ART final report

Advanced air mobility Regionala Tjänster

REVISIONS HISTORY AND AUTHORS

VERSION	DATE	PREPARED BY	COMMENTS
00.01	2025-12-05	Marcus Filipp	Initial draft
00.02	2026-02-03	Jekaterina Basjuka	Added Chapters 3-6
00.03	2026-02-04	Akos Kovacs	Abstract, Background, formatting
00.04	2026-03-02	Marcus Filipp	Final report meeting updates
00.05	2026-03-11	Marcus Filipp	Update with R10 story telling workshop
01.00	2026-03-13	Marcus Filipp	Final deliverable

Authors to this report are Marcus Filipp, LFV, Akos Kovacs, LFV and Jekaterina Basjuka, LiU.

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ABSTRACT

1.1 Abstract – English

The "AAM Regional Services" (ART) project aimed to expand the knowledge and usage of Advanced Air Mobility (AAM) and drone services across different regions in Sweden. The primary goal was to explore the feasibility of integrating drones into regional logistics chains for various applications, including medical deliveries and infrastructure monitoring.

The project employed a multi-phase methodology cantered around a series of workshops and an iterative co-design process with regional representatives, aviation experts, and researchers. This approach utilized interactive simulation and storytelling tools to model potential use cases and gather feedback on real-world challenges, particularly within the regions of Skåne, Stockholm, Jämtland/Härjedalen, and Västra Götaland.

Key results demonstrated that drones offer significant potential, particularly in medical logistics and bridging geographical gaps in rural and island areas, effectively bypassing traffic bottlenecks and ferry schedules. The successful implementation of AED (Automated External Defibrillator) delivery in VGR, which arrives minutes faster than ambulances, highlights tangible health benefits. Furthermore, the project developed a UAM Planning Platform and a library of explanatory stories to help stakeholders navigate the complexity of drone projects and regulations.

Despite these promising use cases, significant barriers were identified. These "pain points" include a complex and restrictive regulatory environment, an identified lack of a cohesive national strategy for UAM implementation, and ambiguity regarding infrastructural responsibilities between different levels of government.

The overarching conclusion is that while drones are a vital tool as part of the logistics chain, they cannot yet replace ground transport entirely due to current limitations in technology, weather dependency, and regulation. The report recommends a transition to multipurpose UAS for economic sustainability and emphasizes the critical need for a clear national framework and continued collaborative planning to realize the full potential of AAM in Sweden.

1.2 Abstract – Svenska

ART-projektet ("AAM Regional Services") syftade till att bredda kunskapen om avancerad flygmobilitet (AAM) och drönartjänster i olika regioner i Sverige. Huvudmålet var att undersöka möjligheten att integrera drönare i regionala logistikkedjor för olika tillämpningar, inklusive medicinska leveranser och övervakning av infrastruktur.

Projektet använde en flerstegsmetodik centrerad kring en serie workshops och en iterativ samverkansprocess ("co-design") med regionala representanter, flygexperter och forskare. Denna metod använde interaktiva simulerings- och berättarverktyg för att modellera potentiella användningsfall och samla in feedback om verkliga utmaningar, särskilt inom regionerna Skåne, Stockholm, Jämtland/Härjedalen och Västra Götaland.

Viktiga resultat visade att drönare har stor potential, särskilt inom medicinsk logistik och för att överbrygga geografiska klyftor i landsbygds- och skärgårdsområden, där de effektivt kan kringgå trafikstockningar och färjetidtabeller. Det framgångsrika genomförandet av AED-leveranser (automatisk extern defibrillator) i VGR, där drönare anländer minuter snabbare än ambulanser, visar på konkreta hälsofördelar. Projektet utvecklade också en UAM-planeringsplattform och ett bibliotek med förklarande berättelser för att hjälpa intressenter att navigera i komplexiteten kring drönarprojekt och regelverk.

