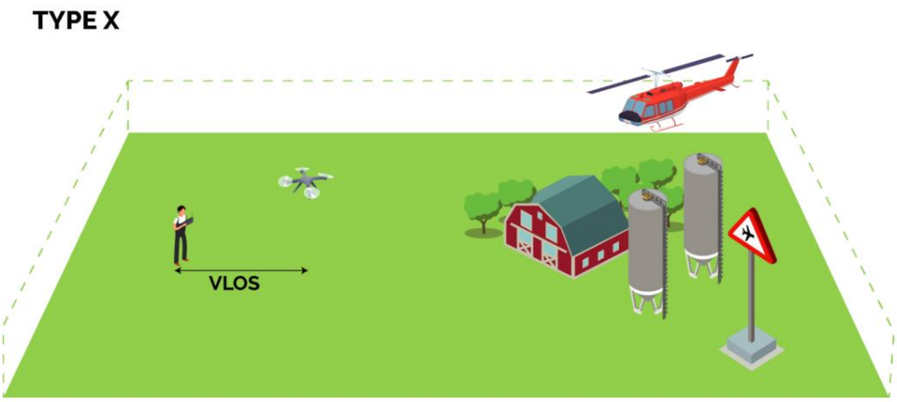

FIGURE 2: TARGET AIRSPACE OF FORESTRY SCENARIO

2.3 Detailed Operational description

2.3.1 USE CASE 1: Forestry Aerial Survey and Mapping

2.3.1.1 Pre-flight

- **Forestry Expert** creates an operation including survey area and mission parameters.
- **Forestry Expert** submits operation to the **Drone Operator**.
- **Drone Operator** accepts and acknowledges the operation.
- **Drone Operator** locates in the operation area and starts the flight by making the necessary preparations.

2.3.1.2 Flight

Take-off and departure

- **Drone** does automated take-off.

En route

- **Drone Operator** monitors **Drone** during mission (**tracking**).
- **Drone** performs highly automated safe flight.

Mission execution

- **Drone** senses environment and avoids obstacles (**detect and avoid**).
- **Drone** provides position information (**tracking**).
- **Drone** records the geo-referenced sensor data.

Return flight

- **Drone** flies back to the starting point.
- **Drone** performs highly automated safe flight.

Approach and landing

- **Drone** does automated landing.

2.3.1.3 After Flight

- **Drone Operator** loads the sensor data to **Processing Station** from Use Case 1.
- **Processing Station** processes raw UAV-derived sensor data.
- **Processing Station** creates orthorectified mosaic map of the mission area.
- **Processing Station** creates elevation map (3D structure) of the mission area.
- **Processing Station** creates spectral thematic map of the mission area.
- **Processing Station** analyzes trees and determine the candidate trees for coarse level harvesting plan.
- **Forestry Expert** views the maps.
- **Forestry Expert** views the harvesting plan.

2.3.2 USE CASE 2: Forestry Analysis

2.3.2.1 Pre-flight

- **Forestry Expert** views the results of Use Case 1.
- **Forestry Expert** loads the Forest Stand and Tree Species information like ancillary data of Mission area to **Processing Station.**
- **Processing Statiton** performs outlier analysis of the canditate trees.
- **Processing Statiton** creates a list of individual tree locations.
- **Forestry Expert** views the list and defines a Low Altitude Flight Operation.
- **Forestry Expert** submits operation to the **Drone Operator.**
- **Drone Operator** locates in the operation area and starts the flight by making the necessary preparations.

2.3.2.2 Flight

Take-off and departure

- **Drone** does automated take-off.

En route

- **Drone Operator** monitors **Drone** during mission (**tracking**).
- **Drone** performs highly automated safe flight.

Mission execution

- **Drone** senses environment and avoid obstacles (**detect and avoid**).
- **Drone** provides position information (**tracking**).
- **Drone** records the VHR Sensor Data.

Return flight

- **Drone** flies back to the starting point.
- **Drone** performs highly automated safe flight.

Approach and landing

- **Drone** does automated landing.

2.3.2.3 After Flight

- **Drone Operator** loads the Sensor Data to **Processing Station.**
- **Processing Station** processes and stores raw UAV-derived VHR Sensor Data.
- **Forestry Expert** views the VHR Sensor Data Imagery and decides whether to cut the tree or not.
- **Processing Statiton** shares list with **Mobile Ground Robot.**

2.3.3 USE CASE 3: Terrestrial forest inventory by autonomous flying drone

2.3.3.1 Pre-flight

- **Forestry Expert** views the results of Use Case 1.
- **Forestry Expert** loads the Forest Stand and Tree Species information like ancillary data of Mission area to **Processing Station.**
- **Processing Statiton** performs outlier analysis of the candidate trees.
- **Processing Statiton** creates a list of individual tree locations.
- **Forestry Expert** views the list and defines a Low Altitude Flight Operation.
- **Forestry Expert** submits operation to the **Drone Operator.**
- **Drone Operator** locates in the operation area and starts the flight by making the necessary preparations.

2.3.3.2 Flight

Take-off and departure

- **Drone** does automated take-off.

En route

- **Drone Operator** monitors **Drone** during mission (**tracking**).
- **Drone** performs highly automated safe flight.
- **Drone** provides position information (**tracking**).
- **Drone** senses environment and avoid obstacles (**detect and avoid**).
- **Drone** moves from position A to B (typically above tree canopies).

Mission execution

- **Drone** navigates down to 5-10 m altitude.
- **Drone** senses environment and avoid obstacles (**detect and avoid**).
- **Drone** provides position information (**tracking**).
- **Drone** systematically scans the assigned forest area by navigating below canopies (autonomously).
- **Drone** records IMU, RGB and LiDAR data.

Return flight

- **Drone** flies back to A when scanning mission completed.
- **Drone** performs highly automated safe flight.

Approach and landing

- **Drone** does automated landing.

2.3.3.3 After Flight

- **Drone Operator** loads recorded data to **Processing Station.**
- **Processing Station** processes and reconstruct high-resolution 3D model of recorded plot. Appropriate forestry data is calculated and combined with other forestry data sources.
- **Forestry Expert** reviews the results and plan for appropriate actions (thinning, harvesting etc). Forestry planning system are updated with the new inventory data.

2.4 Stakeholder overview

Stakeholder name/ stakeholder sector	Relationship *(How does it relates to the Use Case context)*	Interests/stakes *(What interest can the stakeholder have in or through the project?)*
NGOs and local communities	They can restrict operations acting in public interest	Work-place safety, Human rights, Environmental conservation, wildlife conservation, Unemployment
Drone operators and forest experts	They are directly involved in the operations of drone flights and use	Increased job productivity, Efficient, Cost effective, Reliable drone platform, Flight safety
Regulators	They can impact on the drone costs and business size and viability	Noise, Safety, Unemployment
Forester and FSC certification organization	They are responsible of taking care of the forest. They can impact on operations with respect to care of forest and wildlife.	Safety, Noise, environmental conservation (forest care, early detection of diseases)
Forestry industry - Forest management/forestry operations/forest inventory companies, forest owner	Expanding the drone service into the forestry industry and discovering new value chains. They have economic, operations and service benefits	Efficiency (increase in yield such as timber, cut-to-length quality etc.), Accuracy,
Drone manufacturer	This is the main taker of ADACORSA results for integration into drones to sell to Operators or Forestry companies or harvester manufacturers	Cost of systems, Cost of integration, Cost of compliance, Reliability
EU: SESAR	They are exploring and proposing the rules of the airspace/operations and associated infrastructure	Airspace integration

TABLE 3: STAKEHOLDER OVERVIEW

3. Smart Construction Scenario

3.1 Summary description

One of the motivation in SC7 is the realization of smart construction sites for safer and self-operating environments with the support of emerging drone technologies. These smart construction sites will enable safer, faster and cost-efficient construction operations.

Three demonstrators will provide the proof of concept for:

1. Drones in charge of BVLOS control of cargo delivery,
    a. **Mission**: Convey hazardous materials from storage areas to/within construction sites
2. Seamless GSM based communication,
    a. **Mission**: Provide flying base stations to connect construction vehicles, trucks and other drones through GSM based technologies
3. Enable automation of the construction vehicles and trucks in a construction site.
    a. **Mission**: Provide 3D aerial image of the construction site captured through lidar/camera deployed on the drone for optimized motion planning of construction vehicles
    b. **Mission**: Enable self-operating construction vehicles to operate in coordination with drones inside the construction site

3.2 BVLOS cargo drone delivery operation in smart construction site

Today's construction sites are very complex and require operations at a high level of autonomy to work more efficiently. These operations, which generally require a good project management and a large machine park, will be greatly facilitated by the increased use of drones and the easy transportation of materials that need to be brought to the construction site by unmanned aerial vehicles.

The main activity to be implemented within the scope of the project is to autonomously bring the materials needed in the construction site from the warehouse area beyond the line of sight to the required place in the construction area and safely place them. For this purpose, a predetermined drone-port area will be defined in the construction area and this area will be used for loading and unloading purposes. The loads transferred from here will also be transferred to other autonomous vehicles (trucks, work machines, etc.) at the construction site.

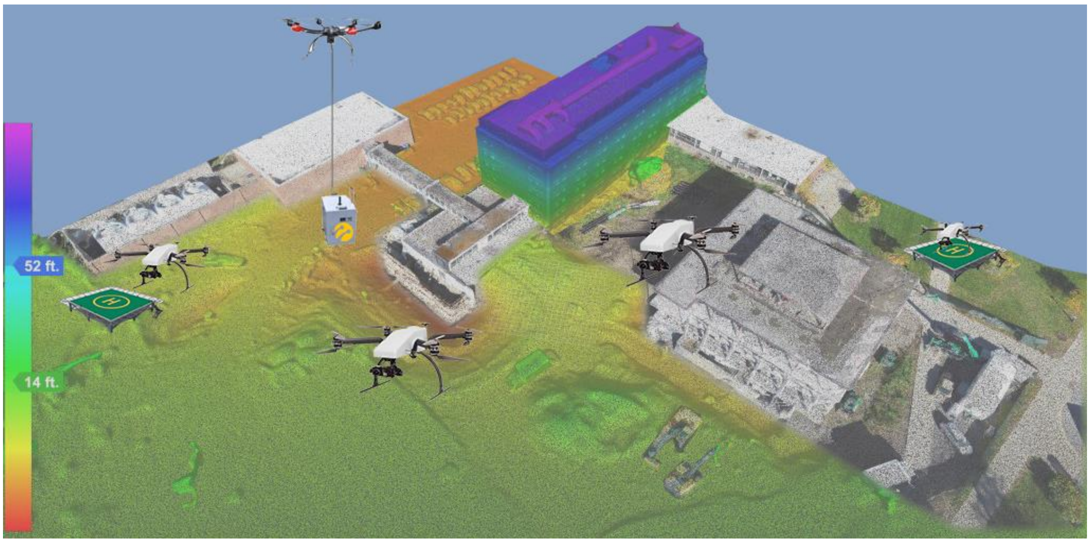

FIGURE 3: DEMO 7.1 USE CASE

The transportation process to be made will be planned bilaterally. While the materials loaded in the warehouse area outside are brought to the construction site, unnecessary materials can be transported to the storage area outside the construction site. As an advanced operation, it will be possible to transfer necessary health material in a possible accident scenario.

This is scenario represents several common features of smart construction autonomy operations.

BVLOS cargo drone delivery operation in smart construction site Summary Table	
Enabled Markets	Construction Sites and Mines
Key Operational Capabilities	Telemetry Detect and Avoid (DAA) Communication, Navigation and Surveillance (CNS) Command and control (CC) Operations management
Involved Supply Chains	SC4, SC5, SC6, SC7
EASA Drone class	specific
Volume	500kg MTOW
Area	5m x 5m drone-port area should be defined
Mission	Cargo transfer between construction site and warehouse
Payload	construction materials in a carriage box max 100kg
U-space	Type Y – restricted area
Operation type	LOS and BVLOS, operation starts with qualified operator and ends automatically
Entities in Scenario	Cargo drone, Site Operator (OpS), construction material, first aid material, Warehouse Operator (OpW), drone-port

TABLE 4: SUMMARY TABLE OF BVLOS CARGO DRONE DELIVERY OPERATION IN SMART CONSTRUCTION SITES

3.2.1 Main Scenario Assumptions

- Construction site has 5m x 5m sized flat and painted drone-port area
- Warehouse site has 5m x 5m sized flat and painted drone-port area
- Two operators have to be ready on both drone-port areas with handheld radios
- Drone might be loaded up to the MTOW (100 kg of payload)
- Weather conditions should be available
- Operators has to have flight checklist and control tablets
- Only one operations are allowed at same time in air
- Operation starts from warehouse drone-port area
- The drone will fly in Y-restricted area SESAR volumes.

Main scenario starts with chief of site's order to take the red box from warehouse to the construction site and send the blue box back. Warehouse Operator (OpW) loads the drone with the red box, controls the environment and flight check list, then energized the drone and starts the operation. After automatic take-off, drone cruises through the given waypoints and lands safely to the construction site's drone-port.

Construction Site Operator (OpCS) releases the red box and loads the blue box. After flight checklist controls, starts the operation and drone goas back to the warehouse drone-port and lands safely.

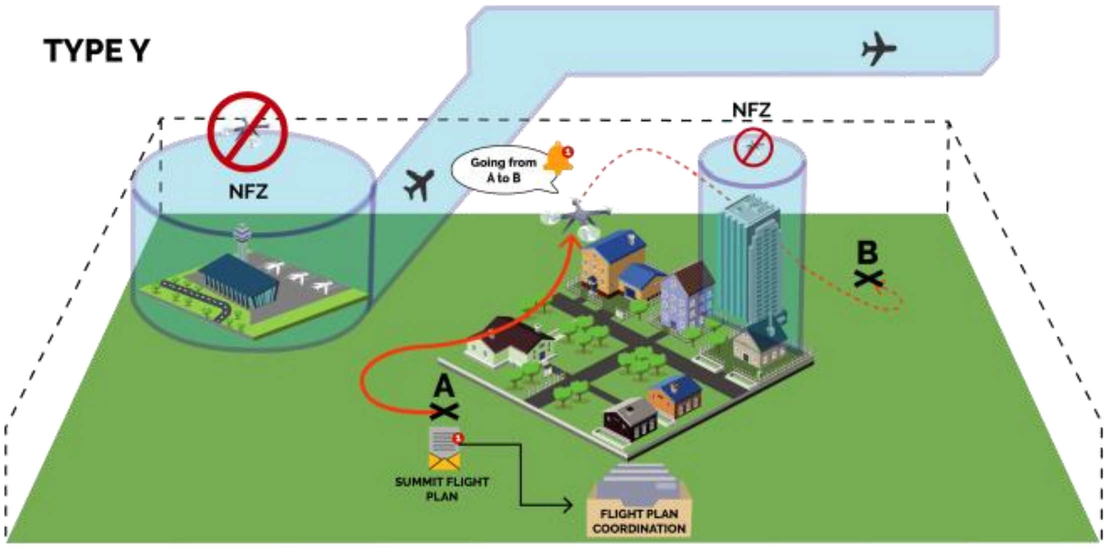

FIGURE 4: TARGET AIRSPACE OF DEMO 7.1

3.2.2 Detailed Operational description

3.2.2.1 USE CASE 1: Warehouse to Site operation

Pre-flight

- **Warehouse Operator** (OpW) should loaded the **cargo drone** with **construction material** (Red Box as payload)
- **OpW** should control the Construction Site **drone-port's** availability
- **OpW** should perform the environmental control and fulfill the flight checklist
- If everything is OK, **OpW** starts the operation from switch on the **cargo drone**
- **OpW** enters the coordinates of Construction Site **drone-port** as destination position, describes the way points and gives the movement authority to the drone autopilot, starts the flight

Flight

- **Cargo drone** takes-off autonomously
- Autopilot raises drone to the operation altitude (given in preflight) (Command and control)
- Autopilot moves **cargo drone** through the way points into the construction site (Communication, Navigation and Surveillance)
- **Cargo drone** flights autonomously using EO (Electro-optics) and radar/lidar and gnss sensors for any obstacle around (detect and avoid)
- **Cargo drone** broadcasts its telemetry data to the both operators using LOS and BLOS datalinks and records to the internal memory (Telemetry, Communication, Navigation and Surveillance)
- **OpW** and **OpCS** may follow the position and status information of the **cargo drone** during flight, may change the way points, and may give new commands. (Only one operator has the authority to give commands at same time, one operator may handover the drone to the other operator.) (Operations management)
- **Cargo drone** lands to the given **drone-port** coordinates autonomously.
    - After landing safely, drone stops the electric motors and propellers and gives the end-of-flight information to the OpCS

Post-Flight

- **Construction Site Operator (OpCS**) should unloaded **construction material** from the **Cargo drone**
- **OpCS** should perform the environmental control of **cargo drone** and fulfill the post-flight checklist

3.2.2.2 USE CASE 2: Construction Site to Warehouse Operation

Pre-flight

- **Construction Operator (OpCS**) should loaded the **Cargo drone** with **construction material** (Blue Box as payload)
- **OpCS** should control the Warehouse **drone-port's** availability
- **OpCS** should perform the environmental control and fulfill the flight checklist
- If everything is OK, **OpCS** starts the operation from switch on the **Cargo drone**
- **OpCS** enters the coordinates of Warehouse **drone-port** as destionation position, describes the way points and gives the movement authority to the drone autopilot, starts the flight

Flight

- **Cargo drone** takes-off autonomously
- Autopilot raises drone to the operation altitude (given in preflight)
- Autopilot moves **cargo drone** through the way points into the warehouse site back
- **Cargo drone** flights autonomously using EO (Electro-optics) and radar/lidar and gnss sensors for any obstacle around
- **Cargo drone** broadcasts its telemetry data to the both operators using LOS and BLOS datalinks and records to the internal memory
- **OpW** and **OpCS** may follow the position and status information of the **cargo drone** during flight, may change the way points, and may give new commands. (Only one operator has the authority to give commands at same time, one operator may handover the drone to the other operator.)
- **Cargo drone** lands to the given **drone-port** coordinates autonomously.
- After landing safely, **cargo drone** stops the electric motors and propellers and gives the end-of-flight information to the OpW

Post-Flight

- **Warehouse Operator (OpW)** should unloaded the drone
- **OpW** should perform the environmental control of **cargo drone** and fulfill the post-flight checklist

Parking and Store of the Drone

- **Cargo drone** should have tow to the parking area at warehouse site
- Maintenance and parking should done always in described workshop area

3.3 Tethered drone to provide connectivity and wide area vision by its sensors

As a tethered drone together with TURKCELL's flying base station is providing 4G & 5G connectivity on a construction area, it will also provide sensor data to create an occupancy grid for trucks and excavators from above. So the end user, construction vehicles and other drones will be connected through GSM based technologies.

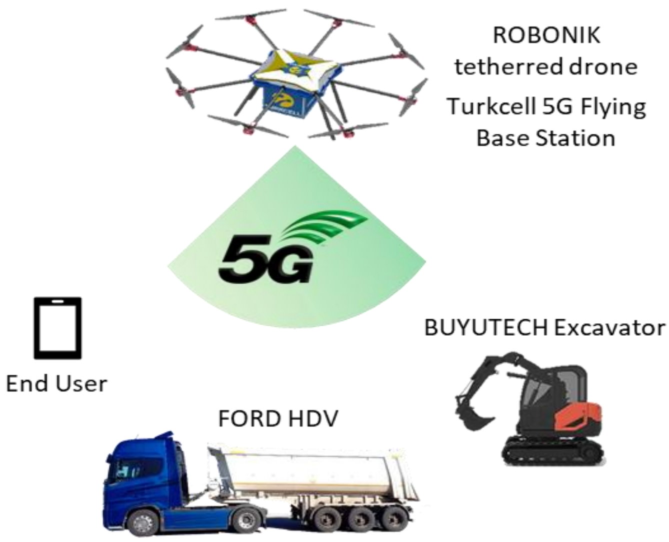

FIGURE 5: DEMO 7.2 USE CASE.

This is scenario represents several common features of smart construction autonomy operations.

Tethered drone to provide connectivity and wide area vision by its sensors Summary Table	
Enabled Markets	Construction Sites and Mines
Key Operational Capabilities	Command and control (CC) Communication, Navigation and Surveillance (CNS) Vehicle to Infrastructure communication (V2I)
Involved Supply Chains	SC4, SC7
EASA Drone class	C4: Drone up to 25Kg MTOW
Volume	U-space volume X
Area	Construction Sites
Mission	Provide connectivity over construction sites
Payload	GSM equipment
EASA Operation type	Specific
Operation type	VLOS
Entities in Scenario	Drone, Drone Operator, Network Expert, Terrestrial Network Backhaul Vehicle, Truck, Excavator and End Users

TABLE 5: TETHERED DRONE TO PROVIDE CONNECTIVITY AND WIDE AREA VISION BY ITS SENSORS SUMMARY TABLE

3.3.1 Main Scenario Assumptions

- **Drone** is capable to carry network equipments around 6-7 kg at least 30 mins
- **Drone** is loaded with network equipments before demo flight
- **Drone** provide stable movements (not much vibration) during flight
- **Drone** should be in Line of Sight with **terrestrial network backhaul vehicle**
- The **drone** will fly in X SESAR volumes.

FIGURE 6: TARGET AIRSPACE OF DEMO 7.2

3.3.2 Detailed Operational description

3.3.2.1 Pre-flight

- **Network Expert** will survey construction area and create network plan.
- **Network Expert** submits plan for **Drone Operator** and **Terrestrial Network Backhaul Vehicle.**
- **Drone Operator** and **Terrestrial Network Backhaul Vehicle** locate themselves in the construction area.
- **Network Expert** prepare communication systems, connections and wireless equipment for flight.

3.3.2.2 Flight

Take-off and departure

- **Drone** takes-off (either manual or automated) (**CC**).
- **Drone Operator** control **Drone** in VLOS during take-off and departure (**CC**).
- **Drone** climbs to a cruise height.

En route

- **Drone Operator** control **Drone** in VLOS during flight (**CC**).
- **Drone** hovers on the air.

Mission execution

- **Drone** does provide low-latency, reliable, safe and secure 5G Connection for **Truck, Excavator and Other End-Users** (**CNS, V2I**).
- **Drone** gather needed datas from **Truck, Excavator and Other End-Users** then transports these data to **Terrestrial Network Backhaul Vehicle** via fiber or radio link (**CNS, V2I**).

Approach and landing

- The **Drone** lands

3.4 Truck & Excavator autonomous & remote-controlled operation

The Demo 7.3 aims to show the smart construction operations of a truck and excavator within the construction site with the occupancy grip provided by the information from sensors on the drones. Most efficient path is developed according to the generated map. Excavator and truck will be autonomously collaborating for optimized excavation work in most efficient way (high excavation in short time).

The smart construction operations are enabled by a tethered drone powered from the ground due to the continuous high power consumptions and connected to the ground station via fiber cable due to the real time and continuous big data transfer. Connected environment supported by tethered drone enables vehicles (truck and excavator) to navigate autonomously after defining the occupancy grid map allowing safer operations.

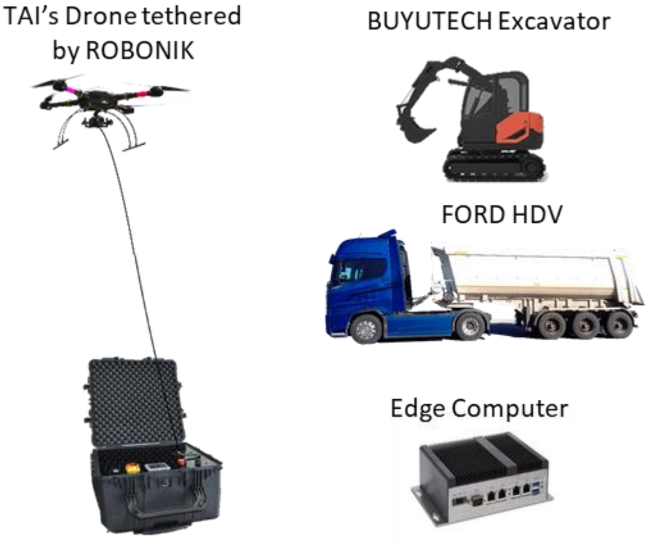

FIGURE 7: DEMO 7.3 USE CASE.

This is scenario represents several common features of smart construction autonomy operations.

Truck & Excavator autonomous & remote-controlled operation Summary Table	
Enabled Markets	Construction Sites and Mines
Key Operational Capabilities	tracking; Command and control (CC) Communication, Navigation and Surveillance (CNS) Vehicle to Infrastructure communication (V2I)
Involved Supply Chains	SC3, SC7
EASA Drone class	C4: Drone up to 25Kg MTOW
Volume	U-space volumes X
Area	Construction Sites
Mission	3D environment perception, Enabling automation of the construction vehicles and trucks
Payload	Camera/LiDAR sensor, Computation Platform
EASA Operation type	Specific
Operation type	VLOS
Entities in Scenario	Tethered Drone, Drone Operator, Construction Truck, Excavator, Edge Computer, End-User

TABLE 6: SUMMARY TABLE OF THE TRUCK & EXCAVATOR AUTONOMOUS & REMOTE-CONTROLLED OPERATIONS

3.4.1 Main Scenario Assumptions

- Tethered drone should transmit the data from either LIDAR or camera or both of them to edge computer for environment perception.
- The drone will fly in X SESAR volumes.

FIGURE 8: TARGET AIRSPACE OF DEMO 7.3

3.4.2 Detailed Operational description

3.4.2.1 Pre-flight

- **End user** activates **Drone** to start the smart construction autonomy operation.

3.4.2.2 Flight

Take-off and departure

- **Drone** does autonomous take-off

En route

- **Drone** sends its position periodically (**tracking**)
- **Drone** climbs to a cruise height
- **Drone** hovers on the air.

Mission execution

- **Drone** transmits the sensor data to the ground station via fiber (**CC**).
- **Drone** ground station transmits the sensor data to the **Edge Computer** for detailed 3D terrain model of the construction site, detailed occupancy grid of the construction site including construction vehicles, equipment and construction workers (**V2I**).
- **Edge Computer** does data fusion and map generation, path planning.
- **Edge Computer** transmits the optimized path data to the truck and the goal position to the excavator.
- **Excavator and Truck** meets at the goal position.
- **Excavator** will dig a predefined area and convey the excavations to the **Truck**

Approach and landing

- **Drone** does autonomous landing

3.5 Stakeholder overview

Stakeholder name/ stakeholder sector	Relationship *(How does it relates to the Use Case context)*	Interests/stakes *(What interest can the stakeholder have in or through the project?)*
Employees, workers within construction site	They can have direct interaction with drones but not with drone operations	Benefits: increased safety due to less human-related physical labor Risks: Unemployment, Noise, Safety, Privacy, Inconveniency
NGOs and local communities	They can restrict operations acting in public interest	Work-place safety, Human rights, Environmental conservation, Unemployment
Drone operators and network experts	They are directly involved in the operations of drone flights and use	Increased job productivity, Efficient, Cost effective, Reliable drone platform, Flight safety
Regulators	They can impact on the drone costs and business size and viability	Noise, Safety, Unemployment
Governmental bodies regulating natural resources	They can impact acceptability of drone-based analysis and output	Accuracy of measurements, Safety
Construction companies/ mining companies	These have high economic, operations and service benefits	Efficiency and effectiveness (Time management, Increasing productivity, decreasing inefficiencies, Reducing waiting times, optimized routes), Rules, freedom to operate, Work-place safety, return of investment
Drone manufacturer	This is the main taker of ADACORSA results for integration into drones to sell to Operators or construction companies or automobile manufacturers	Cost of systems, Cost of integration, Cost of compliance, Reliability
EU: SESAR	They are exploring and proposing the rules of the airspace/operations and associated infrastructure	Airspace integration

TABLE 7: STAKEHOLDER OVERVIEW

4. Logistics by drone Scenario

4.1 Summary description

SC 8 focuses on enabling technologies for enabling BVLOS logistics using drones. The scenario focuses in a general BVLOS drone delivery.