Trots dessa lovande användningsfall identifierades betydande hinder. Dessa "smärtpunkter" inkluderar en komplex och ofta restriktiv regelverksmiljö, en identifierad avsaknad av en sammanhållen nationell strategi för implementering av UAM, och oklarheter kring ansvaret för infrastruktur mellan olika myndighetsnivåer.

Den övergripande slutsatsen är att även om drönare är ett viktigt verktyg som en del av logistikkedjan, kan de ännu inte helt ersätta marktransporter på grund av nuvarande begränsningar i teknik, väderberoende och reglering. Rapporten rekommenderar en övergång till mångsidiga UAS för ekonomisk hållbarhet och betonar det kritiska behovet av ett tydligt nationellt ramverk och fortsatt samarbete för att realisera AAM:s fulla potential i Sverige.

INTRODUCTION

2 PROJECT SPECIFICATION

The Project AAM (Advanced Air Mobility) Regional Services (ART), operating under reference number TRV 2022/33631, models advanced air mobility in and near cities (AAM) for regional services in three regions, to understand how services that use larger and smaller drones can be made possible. The project aims to support the introduction of AAM in an effective and harmonized way by providing knowledge with a high degree of realism and to activate regional and local competencies in the planning and implementation process of AAM.

The aim of the project is a) to model the airspace for AAM for regional services in three regions, harmonized with the development of AAM in Sweden, and at the same time b) to develop a methodology for continued modelling of AAM for different regions in Sweden, from the perspectives of efficiency, safety, controllability, and transparency. In this project, the participating regions with community functions will be given a basis for evaluating opportunities to use AAM for regional services, build competence and thus be able to carry out initial planning for AAM in line with current regulations, methods, and those regulations used by LFV (Swedish Civil Aviation Administration). Further, LFV and other authorities such as Trafikverket and TS will be given an increased basis for analysing and identifying relevant measures for regional planning. Project workshops will be documented, resulting in a methodology for continued modelling of AAM for different regions in Sweden, and use cases will be made available over the web.

The ART project was funded be Trafikverket and conducted in collaboration between LFV, Luftfartsverket, and LiU, Linköping University.

2.1 Background

To allow Sweden to benefit from the advantages of unmanned aviation, systems and infrastructure are needed to manage it. Currently, neither a UTM service nor infrastructure is implemented in Sweden. LFV has recently received a government mandate to implement the foundation for such a system, which will be further developed until 2035.

Research into UTM has been ongoing for a number of years, covering operational concepts, regulatory issues, and the validation of various types of services using unmanned aviation, delivering knowledge and results back to LFV and Swedish aviation. Drones have started to be used by Swedish society, for example, for surveillance and the transport of medical resources. Regional harmonization and services are being promoted as a necessary approach to successfully introduce more advanced, cross-border services.

Working in line with EASA regulations is a given methodology as Sweden aligns with EASA and European standards. In particular, the ART project will focus on EASA 2021/664 and place special emphasis on Article 18f, which describes the planning and decision-making forums and information flows that need to be ensured so that society, actors, and authorities can collectively realize advanced drone services. This regulation thus serves as a guide for the project and the regions' development of drone services.

Within several projects, an interactive simulation and visualization of air traffic within and between cities has been built up over many years. This also forms the technical basis for the current project and has been used in projects in Dubai, UAE, and Brazil. Within these projects, we have built up an understanding and basic scenario for UAM. We have also continuously adapted the interactive visualization so that it is smooth to model airspace and new services, according to current and upcoming/expected regulations, during workshops. To increase capacity for results available over the web, we have started an integration with a computing architecture run and developed by LiU.

METHODOLOGY

3 PART 1

3.1 Workshops with regions

Our method included series of workshops in different Swedish regions who are interested in co-designing for the UAM future. Three parties were involved in those workshops:

- Representatives from the Swedish regions, usually experts from the transport development and innovation sectors, around 10 participants.
- Luftfartsverket, organizers and aviation, UAM experts, 2-6 representatives (usually air traffic controllers).
- Researchers in interactive design and storytelling from university, 1-2 representatives.