A drone is used to transport a package provided by the client (end-user). The end-user will place a request with the logistics provider (mission service provider). The logistics provider has a drone service provider that will handle the package and fly it to destination using a drone. The drone will fly BVLOS and also beyond radio line of sight. Due to specific conditions at the delivery zone, a Mission Ground Station was set-up and control needs to be handed-over from the Base Ground Station to the Mission Ground Station.

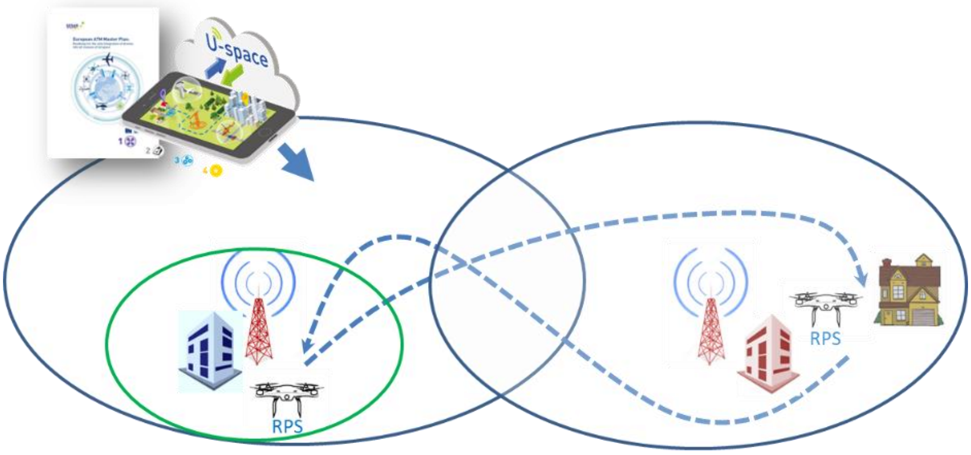

FIGURE 9: FIGURATIVE REPRESENTATION OF BVLOS LOGISTICS BY A DRONE.

BVLOS Logistic Scenario Summary Table	
Enabled Markets	Drone logistics, Special drone logistics
Key Operational Capabilities	e-identification; geofencing; telemetry; tracking; V2V; V2I; CNS; DAA; C2
Involved Supply Chains	SC1, SC2, SC3, SC4, SC5, SC6, SC8, SC9, SC10
EASA Drone class	C4: Drone up to 25Kg MTOW
Volume	U-space volumes Y, Za
Area	Populated
Mission	Commercial Delivery
Payload	Logistic Packages
EASA Operation type	Specific
Operation type	BVLOS

Entities in Scenario	Drone, Drone2, End-User, Base Ground Station, Mission Ground Station, Base Drone Operator, Mission Drone Operator, Mission Service Provider, Drone Pilot, U-space Service Provider

TABLE 8: SUMMARY TABLE OF THE BVLOS LOGISTIC SCENARIO

4.2 Main Scenario Assumptions

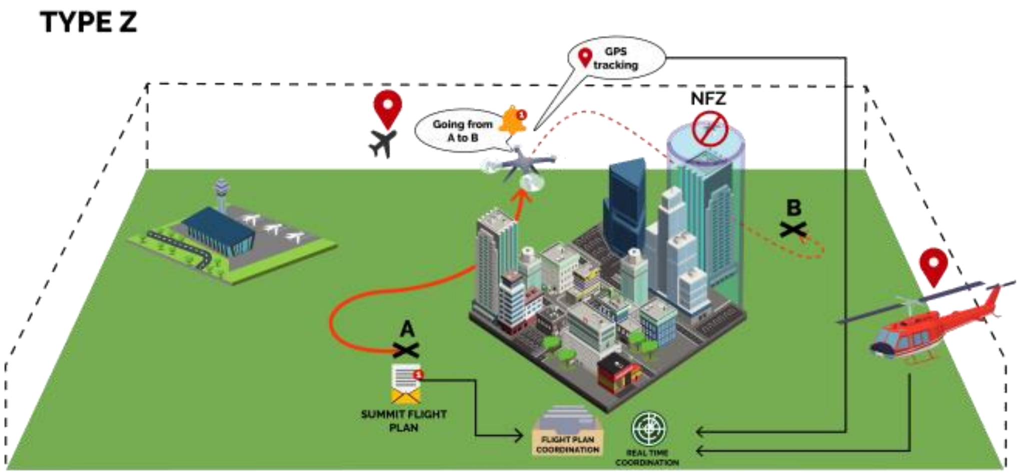

FIGURE 10: TYPE Z VOLUME

- The drone will fly in **Y** and **Za** SESAR volumes
- The mission region demands specific operational procedures due to airspace restrictions. A dedicated Delivery Ground Station provides support for the Mission execution, taking control of the Drone.
- **Base Ground Station** is where the package is loaded into the drone and the drone departs. A **Base Drone Operator** works at this ground station.
- That was pre-authorized with the regulator by executing a SORA analysis.
- **Mission Ground Station** is a dedicated **Ground Station for Mission** execution, located elsewhere. A **Mission Drone Operator** works at this ground station.
- The specific logistics operation requested fits a typology

4.3 Operational description

4.3.1 Pre-flight

- **End-User** does a Delivery Service Request to the **Mission Service Provider**;
- **Mission Service Provider** acknowledges and accepts the Delivery Service Request
- **Mission Service Provider** creates a Mission Plan
- **Mission Service Provider** send Mission Plan to the **Base Drone Operator**
- **Base Drone Operator** accepts and acknowledges the Mission Plan

- **Base Drone Operator** generates a flight plan for the drone from the Mission Plan
- **Base Drone Operator** e-registers **Drone** with the **U-space Service Provider** (**registration**)
- **Base Drone Operator** requests and obtains a Flight Plan Approval from the **U-space Service Provider** (**Drone operation plan processing, Strategic conflict resolution**)
- **Base Drone Operator** obtains Weather information from **U-space Service Provider** (**weather information**)
- **U-space Service Provider** starts digital logbook with Drone information
- **Base Drone Operator** loads the **Drone**
- **Base Drone Operator** clears the **Drone** for Flight
- **Drone** turns on e-identification broadcast (**e-identification**)

4.3.2 Flight

4.3.2.1 Take-off and departure

- **Drone** takes-off (either manual or automated)
- **Base Drone Operator** uploads a specific flight trajectory to the drone.
- **Drone** sends its position periodically to **Base Ground Station** and **U-space Service Provider** (**tracking**)
- **Drone** sends information about the payload status (e.g., pizza temperature, organs temperature) (**telemetry**)
- **Drone, Base Ground Station, U-space Service Provider** record Drone information into Digital logbook (**Digital logbook**)
- **Drone** climbs to a cruise height

4.3.2.2 En route

- **Base Drone Operator** loses visual contact with the drone. The drone starts operating in **BVLOS** conditions.
- The **U-space Service Provider** sends updated geo-fencing information to the **Drone** (**geo-fencing**)
- **Drone** verifies that a no-fly region intersects its flight path and starts hovering (**geo-fencing**).
- **Drone** requests new flight path from the **Drone Operator**
- **Base Drone Operator** uploads updated flight path into the **Drone**
- **Drone** restarts flight with new flight path
- **Drone** switches communication channel due to Quality of Service drop

- **Base Drone Operator** starts receiving information in new channel
- **Drone** authenticates with the **Base Drone Operator**
- **Drone** reaches the region of radio communication overlap.
- **Drone** authenticates with the **Mission Ground Station**
- **Drone** changes C2 from the **Base Ground Station** to the **Mission Ground Station** (**handover**).
- **Mission Drone Operator** at **Mission Ground Station** sends updated flight path to **Drone**

4.3.2.3 Mission execution

- **Drone** nears the payload Mission region. This region is georeferenced.
- **Drone** descends from the cruise flight height to a delivery height
- **Drone** detects several power-lines and re-adjusts local trajectory for avoidance (**DAA**)
- **Drone** arrives at delivery zone
- **Mission Drone Operator** verifies all is ok in the delivery zone and clears delivery
- **Drone** delivers the payload
- **Drone** communicates a successful delivery to **Drone Operator, U-space Service Provider** (**legal recording**)
- **Drone, Mission Ground Station, U-space Service** provider record delivery information into Digital logbook
- **Mission Ground Station** informs **Mission Service Provider** of delivery success
- **Mission Service Provider** informs **End-User** of successful delivery
- **Drone** climbs back to cruise height and starts return flight

4.3.2.4 Return flight

- **Drone** receives a signal broadcasted by nearby **Drone2** (**DAA)**
- **Drone** and **Drone2** cross-authenticate with each other
- **Drone** exchanges trajectory information with **Drone2 (DAA , V2V)**
- **Drone** negotiate avoidance action with **Drone2 (DAA , V2V)**
- **Drone** adjusts trajectory to avoid **Drone2** (**DAA**) and reports to **Mission Drone Operator**
- **Drone** returns to previous flight path
- **Drone** changes C2 from the **Mission Ground Station** to the **Central Ground Station** (**handover**).

4.3.2.5 Approach and landing

- **Drone** reaches the region near home and starts descent from cruise height
- **Drone** lands
- **Drone** sends flight termination notice to **U-space Service Provider**
- **Drone, Base Ground Station, U-space Service** provider record delivery information into Digital logbook **(Digital logbook)**

4.4 Stakeholder overview

Stakeholder name/ stakeholder sector	Relationship *(How does it relates to the Use Case context)*	Interests/stakes *(What interest can the stakeholder have in or through the project?)*
Overflown communities	They can restrict operations	Noise, Safety, Privacy, Inconveniency, sustainability
Logistics Business owners	They execute the business of logistics. (e.g. of influence: size of drone)	Rules, freedom to operate, efficient delivery capability
Drone operators	Operational users of drones	Efficient, cost effective, reliable drone platform,
End user for logistic service	This is the client of the logistic business operator (i.e., his focus)	Delivery assurance, convenience
City planners	They can amplify or restrict the size of the overall business	City planning, infrastructure, revenue, quality of life (mobility), sustainability
Regulators	They can impact on the drone costs and business size and viability	Noise, Safety
EU: SESAR	They are exploring and proposing the rules of the airspace/operations and associated infrastructure	Airspace integration
EU: Digital single market	This is an overall framework which can amplify or accelerate the business cases and technologies.	Enabling aerial IoT, digital integration for logistics drone operations
Drone manufacturer	This is the main beneficiary of ADACORSA results for integration into drones to sell to Operators or Logistic Services	Cost of systems, Cost of integration, Cost of compliance, Reliability

TABLE 9: STAKEHOLDER OVERVIEW

5. High Level Requirements and Means for Verification and Validation

High Level Requirements are describing general conditions for components, sub-systems and platform level needs and derivated from regulations, market expectations, technology standards and application specific needs. Each Supply Chain chapter, there will be demonstration reports which validate and verify HLR table by review, analysis, test and simulation. Main categories are U-space compliance, safety and efficiency should have satisfied by described demonstration methods. There are also additional application specific requirements, described in use cases, should satisfied by demonstrators during tests.

A numbering system for the HLR was created, resulting in a hierarchical tree like structure*:*

- HLR.0 Drone shall be compliant with U-Space
- HLR.1 Drones shall be safe
- HLR.2 Drones shall be efficient
- HLR.7 Drone shall be able to execute Forestry/smart Construction mission
- HLR.8 Drones shall be able to execute BVLOS logistics mission

Verification and validation methods has listed on the table below. Related supply chain validation and verification methods shown as in the table below as P (partial) and F (full) letters. Out of Scope section indicates that this activity is not a part of ADACORSA project, it might be outsourced, acquired or supplied by the third parties.

Platform level scenarios are logistics, smart construction and forestry, they're examined in terms of regulations, functionalities, performance, safety, security and human factors.

The list of demonstrators is provided by **Table 13** in **Annex 2.**

Requirement		Demonstrators																																			
ID	**Description**	1.1	1.2	1.3	1.4	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2	4.3	5.1	5.2	5.3	5.4	6.1	6.2	6.3	6.4	6.5	7.1	7.2	7.3	7.4	8.1	8.2	8.3	8.4	9.1	9.2	10.1	10.2	10.3	Out of Scope
HLR.0	**Drone shall be compliant with U-Space**																																				
HLR.0.1	Drone shall be able to self identify in the U-space											P	P						F				P														
HLR.0.2	Drone shall be able to comply with geographical, altitude and time restrictions defined by the geofencing service. (Geo-fencing)																							F				F	F		F						
HLR.0.3	Drone shall be able to transmit measurement data from the drone-to-drone operator and/or service provider (Telemetry)								P				P					F	F					F		F	F	F	F		F						
HLR.0.4	Drone shall be able to provide flight parameters including at least its position and height. (Tracking)								P									F	F					F		F	F	F	F		F						
HLR.0.5	Drone shall be able to share information with infrastructure components. (V2I Comm)								P				P			P		P			p				P	P	P	F	F		F						
HLR.0.6	Drone shall be able to communicate information to each other. (V2V Comm)												P			P		P			p								P		P						
HLR.0.7	Drone shall be able to meet the communication, navigation and surveillance performance requirements for the specific environment in which they will operate. (CNS)												P					P	F		p			F	F	F	F	P	P		P						
HLR.0.8	Drone shall be able to detect cooperative and non-cooperative conflicting traffic, or other hazards, and take the appropriate action to comply with the applicable rules of flight. (Detec&Avoid)																				p									P	P						
HLR.0.9	Drone shall be able to take account of failure modes, such as command and control (C2) link failure, and take measures to ensure the safety of the vehicle, other vehicles and people and property on the ground. (Emergency Recovery)																	P						P		P		P			P						
HLR.0.10	Drone shall be able to communicate with their ground control station to manage the conduct of the flight, normally via a specific data link. (Command & Control)								P			P	F					F			p			F		F	F	F	F	F	F						
HLR.0.11	Drone shall comply with REGULATION (EU) 2018/1139 as far as they are applicable within the scope of their intended operation.																														P			P	P	P	
HLR.0.12	Drone systems shall comply with DELEGATED REGULATION (EU) 2019/945 as far as they are applicable within the scope of their intended operation.																														P			P	P	P	
HLR.0.13	Drones shall comply with IMPLEMENTING REGULATION (EU) 2019/947 as far as they are applicable within the scope of their intended operation.																														P			P	P	P	

Requirement		Demonstrators																																			
ID	**Description**	1.1	1.2	1.3	1.4	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2	4.3	5.1	5.2	5.3	5.4	6.1	6.2	6.3	6.4	6.5	7.1	7.2	7.3	7.4	8.1	8.2	8.3	8.4	9.1	9.2	10.1	10.2	10.3	Out of Scope
HLR.1	Drones shall be safe																																				
HLR.1	Drones shall have auto-pilot feature and related software interfaces for control and monitoring				F											P								F		F											
HLR.1.1	Drone shall be able to prevent uncontrolled falling over people and assets on the ground																	P						F		F	F										
HLR.1.1.1	Drone shall be able to perform emergency landing																	P						F	F	F	F										
HLR.1.1.2	Drone shall be able to perform automatic landing			P	F				F															F	F	F	F										
HLR.1.2	Drone shall be able to prevent uncontrolled flight				P													P																			
HLR.1.2.1	Drone shall have safe communication with the ground control station												F					P						P		P		P	F		F						
HLR.1.2.2	Drone shall have secure communication channel with the ground control station											P				P		P						F		F		P	F		F						
HLR.1.2.3	Drones shall able to optionally be remotely controlled by a pilot																							P	P	P											
HLR.1.2.4	Drone shall have fault-tolerant avionics systems														F			P						F		F		P	P	P	P						
HLR.1.3	Drone shall be able to prevent collision against obstacles or other vehicles in the air				P											P						P								P	P						
HLR.1.3.1	Drone shall be able to detect obstacles or others vehicles in the air	F		P	P	F														P		P		P		P				P	P						
HLR.1.3.2	Drone shall be able to deviate and avoid collision with obstacles or others vehicles in its trajectory					P														P		P					P			P	P						
HLR.1.4	Drones system architecture and functions shall satisfy functional requirements from safety and risk assessments, namely SORA														P	P		P						P	P	P	P	P	P	P	P			P	P	P	
HLR.1.5	Drone shall be equiped with a qualified aero structure platform				F																			P	P	P											
HLR.1.6	Drone shall be equiped with a qualified propulsion system				F																																

Requirement		Demonstrators																																			
ID	**Description**	1.1	1.2	1.3	1.4	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2	4.3	5.1	5.2	5.3	5.4	6.1	6.2	6.3	6.4	6.5	7.1	7.2	7.3	7.4	8.1	8.2	8.3	8.4	9.1	9.2	10.1	10.2	10.3	Out of Scope
HLR.2	**Drones shall be efficient**																																				
HLR.2.1	Drones shall be able to execute acurate navigation				P				P							P		P						P	P	P	P	P	F	P	F						
HLR.2.1.1	Drone shall be able to perform automatic take-off				F																			F	F	F	F										
HLR.2.1.2	Drone shall be able to estimate navigation position				F				P									P						F					F		F						
HLR.2.1.3	Drone shall be able to maintain attitude control				F																			F	F	F											
HLR.2.1.4	Drone shall be able to provide guidance control to auto-pilot								P																												
HLR.2.1.5	Drone shall be able to maintain thrust control																							F	F	F											
HLR.2.1.6	Drone shall be able to plan an optimal flight trajectory								F	F																F				P	P						
HLR.2.5	Drone shall have enough energy for mission execution	P		P		P			P							P											F		F								
HLR.2.5.1	Drone shall be able to plan a optimal performance mission																												P								
HLR.2.6	Drones shall be able to receive mission planning																							F													
HLR.2.7	Drone shall prevent payload damage																							F													
HLR.2.8	Drones shall be able to take-off and land vertically																												P								
HLR.2.9	Drones shall be able to carry a payload																							F													
HLR.2.10	Drones shall be able to perform BVLOS operations																							P			P	P	P	P	P	P	P	P	P	P	

Requirement		Demonstrators																																			
ID	**Description**	1.1	1.2	1.3	1.4	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2	4.3	5.1	5.2	5.3	5.4	6.1	6.2	6.3	6.4	6.5	7.1	7.2	7.3	7.4	8.1	8.2	8.3	8.4	9.1	9.2	10.1	10.2	10.3	Out of Scope
HLR 7	**Drone shall be able to execute Forestry/Smart Construction mission**																																				
HLR.7.1.1	Drone shall have hover capabilities																							F	F	F											
HLR.7.1.2	Drone shall fly up to min 60m altitude																							F													
HLR.7.1.3	Drone shall be able to be feeded of eletrical energy from the ground																								F												
HLR.7.1.4	Drone shall fly up to min 120m altitude																								F												
HLR.7.1.5	Drone shall do autonomous descent and ascent close to the recording target																							F			F										
HLR.7.1.6	Drone shall do automated flight																							F		F	F										
HLR.7.1.7	Drone platform shall fly with low speed of 5-6 m/s during shooting																										F										

Requirement		Demonstrators																																			
ID	**Description**	1.1	1.2	1.3	1.4	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2	4.3	5.1	5.2	5.3	5.4	6.1	6.2	6.3	6.4	6.5	7.1	7.2	7.3	7.4	8.1	8.2	8.3	8.4	9.1	9.2	10.1	10.2	10.3	Out of Scope
HLR 8	**Drone shall be able to execute BVLOS logistics mission**																																				
HLR.8.1	Drone shall be able to deliver payload at the agreed destination																														P						
HLR.8.2	Drone shall be able to deliver payload at the agreed time																														P						
HLR.8.3	Drone shall be able to deliver payload at minimum cost																																				
HLR.8.4	Drone shall be able to operate in X, Y and Za U-space volumes																											P	P	P	P	P		P	P	P	
HLR.8.5	Drone for long range logistics shall be able to deliver up to 2Kg in a 80Km radius under 60 minutes																											P	P	P	P	P		P	P	P	
HLR.8.6	Drone for short range logistics shall be able to deliver up to 2Kg in a 25Km radius under 20 minutes																											P	P	P	P			P	P	P	
HLR.8.7	Drone shall be able to deliver package in adverse weather conditions																																				

6. Drone Stakeholder Analysis

Drone technologies are now increasingly paving their way into the commercial spectrum with a promise of better facilitating traditional operations. This new market would open doors to advancements in automation, increase opportunities for more optimized, safe and efficient operations across diverse domains, create new sectors for jobs and even transform the concept of mobility.

Understanding the stakeholders and analyzing their benefits and concerns at an early stage helps in strategizing the best relevant conceptual approach for ADACORSA and the drone industry. This section describes the systematic methodology and findings of the stakeholder analysis performed within WP1. The objective of the analysis was to present a framework of actors related to the drone industry within three use case scenarios – delivery, smart construction and forestry management, and understand the different perspectives and perceived attitudes of each stakeholder towards the usage of drones. The findings would assist in subsequent project activities in particular deriving indicators for public acceptance of drones.

6.1 Method

The methodology included the use of Delphi method – a three-step iterative process: interview with industry experts, internal workshop of the analysis team, and external workshop with industry experts. As preparation, a search of the literature was carried out with a focus on similar or related drone applications as the three use cases: delivery, forestry and smart construction. Based on the literature search and available use-case scenario descriptions, stakeholders were identified and initially categorized as industry-related stakeholders, governmental stakeholders, and (general) public and classified into respective groups (an example is shown in Figure 11). Actors from the literature search were highlighted in yellow and from the use-case scenario description in blue. Separate templates were created for the three use cases.

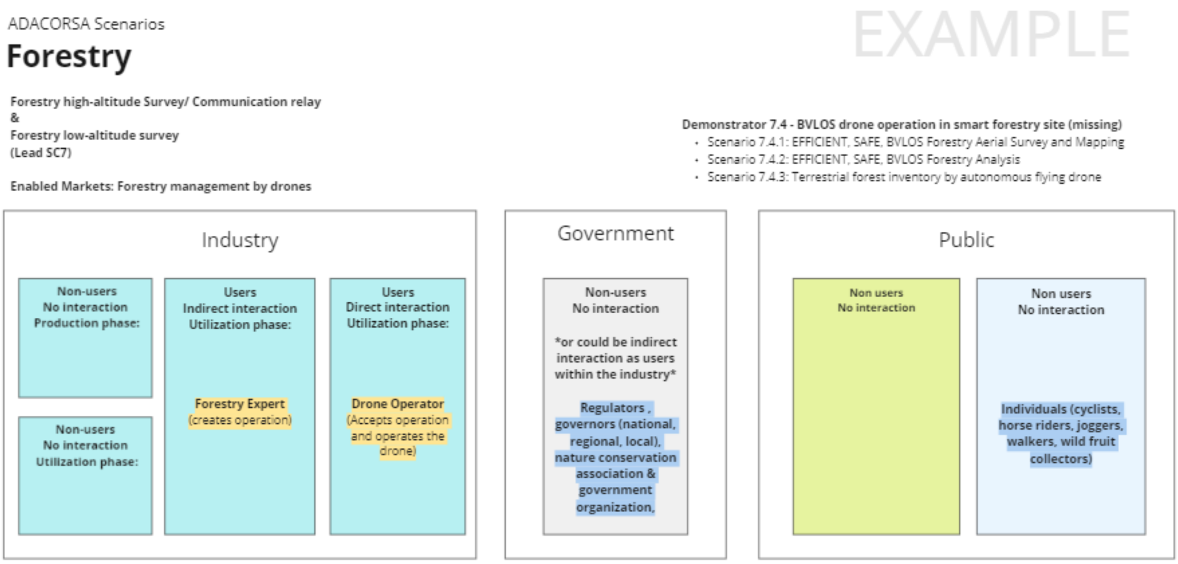

FIGURE 11: EXAMPLE OF INITIAL PREPARATION BASED ON LITERATURE SEARCH AND AVAILABLE FORESTRY USE CASE SCENARIO DESCRIPTIONS.

The foundation of the semi-structured interview topics was based on a new technology acceptance model, an inductive model, proposed in Chamata & Winterton [1]. According to their paper, perceived risks and perceived benefits have a direct impact on attitude as well as intention towards the technology. The final questionnaire schema explored stakeholders within the three use case scenarios, their perceived advantages and disadvantages, and ideas on how to mitigate the recognized disadvantages.

6.1.1 Interviews with Experts

A total of 15 interviews were conducted with 22 experts; including first- and second-tier technology developers and integrators, drone manufacturers, end-user consultants and policy makers/regulators. Each interview was approximately 60 minutes and was performed through an online platform due to Covid-19 travel restrictions. The interviews were held from mid-January 2021 over a span of five weeks. The collected data was then analyzed to i) identify stakeholders for each use case; ii) differentiate and categorize between the identified stakeholders; iii) investigate the concerns and benefits of each stakeholders group, and iv) determine the stakeholder group's position and draw mitigation solutions.

6.1.2 Internal Workshop and Literature Search

The results of the analysis were discussed in an internal workshop between the analysis team. Further, the findings of the literature search were incorporated to strengthen the analysis. This entire process helped in verifying the data collected but also raised questions about any variations found. The internal workshop resulted in the development of a new stakeholder identification framework and a thorough classification of stakeholder benefits and possible concerns. This was then visualized using graphs and diagrams.

6.1.3 Workshop with Experts

A last round was performed in a workshop where participants of the interviews were invited and presented with the visualized findings. The goal of the workshop was to identify and address any gaps and inconsistencies. The concept of the workshop consisted of three phases:

- PRESENTATION PHASE where the visualized results were presented to the participants
- REVIEW PHASE where the participants reviewed the presented results
- CREATIVE PHASE where participants actively took part in structured tasks. The aim of this phase was to encourage discussions and idea generation both individually and in groups

13 experts took part in the 2-hour workshop session that took place on the 19th of March, 2021. Miro board, a digital white board online platform was used for conducting the workshops. Figure 12 shows a screenshot of the white board layout.