We structured our workshops in the following way:

- Initial Presentations: LFV provides a general UAM context, followed by regional presentations on their specific projects.
- Interactive Storytelling: Participants watch stories created from previous workshops to spark discussions.
- Modelling and Sketching: Participants engage in UTM City simulator sessions to model scenarios and sketch ideas.
- Data Collection and Analysis: We gather sketches in the UTM City simulator, feedback notes (the bullet point list of scenarios, concerns and questions), and transcribed audio recordings, which are analysed post-workshop to create new interactive stories.

This structured approach ensures that each workshop builds on the previous ones, fostering a continuous cycle of knowledge sharing and story evolution. The main objective for the storytelling part was to develop a collection of storytelling elements that could be used as a feature for modelling and sketching during upcoming workshops.

Four regions were chosen for the workshops (Skåne, Stockholm, Jämtland, VGR). Each one was visited separately with the workshop activity; Stockholm region was visited twice.

3.2 Technology

For this project, to facilitate cross-group knowledge sharing, we developed and connected a storytelling toolkit. This storytelling toolkit was designed to create stories that follow the flight path of a drone, launching visual stories along the path, to describe the subjective views of various stakeholders, on the service being simulated.

The toolkit consists of three parts. Two screens that participants see during the workshop: one for the drone traffic simulation on the map (UTM City), second one for the visual stories (Watchout). Additionally, the timeline tool is used as a backend tool that participants do not see but which orchestrates what is happening on both simulator and story screens. On the first screen Drone Simulator, UTM CITY, is used to model traffic from a 2.5D top-down map perspective. For example, a route for a drone can be created in the simulator. Along the route a trigger can be placed, and when a drone passes the trigger, it will instruct a specific action in the timeline tool. One action could be to trigger a story to be played on the storytelling screen. The drone could be launched on the simulation screen and when it reaches the trigger on the route, the explaining story video will start on the second screen. In this way, an interactive story can follow the path of a simulated drone.

In the timeline tool, it is possible to control, synchronize or create new triggers for both screens. For example, triggers could be set to launch several drones or to set a no-fly zone in the simulations that drones need to avoid and those triggers could be accompanied by the triggers for playing stories on the second screen.

3.3 Interactive Visual Storytelling

Our approach to interactive visual storytelling has three stages: preparation, workshop, iteration (preparation for the next workshop). In the preparation stage, story elements were made in the Watchout software. The story design process involved analyses of collected data (transcribed audio recordings and notes from the previous workshop). Defining stories with feedback points that have to be included. Creating storyboards based on the selected feedback points. Discussing storyboards with experts to check that stories are realistic according to current UAM rules. Then based on the storyboards, videos were made by creating animations using stock materials. Additionally, graphical boxes with feedback text were created, to display the feedback of participants.

In the workshop stage, services were sketched into the simulator, to be simulated, and story triggers were placed along the path of the drone(s). If all the required story elements were foreseen, the story can immediately be played. However, especially early in the project, some or all story elements must be created after the workshops (in the iteration phase in the preparation for the next workshop), adding to the library of story elements. Stories can then be played back, showing both the traffic, and the subjective view of the stakeholders in the workshops. As stories are shown, reactions from other stakeholder groups can be added. For the next workshop, the loop of the same actions was repeated.

3.4 Conclusion

The transition between Q&A sessions and scenario sketching in the simulator was challenging, often shifting focus away from designing stories. We wanted to encode participants' concerns, but not engage in solving them during the scenario generation which was supposed to give an overview of the concerns before engaging with them. The regions were very solution focused and expressed a need for in-depth help with designing different solutions and addressing different existing challenges that's how the idea of in-depth workshop and equal co-design process emerged. The last workshop was conducted with Stockholm for the second time where one of the participants expressed a need for adoption of such sketching tools specifically for the current project that they were running in Stockholm Stad. That served as a base for the Part 2 of ART project that is described in detail below.

4 PART 2

4.1 Co-design Process Overview

Our research employed an iterative co-design methodology, systematically structured into five distinct phases, to progressively define problems, ideate solutions, develop prototypes, and refine them through continuous feedback. This approach facilitated in-depth engagement with one Stockholm Stad representative, who is an expert drone operator (our primary co-designer) and external stakeholders (Stockholm Stad and Kista Science City project managers), ensuring the developed tools were relevant, practical, and grounded in real-world Urban Air Mobility (UAM) needs. Throughout the generative co-design phases (Workshops 1-3), the researcher and expert drone operator engaged as equal partners, jointly defining problems, ideating solutions, and collaboratively structuring tool concepts. While the researcher took primary responsibility for developing high-fidelity digital prototypes in inter-session periods, all workshop structures, plans, and evaluation strategies were consistently co-determined.

4.2 Phase 1: Problem Definition & Goal Setting (Workshop 1)

This initial phase focused on a broad exploration of challenges within the UAM domain. Through a facilitated workshop, drone operator articulated pervasive problems in region, municipality, drone operations, regulatory compliance, and communication with clients, authorities, and the public. This collaborative mind mapping identified "communication gaps" and a "high learning curve" as central issues. Consequently, two overarching co-design goals were collaboratively established: 1) developing an accessible platform for planning drone projects, and 2) creating an introductory library of explanatory UAM stories.

4.3 Phase 2 & 3: Ideation & Low-Fidelity Prototyping (Workshops 2 & 3)

Building on the established problems and goals, these phases focused on initial conceptualization. Through collaborative sketching and discussion with drone operator:

For the story library: A mind map was created detailing "what critically needs to be explained" (e.g., technical features, regulations). Generic story structures were co-sketched, outlining narrative components (Situation, Challenge, Resolved, Key Message, Audience) for specific use cases like "Pharmacy Delivery", "Traffic Accident Response",

For the planning platform: Initial ideas explored its core functionalities, such as structuring planning phases, identifying key actors, and integrating regulatory checklists, leading to conceptual sketches of its visual, interactive workspace.

4.4 Inter-session: Researcher-led Prototyping

The researcher translated these co-designed low-fidelity concepts into higher-fidelity digital prototypes:

Planning Platform Prototype: Developed in Miro, this interactive prototype visually represented the platform's phased structure (Introduction, Phase 1: End User Goal Setting, Phase 2: Collaborative Sketching, Phase 3: Flight Procedure Planning, Phase 4: Debrief & Lessons Learned) and modular components (e.g., decision trees, mapping tools, checklists).

Animated Story Videos: Six animated videos were produced based on the co-sketched narrative structures and use cases, designed for accessible and engaging UAM explanation.

Phase 4: Prototype Evaluation & Refinement with Primary Co-designer Drone Operator (Workshop 4)

This phase involved a detailed "talking aloud" walkthrough and semi-structured interview with expert drone operator to gather feedback on both prototypes.

Planning Platform Refinements: Feedback led to significant enhancements, including:

- **Usability Improvements:** Clarification of Miro interaction (e.g., "click and drag" instructions), and adjustments to visual prominence.
- **Content Expansion:** Explicit differentiation of "flight operation" vs. "total project" duration, expansion of stakeholder identification fields, and integration of an "Emergency Contacts & Action Plan Reference" module.
- **Terminology:** Revision of platform terminology for greater inclusivity (e.g., "operational authorization" instead of "SORA").

Story Videos Refinements: expert drone operator's review highlighted strengths in clarity and engagement, and led to specific adjustments in pacing, visual accuracy, and narrative conciseness.