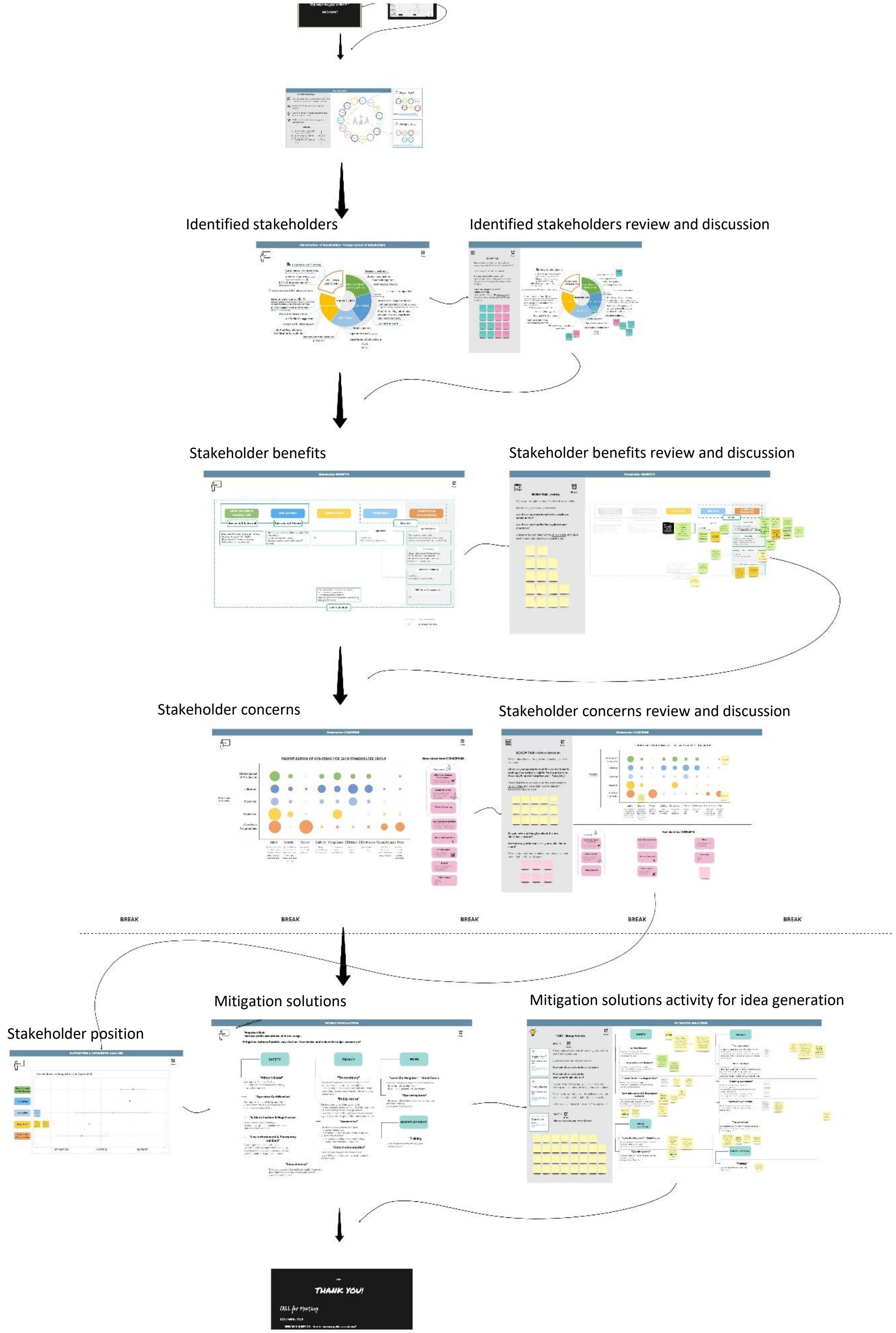

FIGURE 12: LAYOUT OF THE DIGITAL WORKSHOP CONDUCTED USING MIRO BOARD, A DIGITAL WHITE BOARD TOOL.

6.2 Stakeholder identification framework

Based on the information collected from interviews, literature and workshop, we assessed the list of actors and clustered them into five major categories (see Figure 13). Specific placement within a category was determined based on their primary role and function however might entail interchanging roles. A drone-use stakeholder is defined as ‘an individual, group, or organization who has an interest or some stakes in, can contribute in the form of knowledge or support, or can impact or be impacted by, the use of drones (modified from Bourne, 2008 [3]).

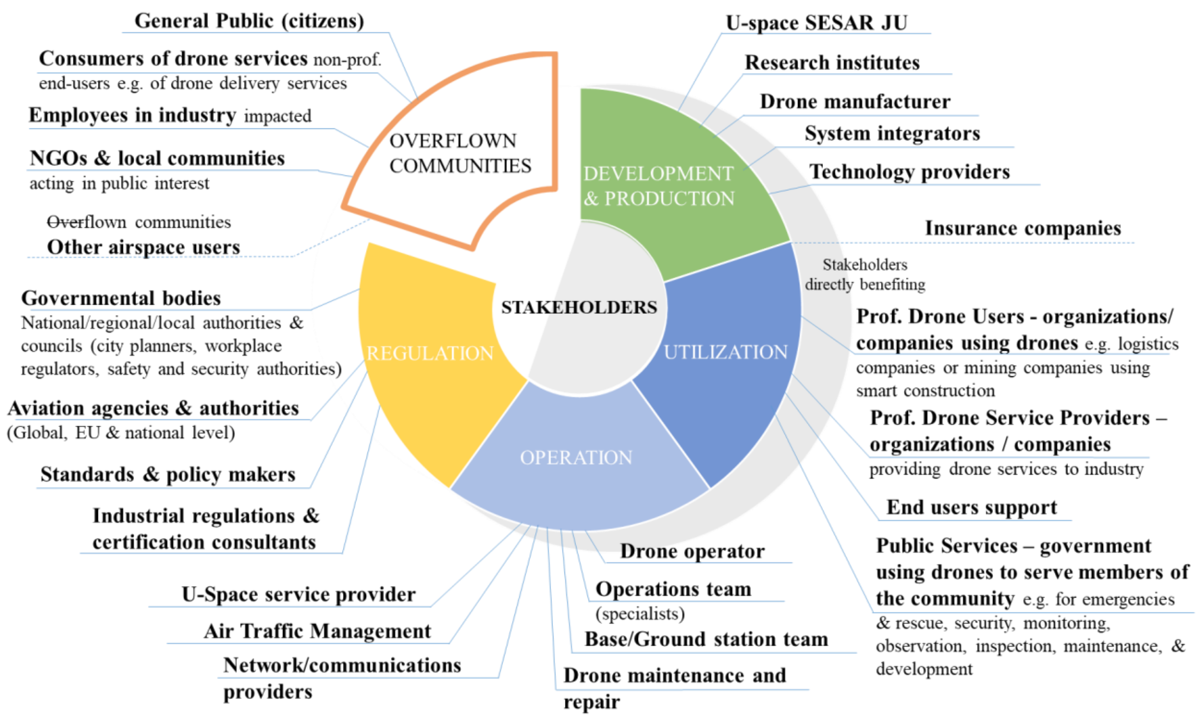

FIGURE 13: DRONE-USE STAKEHOLDER FRAMEWORK: ACTORS ARE CLASSIFIED AS PER FIVE STAKEHOLDER CATEGORIES BASED ON THEIR ROLES AND FUNCTIONS

6.2.1 Stakeholder Categories

The identified stakeholders have been classifies into the following five categories:

Development and Production stakeholder are concerned with development and production/ developing, designing, and manufacturing of drones. Mainly technology developers, system integrators, and drone manufacturers are experts in their fields and ensure safe and secure state-of-practice drones as per the set requirements. Research institutes and research projects contribute to the specifications of the new technology by expanding knowledge, evaluating outcomes and providing recommendations.

Utilization stakeholders can be defined as ‘professional-users employing drones’. These consist of individuals, companies or organizations who use drones as an instrument for business purposes to satisfy economic needs. We identified two main types of users 1) individuals, companies or organizations utilizing drones to increase productivity and efficiency of their own operations and/or expand their current services e.g. by offering drone delivery services, and 2) individual, companies or organizations providing drone-based services to industry e.g. drone-based logistics service provider to transport goods or drone-based construction service provider offering building inspections via drones. Lastly, government departments and public service agents are important users who would deploy drones to better serve members of the community e.g. police surveillance drones will increase safety and security and reduce crime-rates, search and rescue drones for instance in case of natural calamities, forest inspection and maintenance drones used to determine the health of the trees.

Operation stakeholders are all those directly involved in the operations of drone flights. These include 1) the operational users of drones i.e. drone operators or drone pilots, other individuals or team involved in the operations e.g. specialists, engineers, controllers, ground station team etc. working as individual entities or with/in collaboration with/as part of utilization stakeholders organizations, and 2) all involved in developing and overseeing systems and services that assist in drone flights both ground level and through controlled airspace.

Regulation stakeholders are all agencies and authorities (global, EU, national level) who are responsible for establishing, governing and regulating civil aviation legal frameworks e.g. EASA and sister organizations, carrying out certifications e.g. drone operator license, enforcing compliance/legislations, building standards and recommending guidelines, and also for performing investigations and monitoring. Additionally, industrial regulatory consultants working closely with development and production actors are placed within this category due to their function of facilitate and support companies to obtain certification and authorization. They aid in setting boundaries and conditions for drone flights and in developing regulatory framework. Lastly, all governmental bodies concerned with local authorities including local councils, municipalities, city planners, work-place/occupational health and safety, safety and security authorities e.g. police, fire brigade, etc. would have a high influence on commercial usage of drones.

Overflown Communities stakeholders refer to the general public. Even when their roles within the communities could differ, we categorized four major roles; 1) individuals or communities in society i.e. citizens, 2) consumers can also be referred to as non-professional end-users who opt for drone services (e.g. priority delivery) are recognized to have some direct benefits e.g. faster delivery of a package, 3) employees and workers who would be directly or indirectly impacted in their professional lives e.g. gain/loss of jobs, and 4) NGOs and local communities that are acting in the interest of the general public.

Another subcategory includes the flown community i.e. civil airspace users (airports, airlines, pilots) from the aviation traditional sector.

6.2.2 Stakeholder actors

Interviews with experts either focused on one use case scenario i.e. delivery, forestry or smart construction, or inclined more towards a general drone use scenario. Even though most identified stakeholders overlapped, some differences were noticed between the three use case scenarios. The most prevailing difference lies in the *overflown communities*. The experts were of the opinion that within the smart construction and to some extent the forestry scenario, the impact on the overflown community would be relatively less as compared to a delivery scenario. This mainly attributes to the adequate distance of construction sites from residential areas, lack of pedestrians in such sites e.g. mining site, lower frequency in use of drones (compared to delivery) etc. Table 10 lists in detail different stakeholder sub-categories and actors for each of the three drone use case scenarios. Additionally, the stakeholders identified (across similar drone applications) from the conducted literature search have been included to strengthen the analysis.

TABLE 10: STAKEHOLDER SUB-CATEGORIES/ACTORS ACROSS THE THREE DRONE USE SCENARIOS: DELIVERY, FORESTRY, AND SMART CONSTRUCTION.

	Delivery	Forestry	Smart Construction
Development and Production	Drone manufacturer, System integrator, Technology providers, Drone OEMs (traditional aerospace and automotive industry and new entrants such as starts-ups, logistic companies etc.), Research institutes, U-space SESAR JU, EU Digital single market		
		Forestry harvester manufacturer	Automobile manufacturer
	[Commercial Drones] Drone manufacturers, Technology developers, Research institutes [13] *[Life-ring Drone Delivery]* Lifeguard equipment manufacturers [16] *[Drones for Light Shows]* Manufacturers [10] *[Connected and Automotive vehicles]* OEMs, Mobility experts and consultants, Academics [7]		
Utilization	Logistics companies (UPS, FedEx, DHL, TNT) Logistics business owners Postal services Retailers Delivery service providers (e.g. food delivery), Emergency medical services (EMS) Healthcare sector	Forestry industry - Forest management/forestry operations/forest inventory companies Construction companies Forest owners Forest surveying service provider Forest research organizations (determining biological values) Scientific/research persons	Construction companies Mining companies Infrastructure companies Sub-contractors Scientific/research persons

	Delivery	Forestry	Smart Construction
	[Commercial Drones] Service providers, Private and public establishment drone users, Insurance companies [13] *[Commercial Delivery]* Commissioners, Logistics service providers, Platform providers [12] Retailers, Transport providers, (Gatta et al., 2019) *[Ambulance Drones]* Medical personnel, Norwegian Ministry of health [15] *[Life-ring Drone Delivery]* Lifeguarding associations, Municipalities as beach owners [16] *[Drones for Light Shows]* Venues, Entertainment industry, Competitors, Sponsors, Insurance companies [10] *[Connected and Automotive vehicles]* Public transport and transport service providers, Insurance companies [7]	Forest administration, Wood processing industry, Public and private forest enterprises, Forest and wood sciences [6]. Commercial companies, Investors, Professional organizations (national specialty or advice), Woodland owners, Communities (formal or semi-formal managers of woodland, Science organizations [14].	*[Drones in Construction]* Architects, Builders, Engineers, Quantity surveyors, Land surveyors, Estate surveyors, Clients [11] *[Robotics and Automated systems in Construction]* Contractors, Engineering consultants, Architects, Designers, BIM managers, Standard developers [4] *[Autonomous Mining Systems]* Contracting companies, employees and workers in mining companies, Students and academic staff (as future users of technology) [8] *[Digital Construction]* Contractors, Engineers, Architects, Facility managers, Consultants, Suppliers, Clients [2]
Operation	Drone operator/pilot, Operations team (specialists), Base/Ground station team, Drone maintenance and repair, Network/communications providers ATM Air traffic management U-space service providers		
		Forest experts, Forest machine operators (forest harvester or thinning machines)	

	Delivery	Forestry	Smart Construction
Regu-lation	Industrial regulations & certification consultants, Standards & policy makers, Aviation agencies & authorities (Global, EU & national level), Other governmental bodies - National/regional/local authorities & councils (city planners, workplace regulators, safety and security authorities)		
	Governmental bodies – city planners	Governmental bodies for regulating natural resources Forester (gov. caring for forests) FSC certification organization	Governmental bodies for regulating natural resources
	[Commercial Drones] Governmental regulatory organisations, Judicial bodies, Policy organisations [13] *[Commercial Delivery]* Public administration [5] *[Ambulance Drones]* Civil Aviation Authority (Luftfartstilsynet; CAA) [15] *[Life-ring Drone Delivery]* Municipalities as regulators (documenting lifeguard certification status and requirements) [16] *[Drones for Light Shows]* Law enforcement, FAA/ OSHA [10] *[Connected and Automotive vehicles]* Government, Public administration, Politicians [7] *[Forestry management]* Regulators and governors (national, regional, and local) [14] *[Autonomous Mining Systems]* Government (regulator of natural resources) [8]		

	Delivery	Forestry	Smart Construction
Overflown communities	General public (citizens) e.g. pedestrians Consumers/End-users of drone services e.g. individuals receiving deliveries via drones Citizens in industry impacted e.g. employees/workers etc. NGOs & local communities acting in public interest	Citizens in industry impacted e.g. employees/workers etc. NGOs & local communities acting in public interest	Citizens in industry impacted e.g. employees/workers etc. NGOs & local communities acting in public interest
	[Commercial Drones] Individual users, Activists for privacy, Activists for or against drones, Non-profits acting in public interest, New organizations [13] *[Commercial Delivery]* Receivers, Crowd [12] Citizens [5] *[Ambulance Drones]* Bystanders [15] *[Drones for Light Shows]* Viewers [10] *[Life-ring Drone Delivery]* Beach goers [16] *[Connected and Automotive vehicles]* "Vulnerable" population [7] *[Forestry management]* Forest and wood sciences, Nature conservation association and Government organization, Forest related local citizens' initiative, Forest advocacy group [6] *[Forestry management]* NGOs (conservation, education, social matters), Science organizations, Communities (formal or semi formal managers of woodland), Individuals (cyclists, joggers, walkers, horse-riders, wild fruit collectors) [14]		

	Delivery	Forestry	Smart Construction
Flown communities/ other airspace users	All airspace users e.g. airlines, aircraft pilots, air taxi users (urban air mobility)		

6.1 Stakeholder Interest Analysis

6.1.1 Stakeholder Benefits Assessment

In the literature on drone use, there has been scarce discussion of benefits, and only some general aspects like economic benefit for companies, reduction of urban traffic, and ecological benefit were mentioned [9]. Thus, during the stakeholder interviews, benefits of drone use were targeted for discussion with our experts. Different benefits for various stakeholders were identified and combined into main categories. Stakeholders in *Development & Production, Utilization*, and *Regulation* mainly seem to gain economic benefits. *Overflown communities* are considered to benefit mostly from social aspects. Finally, environmental benefits are considered benefits for all stakeholders. Table 11 explains in detail different stakeholder benefits for each of the three drone use case scenarios: delivery, forestry, and smart construction.

TABLE 11: ECONOMIC, SOCIAL, AND ENVIRONMENTAL BENEFITS DISTRIBUTED ACROSS STAKEHOLDER CATEGORIES AND THE THREE DRONE USE SCENARIOS: DELIVERY, FORESTRY, AND SMART CONSTRUCTION.

<table>
<tr><th></th><th>Delivery</th><th>Forestry</th><th>Smart Construction</th></tr>
<tr><td rowspan="3">Development and Production</td><td colspan="3">Economic Benefits</td></tr>
<tr><td colspan="3"><u>General Business Benefits:</u>
• Expanding drone technology applications and standards i.e., expanding the market of drones
• Introducing research proceedings into industrial use
• Generating profit from the high demand of drones, increasing pool of customers, and increased turnover in drone sales
<u>Service Benefits:</u>
• Improving the features of the products and services and expanding the scope of drones through BVLOS
<u>Offering services with higher customer satisfaction rates</u>
• Generating profit from the high demand of drones, increasing pool of customers, and the consequent turnover in drone sales</td></tr>
<tr><td></td><td></td><td>• Increasing trust in autonomous mobility and its safety, beneficial for automobile and drone industries
• Creating new opportunities for 5G networks as a benefit for GSM companies</td></tr>
<tr><td>Utilization</td><td colspan="3">Economic Benefits</td></tr>
</table>

Delivery	Forestry	Smart Construction
General Business Benefits: • Saving delivery costs by replacing human labor and fuel expenses with drones (especially that last mile delivery is considered to be very expensive) • Expanding and diversifying the customer base • Decreasing maintenance and investment costs with airspace use instead of ground transport Operation & Service Benefits: • Speeding delivery services by avoiding ground traffic (for last mile delivery) • Widening delivery coverage area and gaining the ability to deliver to new regions, rural areas, islands, mountain tops, or thinner regions (sparsely populated areas) due to extended drone range • Increasing efficiency due to time and energy savings	General Business Benefits: • Expanding the drone service into the forestry industry and discovering new value chains • Selling drone inventory as a service to forest owners and organizations Operation & Service Benefits: • Increasing general efficiency of forestry operations, saving time and money • Providing better forestry services and features (in general) • Increasing the yield (production) such as timber for construction and its speed, increased cut-to-length quality, and possible decrease of wood price • Improved forest management by faster and more efficient, and large-scale forest inventory, faster inspections above and below tree canopies, and more accurate and detailed data collection, leading to better forecasts and better decision making which in turn improves volume growth, forest care and early detection of forest diseases • Improved terrain inspection before cutting trees for construction	General Business Benefits: • Decreasing cost of operations by decreasing fuel consumption and reducing human work replaced by automation Operation & Service Benefits: • Improving operations and accuracy, better time management, increasing productivity, and decreasing inefficiencies in general • Reducing waiting times for excavators • Increasing safety of operations within construction sites • Generating more accurate measurements relevant to the operations (e.g., of the volume or quantity of earth that has been extracted in mining)

<table>
<tr><th></th><th>Delivery</th><th>Forestry</th><th>Smart Construction</th></tr>
<tr><td rowspan="3">Operation</td><td colspan="3">Social Benefits</td></tr>
<tr><td colspan="3">• <u>Livelihood:</u> Gaining a job opportunity/ procuring a livelihood (not only operators but also specialists in drone technology, maintenance, software, etc.)
• Benefiting from the diversification of drone services/ uses
• Improving the nature of the work, and consequently increasing job satisfaction and self-actualization</td></tr>
<tr><td>• Gaining social status from the job/ a good social reputation from the profession (similar to pilots)</td><td>• Increasing efficiency of their work due to the upgraded equipment and the accurate data and metrics that they can collect (can also apply in other applications)</td><td>• Decreasing work stress in certain aspects of the job (can also apply in other applications)</td></tr>
<tr><td rowspan="2">Regulation</td><td colspan="3">General/ Economic Benefits</td></tr>
<tr><td colspan="3">• Expanding their business scope and gaining more authority / decision making in new areas
• Financial benefit incoming from pilot trainings and annual auditing, ensuring that operation of drones is up to legal standards</td></tr>
<tr><td rowspan="2">Overflown Communities</td><td colspan="3">Social Benefits</td></tr>
<tr><td colspan="3">General public
• Increasing awareness on privacy issues (e.g., creation of drone free zones) & improving safety standards for drone operation through establishment of drone use regulations
• Possible creation of new job opportunities for highly skilled labour
• Reducing gig economy and low paid jobs, and creating higher paid job opportunities and more interesting jobs
Making drones more accessible to the public through better regulatory frameworks
• Improving efficiency (in cost and time) in building and maintenance of infrastructure as a benefit for society
• Improving research in different areas as a benefit for society in general (like drone use in forestry research for better forest management)</td></tr>
</table>

Delivery	Forestry	Smart Construction
General public • Benefiting from decrease in traffic on ground • Improving access to health services *Consumers* • Receiving deliveries faster within urban and rural regions • Gaining accessibility to a wider range of services for a larger base of consumers and especially citizens of thinly populated regions, rural areas, islands, and mountains • Increasing safety of deliveries • Decreasing delivery charges (after logistics companies' economic benefit becomes large enough to transfer to consumers, but this is a major benefit for companies rather than consumers) • Gaining access to 'greener' products/ services Eliminating human contact in last mile delivery, important in pandemics like current times	*General public:* • Increased safety from improved control of vegetation	*Citizens within the industry* • Increasing safety and security of workers in construction sites (e.g., drone might carry construction equipment instead of workers)

	Delivery	Forestry	Smart Construction
Flown communities/ other airspace users	*No benefits identified*		
	Environmental Benefits		
	• Reducing road vehicles used in delivery • Decreasing pollution produced by current delivery transportation means and thus decreasing the carbon footprint (by using drone technology as an alternative transport means)	• Decreasing fuel consumption of harvester machines by optimizing their routing and operations • Decreasing damage to forest soils through optimized routing and operations of forestry machines, and use of drones for inspections instead of using 4 wheelers or jeeps as an example • Increased carbon absorption (as a climate benefit) through increasing tree growth • Improving forest health in general due to enhanced forest care from higher efficiency of inspection and data collection processes • Improved control of vegetation	• Decreasing fuel consumption due to optimization of truck routes within construction sites

6.1.2 Stakeholder Challenges and Concerns

Based on the current literature, the major challenges, issues and concerns with respect to adoption of drones were identified and included in the interview questionnaire framework. These consisted of ADACORSA's operational capabilities, safety, security and compliance as well as other pressing issues namely privacy, liability, efficiency, effectiveness, unemployment and noise. During the interviews, experts were asked to highlight and prioritize the listed concerns from the perspective of each stakeholder. Subsequent weights (3 being very high concern, 2 high concern and 1 being moderate concern, low concerns were provided with 0 weight) were given based on their assessment to quantify their inputs. The aggregated results are illustrated in Figure 14. Larger dots indicate a higher weight for that particular concern as well as a higher probability of concern for that stakeholder category. Furthermore, experts were encouraged to explore additional attributes that might be perceived as a risk. The results based only on the opinions of the interviewed experts, and thus the ratio of each concern with the other do not have to correspond with reality.

FIGURE 14: PRIORITIZATION OF CONCERNS FOR EACH STAKEHOLDER GROUP. LARGER DOTS INDICATE A HIGHER CONCERN IN RELATION TO THE DISPLAYED LIST OF IDENTIFIED CONCERNS (X-AXIS) FOR THE RESPECTIVE STAKEHOLDER GROUP (Y-AXIS)

As Figure 14 shows, safety- related risks were regarded as high priority for all stakeholder groups. Safety risks can be categorized as ground risks, i.e., risks related to persons and objects on the ground, and air risks, i.e., risks related to other traffic in the air. Safety is closely linked with security risks (physical and network safety from intentional harm) and is a joint concern between manufacturers, users and authorities. From the perspective of the *development and production* stakeholders, the interviewed experts additionally saw safety to overlap with compliance (as safety requirements are mostly set by regulations) making these their greatest challenge. They have to adhere to the standards, policies and requirements set by the regulation authorities with respect to safety directives, quality standards, drone operation, practice and process. Failure to meet the minimum requirements would result in non-successful product verification and no sales. Once the safety requirements are met, efficiency and effectiveness come into play. This includes the development of a robust technology that would enhance workflow, enable fast operations, and provide value-add services (e.g. flawless data), able to be commercialized and ensure user satisfaction. Low noise levels were recognized as an efficiency requirement. Lastly, the uncertainties around the novel technology adoption raised questions regarding warranty, claims on product responsibilities, liabilities in malfunctions and accident situations, software quality liabilities, and liabilities related to conformance with machine standards and safety directives.

Utilization stakeholders' basic concerns consisted of the capabilities of drones, i.e. reliable operations, value-adding, efficient and effective processes when compared to traditional processes (e.g. human driven vehicles), complimentary with other machines and systems (e.g. connection with other forestry system), and approval of drone-based data for e.g. in applications such as agriculture, forestry for mining inspection reports need to be submitted to relevant authorities. Data recorded via drones for such inspection reports e.g. health of crops might pertain to being approvable by the respective authority. Moreover, autonomous flight applications could include stricter compliance and thus operations have to rely on certain regulations such as geofencing rules. Liability and insurance were seen as a bigger concern especially for delivery use case mainly due to the fact of operating in close proximity to the general public. Users of the delivery use case would show strong interest in liability since they will be the first to be hit with claims (e.g. consumers of drone delivery services will claim losses for damaged products, drone-related damage to property such as broken window etc. from drone-based delivery companies). This concern would however extend to drone service providers in other applications.

Actors involved in the direct usage of drones, *operation* stakeholders, are perceived to be responsible for the efficient operations of the drones and ensuring a safe air space. Efficiency concerns comprise of optimization of operations in terms of precision, accuracy, and consumption of time and resources (speed and minimum energy). Drone operator roles often might overlap with actors of *utilization* making liability as a higher concern for this subcategory.

Regulation stakeholders have a high stake in the safety of the general public, workplace safety, air traffic safety, safety of other airspace users as well as security concerns such as cyber breaches that may lead to safety issues. This applies even more for drone flights around protected areas such as infrastructure, power plants and airports. They are the main contributors in issuing legal regulations and are responsible to have the right regulations in place and maintaining compliance, thus making it their primary focus. Sub-groups of governmental bodies such as local councils acting in public interest were further recognized to have a strong influence on noise regulations and unemployment issues.

Risk perceptions for the *overflown communities* were seen to be privacy and safety. Privacy concerns include risk of being filmed and recorded through the drone cameras, risk of pictures being taken by the drone, feeling of being observed or monitored resulting in discomfort due to invasion of personal privacy when drones fly close to a person or their home. Privacy concerns were found to overlap with security concerns with regards to confidentiality of personal data. For e.g. consumers of a delivery service receiving parcels might be distressed about drones using personal data for target advertisements. According to the interview experts, safety concerns for this group were directed more towards individual safety i.e. collisions to persons or objects falling from the sky and causing damage to property such as cars. Apart from privacy and safety, there is a growing awareness of the increase in noise pollution due to drone operations especially in residential areas, near schools, hospitals, recreational areas, urban areas, and unemployment rates as a result of autonomous drone operations.

6.2 Stakeholder Position Analysis

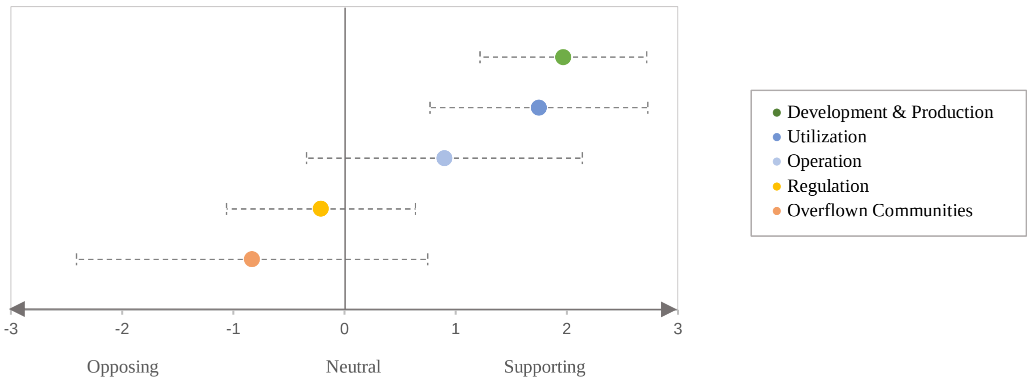

FIGURE 15: POSITIONS OF STAKEHOLDER CATEGORIES BETWEEN OPPOSITION AND SUPPORT OF DRONE USE AND THEIR STANDARD DEVIATION, BASED ON THE AGGREGATED AND AVERAGED DATA

Initially, it is important to emphasize that the distribution of the stakeholder categories in the above graphs are based on our expert's expectations of their position towards drone use.

The graphs reflect the aggregation of the participants' opinions on the position of different stakeholders towards drone use at a scale of [-3, -2, -1, 0, +1, +2, and +3] equivalent to [strong opposition, opposition, weak opposition, neutral, weak support, support, and strong support]. The position values of stakeholders in the same stakeholder category, based on our stakeholder categorization, are averaged. These averages are reflected in the dots for each stakeholder category, and the horizontal dashed segments reflect the standard deviation of those values as seen in Figure 15. In Figure 16, the dots reflect the position average value and standard deviation of each subcategory within *Overflown Communities* in specific.

As Figure 15 shows, stakeholders in *Development and Production* were the highest supporters of drone use since they benefit massively from its sales, and those in *Utilization* came as second-highest supporters, since they would also gain economic advantage from the use of drones in their operations. The standard deviation of stakeholders in *Utilization* is slightly higher than that in *Development & Production*, and that refers to small organizations or competitor companies in who might be unable to afford drone technology and adopt it as fast as large corporations. Those stakeholders might weakly oppose drones or weakly support it, at least until they have the resources to finance it, according to our experts.

Stakeholders in *Operation* came as third-position supporters, and they had a larger standard deviation than the latter, caused by a substantial contrast in their stances towards drone use, predicted by our experts. Stakeholders like Air Traffic Control, who might be highly concerned with the safety threats that drones can pose on manned aircraft, are considered to be weak opponents, while operators and other specialists who potentially gain a livelihood due to the use of drones are expected to strongly support the technology.

Stakeholders in *Regulation* are positioned as very weak opponents, almost neutral even, with a relatively small standard deviation shifting between weak opposition and weak support. This reflects our experts' opinions on how all stakeholders in *Regulation* would mostly be neutral, nevertheless they can also potentially stand against the technology in case of high concerns of safety, or be in slight support of the technology if it reaches their standards for safe operation.

Overflown communities are expected to be the highest opponents of drone use amongst all stakeholder categories. However, they also have the highest standard deviation which reflects again great diversity in the opinions of individuals in this category. This diversity is well explained in Figure 16, which dissects the subcategories of *Overflown Communities* on the same scale as Figure 15.

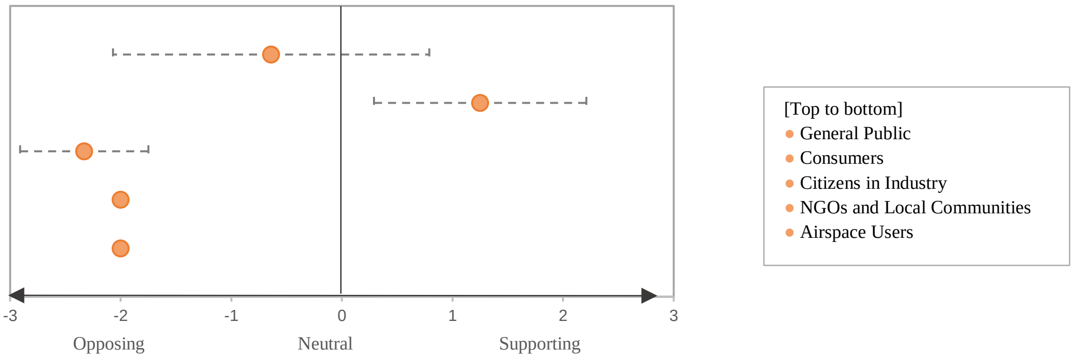

FIGURE 16: POSITIONS OF OVERFLOWN COMMUNITY GROUPS BETWEEN OPPOSITION AND SUPPORT OF DRONE USE AND THEIR STANDARD DEVIATION, BASED ON THE AGGREGATED AND AVERAGED DATA

The *General Public* are predicted to be weak supporters on average with a very large standard deviation between strong opposition of people who consider drones an appropriation of their safety and privacy, and strong support of tech savvy individuals, for example, who would appreciate the technology and be accepting of its use. On the other hand, *Consumers* of drone delivery services are considered supporters on average as they would mainly benefit from the convenience this technology would bring them. *Citizens in the Industry* are predicted to be the strongest opponents within *Overflown Communities* since they mainly represent individuals who might lose their jobs, and thus their main source of income, due to automation. Finally, *NGOs & Local Communities* are expected to be strong opponents for reasons related to privacy or environmental threats, as are *Airspace Users* for safety reasons mainly as suggested by our participants.

6.3 Mitigation Solutions

During the interviews various ideas were collected on mitigating the concerns of the members of the overflown communities. This was then further investigated in the workshop as a creative activity. Participants were encouraged to discuss ideas in two separate groups. The following screenshot (Figure 17) illustrates the possible actions/ways to minimize and reduce safety, privacy, noise and unemployment concerns. The goal of the activity was to generate solutions on how to increase public acceptance of drone use.

This project has received funding from the ECSEL Joint Undertaking under grant agreement No. 876019.
This Joint Undertaking receives support from the European Union's
Horizon 2020 research and innovation programme and the ECSEL member states.

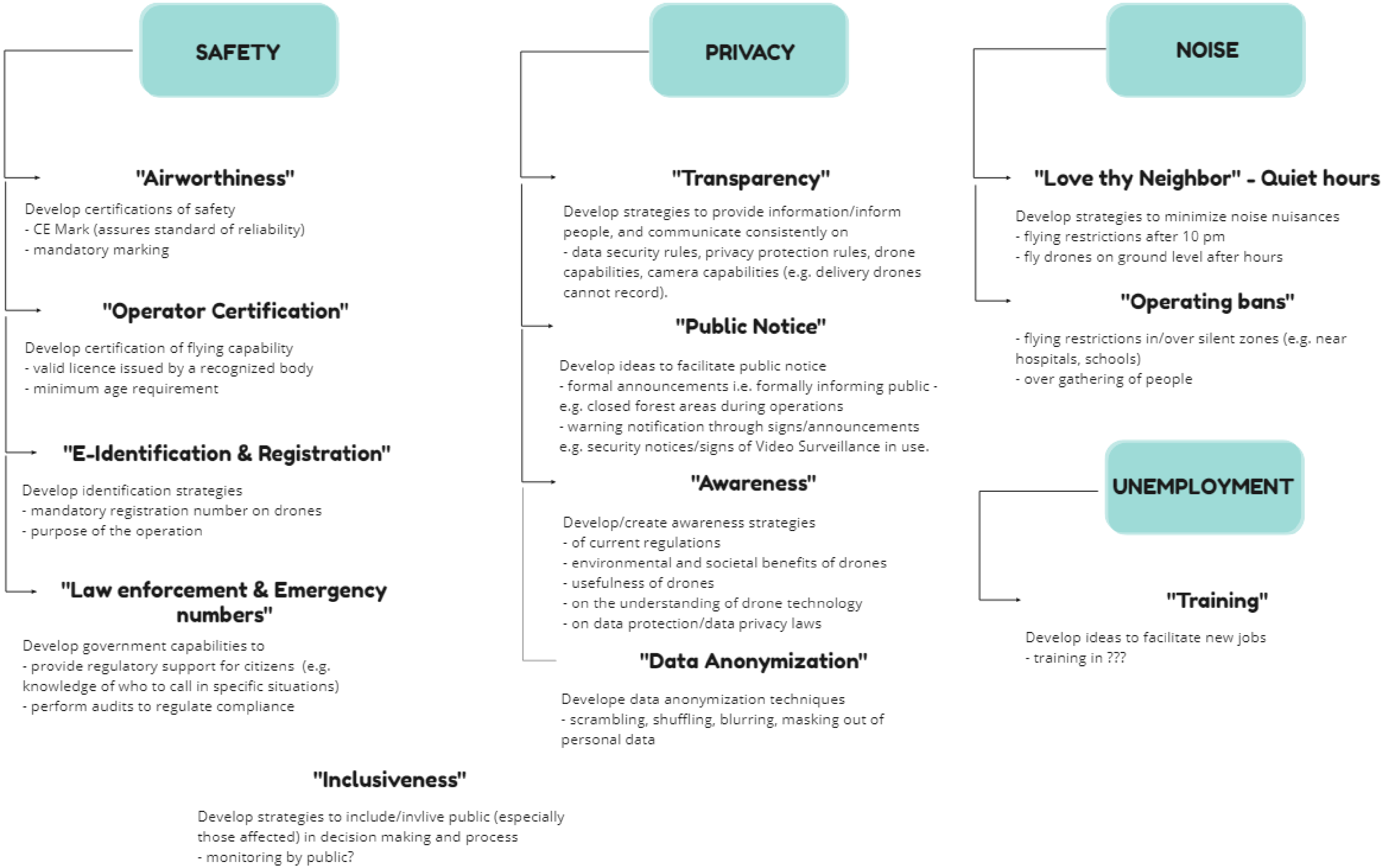

FIGURE 17: POSSIBLE SOLUTIONS FOR MITIGATING SAFETY, PRIVACY, NOISE AND UNEMPLOYMENT CONCERNS OF MEMBERS OF THE OVERFLOWN COMMUNITIES

A larger section of the general public does not have the opportunity to make a trade-off between benefits such as economic gains and their concerns of drone usage. It is therefore very important to openly communicate the potential societal and environmental benefits, be transparent in the data shared, and promote inclusiveness i.e. allow their participation in one way or another. This will further spread awareness about regulations, privacy and data protection laws and build trust. Some concepts are already being explored and implemented in this context: E-identification and registration of drones, app-based identification of in-flight drones and its operation, no-flight zones and operating bans, and data anonymization techniques such as scrambling or masking out the faces of pedestrians/personal information (similar to google earth). Current EU regulations requirements such as 'airworthiness' CE mark certification and operator licensing further aid in mitigating the general public's safety concerns. As a conclusion, proper regulations for citizens in terms of law enforcement, emergency numbers, and legal support is vital for public acceptance and adoption of drones.

6.4 Outlook

The stakeholder analysis captures experts' opinions for the five defined stakeholder categories: development and production, utilization, operation, regulation and overflown communities. The results describe the perspective of each stakeholder group within the three use case scenarios: delivery, forestry and smart construction. The interest analysis and derived position of the stakeholders towards drone use further provides a clear overview of industry experts' expectations and concerns. These findings and insights achieved would aid in subsequent SC9 ADACORSA project activities in particular for T2.9 – drone market analysis and public acceptance.

7. Conclusion

7.1 Contribution to overall picture

This document is part of an integrated package for requirements reference.

It provides the operational understanding for deployment and integration of technologies developed by the SCs, linking to the operational capabilities resulting from the analysis in D1.1. The document also supports the traceability of the means for verification or validation (demos) to the HLR, which will then be further detailed into lower level requirements in D1.3. The document will serve as a reference to the other WP regarding the operational context and support WP6 regarding the verification and validation activities.

7.2 Relation to the state-of-the-art and progress beyond it

Services and applications based on drone today are still only allowed under waivers and not mass adopted. Services, technologies, regulations and operational concepts are still being developed, as well the overall socio-technical system that involves drone enabled services and applications.

The operational descriptions provide represent reference future applications, where U-space services are assumed to be operational.

Understanding the different stakeholders, their focus and influence on drones is an emergent field of research. The document sets up an initial analysis that will be expanded by the project

Understanding how to derive low level requirements (functional, non-functional) for systems, sub-systems and components for drone is not a straightforward issue. Annex II, by SC10, proposes an understanding and first guidelines on how to leverage the current SORA methodology with other approaches to bridge this gap.

7.3 Impacts to other WPs, Tasks and SCs

Work Package 1 prepares the high level requirements for WP2-WP3-WP4 and WP5 and their related supply chains. Partners will evaluate this HLR baseline for their further requirements sets and referenced HLR items for traceability. As described in T1.3, ADACORSA project follows common systems engineering V-Model method and WP1 HLR document shall verify at WP6 – Validation, test and demonstration.

In WP5 – System Integration phase, requirements in terms of interfaces, functionalities and performances to conveniently match with the HLRs. During the development phase, HLR document may updated according to the needs comes from the low level sub-system requirements.

This revision of requirements is at this stage becoming fundamental to drive the final stage of development with WP6 about test and validation. The demonstrators are indeed evaluated in respect to the numerical, functional and behavioral targets identified in the requirements and update along the development process.

7.4 Contribution to demonstration (what aspects of the work that will be demonstrated

Not necessary.

7.5 Other conclusions and lessons learned

- **Use cases:**
    - Drone business and operations are evolving and the full ecosystem in a learning state. In that regard, operational descriptions must be understood as propositions, working from the best understanding of what the user want and what operational services and rules will be (e.g., proposed U-space services). The operational descriptions should be considered with this in mind, and a revision should be done, to fine-tune and improve alignment with external developments where needed.
- **Stakeholder:**
    - The stakeholders are broad and varied. Priorization must be done to focus on more relevant stakeholders and collaborations with other projects and initiatives developed to be able to address user adoption and the citizen voice.
- **High level requirements:**
    - Link with low level is challenging. The material is a base from which further understanding and integration can be developed, namely framed by systems engineering processes and in particular model based systems engineering.
- **Regulatory:**
    - Regulations are being established and need update and keep up.
    - An approach was developed to link methods like SORA with other aerospace known methodologies regarding linking lower level requirements to operational understanding. This must be exercised and connected with the content of the use cases for added value.

8. References

[1] Chamata, J., & Winterton, J. (2018). A Conceptual Framework for the Acceptance of Drones. *The International Technology Management Review*, *7*(1), 34–46. https://doi.org/10.2991/itmr.7.1.4

[2] Craveiro, F., Duarte, J. P., Bartolo, H., & Bartolo, P. J. (2019). Additive manufacturing as an enabling technology for digital construction: A perspective on Construction 4.0. *Automation in Construction*, *103*, 251–267. https://doi.org/10.1016/j.autcon.2019.03.011

[3] Bourne, L., & Walker, D. H.: Project relationship management and the Stakeholder Circle™. In: International Journal of Managing Projects in Business (2008)

[4] Delgado, J. M. D., Oyedele, L., Ajayi, A., Akanbi, L., Akinade, O., Bilal, M., & Owolabi, H. (2019). Robotics and automated systems in construction: Understanding industry-specific challenges for adoption. *Journal of Building Engineering*, *26*, 1–11. https://doi.org/10.1016/j.jobe.2019.100868

[5] Gatta, V., Marcucci, E., Delle, P., Le, M., & Sacha, C. (2019). Planning with stakeholders: Analysing alternative off-hour delivery solutions via an interactive multi-criteria approach. *Research in Transportation Economics*, *73*(December 2018), 53–62. https://doi.org/10.1016/j.retrec.2018.12.004

[6] Hengst-Ehrhart, Y., & Schraml, U. (2020). Back to the Forest' s future: Guiding principles of German forest stakeholders and their impact on the forestry sector. *Land Use Policy*, *94*, *104496*, 1–14. https://doi.org/10.1016/j.landusepol.2020.104496

[7] Kacperski, C., Vogel, T., & Kutzner, F. (2020). Ambivalence in Stakeholders' Views on Connected and Autonomous Vehicles. *International Conference on Human-Computer Interaction*, *12212*, 46–57. https://doi.org/10.1007/978-3-030-50523-3_4

[8] Kansake, B. A., Kaba, F. A., Dumakor-Dupey, N. K., & Arthur, C. K. (2019). The future of mining in Ghana: Are stakeholders prepared for the adoption of autonomous mining systems? *Resources Policy*, *63*, *101411*, 1–11. https://doi.org/10.1016/j.resourpol.2019.101411

[9] Kellermann, R., Biehle, T., & Fischer, L. (2020). Drones for parcel and passenger transportation: A literature review. *Transportation Research Interdisciplinary Perspectives*, *4*, 100088. https://doi.org/10.1016/j.trip.2019.100088

[10] Lanteigne, A., Kibru, E., Azam, S., & Shammary, S. Al. (2017). Design of a Drone Lead-Follow Control System. *Published in 2017 Systems and Information Engineering Design Symposium (SIEDS)*, 162–167. https://doi.org/10.1109/SIEDS.2017.7937709

[11] Patrick, O. O., Nnadi, E. O. E., & Ajaelu, H. C. (2020). Effective use of Quadcopter drones for safety and security monitoring in a building construction sites: Case study Enugu Metropolis Nigeria. *Journal of Engineering and Technology Research*, *12*(1), 37–46. https://doi.org/10.5897/JETR2020.0695

[12] Rai, H. B., Verlinde, S., Merckx, J., & Macharis, C. (2017). Crowd logistics: an opportunity for more sustainable urban freight transport? *European Transport Research Review*, *9*(3), 1–13. https://doi.org/10.1007/s12544-017-0256-6

[13] Rao, B., Gopi, A. G., & Maione, R. (2016). The societal impact of commercial drones. *Technology in Society*, *45*, 83–90. https://doi.org/10.1016/j.techsoc.2016.02.009

[14] Raum, S. (2018). A framework for integrating systematic stakeholder analysis in ecosystem services research: Stakeholder mapping for forest ecosystem services in the UK. *Ecosystem Services*, *29*, 170–184. https://doi.org/10.1016/j.ecoser.2018.01.001

[15] Rootwelt, T. (2016). *Ambulance Drones in Norway* (Issue June). NTNU.

[16] Xiang, G., Hardy, A., Rajeh, M., & Venuthurupalli, L. (2016). Design of the Life-ring Drone Delivery System for Rip Current Rescue. *In 2016 IEEE Systems and Information Engineering Design Symposium (SIEDS)*, 181–186. https://doi.org/10.1109/SIEDS.2016.7489295

[17] SC10 High Level Requirements Document for regulatory alignment within ADACORSA project task 1.2.; Final Version 1.6; Syrphus GmbH – Wilfried Kallert

9. Acronyms and Abbreviations

ABREVIATION	DESCRIPTION
AP	Access Points
BLE	Bluetooth Low Energy
BVLOS	Beyond Visual Line of Sight
CAA	Civil Aviation Authority
CIS	Common Information Service
CONOPS	Concepts of Operations
DAA	Detect and Avoid
EASA	European Union Aviation Safety Agency
ECSEL	Electronic Components and Systems for European Leadership
EUROCONTROL	European Organisation for the Safety of Air Navigation
FAA	Federal Aviation Administration
FIMS	Flight Information Management System
IEEE	Institute of Electrical and Electronics Engineers
IMU	Inertial Measurement Unit
LIDAR	Light Detection And Ranging
RPAS	Remote Piloted Aircraft Systems
SESAR	Single European Sky ATM Research
SC	Supply Chain
SLAM	Simultaneous Location and Mapping
SME	Small Medium Entreprise
SoC	System on a Chip
SORA	Specific Operational Risk Assessment
UAS	Unmanned Aircraft System / Uncrewed Aircraft System
UTM	Unmanned Traffic Management
VLL	Very Low Level
VLSI	Very Large-Scale Integration
VLOS	Visual Line of Sight
WiFi	Wireless Fidelity

10. List of figures

11. List of tables

1. ANNEX U-space DRONE CAPABILITIES FOR AIRBORNE COMPONENT

TABLE 12: U-SPACE DRONE CAPABILITIES FOR AIRBORNE COMPONENT FROM [2]

Capability	Description
e-identification	Ability to identify the drone and its operator in the U-space system
Geo-fencing	Ability to comply with geographical, altitude and time restrictions defined by the geo-fencing service. This capability covers the technology, processing and any required communication links, as well as management and use of geo-fencing information used in the provision of this service.
Security	Ability to protect vehicle and data (interaction with other vehicles and infrastructure) against attacks on information technology and communications systems.
Telemetry	Ability to transmit measurement data from the drone-to-drone operator and/or service provider to meet the demands of relevant services.
Tracking	Ability of the drone to provide flight parameters including at least its position and height.
Vehicle to Vehicle communication (V2V)	Ability for drones to communicate information to each other. The nature of the information exchanged, and its performance requirements, will depend on the application.
Vehicle to Infrastructure communication (V2I)	Ability for drones to share information with infrastructure components
Communication, Navigation and Surveillance	Ability for drones to meet the communication, navigation and surveillance performance requirements for the specific environment in which they will operate. This capability involves the combination of on-board sensors and equipment (e.g.data link, voice radio relay, transponder, laser, GNSS, cellular etc.) as means of achieving the required performance.
Detect and Avoid	Ability for drones to detect cooperative and non-cooperative conflicting traffic, or other hazards, and take the appropriate action to comply with the applicable rules of flight. This includes the collision avoidance, situational awareness and "remain well clear functionalities, as well as the other hazards described in chapter 10.2.3 of the ICAO RPAS Manual: terrain and obstacles, hazardous meteorological conditions, ground operations and other airborne hazards.
Emergency Recovery	Ability of drones to take account of failure modes, such as command and control (C2) link failure, and take measures to ensure the safety of the vehicle, other vehicles and people and property on the ground. This includes identification of possible problems (auto-diagnostic) and all equipment required to manage solutions.
Command and control	Ability of drones to communicate with their ground control station to manage the conduct of the flight, normally via a specific data link.
Operations management	Ability to plan and manage drone missions. This includes access to and use of all aeronautical, meteorological and other relevant information to plan, notify and operate a mission.

2. ANNEX Demonstrator list

DEMO	DESCRIPTION	PARTNERS
Demo1.1	Static Radar Demonstrator	RUB, FHR, IFI
Demo1.2	Static LiDAR demonstrator	TUG
Demo1.3	Static 3D Imaging demonstrator	UNI-KLU, IFAT
Demo1.4	Flying Sensor demonstrator	IFAG, ERI
Demo2.1	Energy-efficient accelerator platforms for perception	ERI, ULUND
Demo2.2	Emerging technologies for power efficiency	IFAG, INBV
Demo2.3	Blockchain Technology for Reliability and Trust	CEA
Demo3.1	Fail-operational environment perception	VIF, HUA, TAU, NOKIA, ESC, UNIPR
Demo3.2	Virtual verification	VIF, HUA, TAU, NOKIA
Demo3.3	DAA system using localisation & transponder	CTG, NLR, TUD, ANYWI
Demo4.1	eUICC/iUICC base network connectivity and identification of drones, DIM and drone license verification using the UICC	IFAG, GD, IFAT
Demo4.2	Secure and reliable combined (5G/LTE/LTE-A/IEEE 802.11x/BLE/NFC/SubGHz) communication	CISC, OTH-AW,CEA, UNIPR, NXP, ISEP
Demo 4.2.1	Multi interface gateway	
Demo 4.2.2	Decentralized authentication and trust management based on a blockchain	
Demo 4.2.3	Electronicaly reconfigurable antenna design for drone usage	
Demo 4.2.4	Secure communication gateway for drone to infrastructure communication	
Demo4.3	Equipment for tethered drones (4G/5G)	TCELL, TB
Demo5.1	Fail-operational avionics architecture	IFI, TTT
Demo5.2	Modular UAS system	NXP
Demo5.3	Fail-operational distributed data processing and communication architecture for safe and computational efficient drone flight control and navigation systems	ISEP, EMBRT

Demo5.4	Fail-over recovery functionality for precise drone navigation	ESC
Demo6.1	Flight Information Management System (FIMS)	FRQ
Demo6.2	UAV Lab: On-board Safety Layer for Autonomous Flight	UBW, ALM, SYR
Demo6.3	UTM Traffic Simulation Environment	BHL, ALM
Demo6.4	Detect and Avoid Testbed	NLR
Demo6.5	UTM Blockchain Simulation Environment	CEA
Demo7.1	BVLOS cargo drone delivery operation in smart construction site	TAI
Demo7.2	Tethered drone to provide connectivity and wide area vision by its sensors	TCELL, ROBONIK
Demo7.3	Truck & Excavator autonomous & remote-controlled operation	FORD, ROBONIK, TB, BUYUTECH
Demo7.4	BVLOS drone operation in smart forestry site	TB, CC, KATAM
Demo8.1	Control hand-over between BVLOS ground control stations	ISEP, EMBRT, ANYWI
Demo8.2	High accuracy, secure and resilient positioning and communication technology	ESC
Demo8.3	Detect and Avoid for safe BVLOS flight execution	NLR, EMBRT
Demo8.4	SC8 Integrated Demonstrator	NLR, EMBRT, ANYWI, ISEP, ESC
Demo9.1	User Acceptance	HFC
Demo9.2	Market Analysis	ITML
Demo10.1	Current and future regulatory framework by EASA	SYR
Demo10.2	Analysis of the future drone market with respect to regulatory frameworks	SYR
Demo10.3	Guidelines, checklists and templates for drone development and operation	SYR

TABLE 13: LIST OF DEMONSTRATORS AND PARTNERS

3. ANNEX SC10 High Level Requirements for regulatory alignment within ADACORSA project task 1.2

Annex SC10 shows the high Level Requirements for regulatory alignments within the ADACORSA project [17].

- Last page of the document is intended to be blank! -