4.5 Phase 5: Prototype Evaluation & Refinement with External Stakeholders (Workshop 5 & Student Seminar)

The final evaluation phase gathered broader feedback from external stakeholders:

- **Platform Evaluation (Stockholm Municipal Representatives):** The refined planning platform was presented to two municipal representatives (two project managers) via semi-structured interviews. This provided validation from an organizational perspective, affirming its value for clarity and collaborative problem-solving, while also highlighting the need for hybrid digital-physical approaches and considering existing organizational tool structures for adoption.
- **Story Evaluation (Drone Operator Program Students):** The co-designed stories were integrated into a real-world seminar led by expert drone operator who also works as a teacher on the drone operator program. The researcher observed the seminar and conducted semi-structured interviews with students. This directly assessed the stories' pedagogical effectiveness, revealing their strength in simplifying complex UAM concepts for novices, but also identifying a preference for more "real life footage" and a need for tiered content complexity to cater to advanced learners. A follow-up interview with expert drone operator captured her reflections on the seminar's flow and the stories' perceived impact and sustainability in her teaching.

4.6 Service provision R10 drone desk-top workshop

The R10 workshop with the Västerbotten region, covering the area from costal area all the way to the mountains, aimed to present the current regulations for drone usage as well as future possibilities with specific drone airspaces, USSP´s.

The workshop had two mayor topics, an initial part to present current regulations and possibilities to get started on a short-term horizon. Second part of the workshop embedded future capabilities including a desk-top simulation with possible airways for drone support within the region. This together with shared skills on how to build even more Use Cases on drone usage within each municipal area of the region.

4.6.1 Deployment

One aspect of deployment is to get started at an early stage using the tool available on LFV drone chart, Dronechart - UAS. This part is covered in following images gathered from the desk-top simulation. Images below present different scenarios and complications discussed during the workshop within the region.

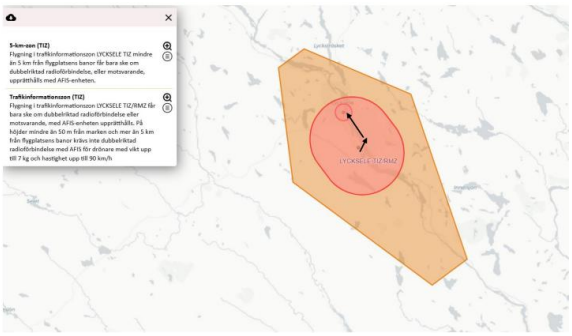

Figure 1 Use Case Skellefteå

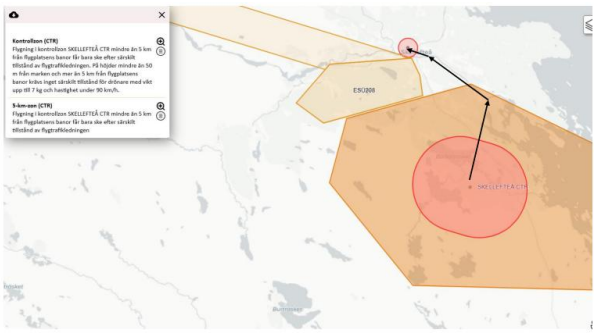

Figure 2 Use Case Lycksele

Images above present complications to develop a drone corridor from the cities airports with aspects taken to existing tools for approval of a drone flight.

5 RESULTS

Initial results from the project proved that drones are a useful tool as part of the logistic chain in regions, especially in more rural regions where distances are long between hospitals and health care centres.

5.1 Region Skåne

The workshop identified Region Skåne as a high-potential area for drone-based logistics, particularly for time-critical services. Participants from LFV, Linköping University, and Region Skåne concluded that drone technology could significantly improve response times for medical and logistical needs compared to ground transport.

Key findings include:

- **Infrastructure & Responsibility**

  There is a clear need for dedicated infrastructure, such as vertiports and charging stations. However, the responsibility for building and maintaining these (e.g., Skånetrafiken vs. municipalities) remains an open question.

- **Regulatory & Safety Challenges**

  Discussions emphasized the complexity of flying over populated areas. Participants weighed the safety of following established infrastructure (like railways) against the efficiency of direct "point-to-point" routes.

- **Environmental & Restricted Zones**

  Routes must account for "bird directives" (wildlife protection in areas like Saltholm), proximity to major airports (Kastrup and Sturup), and sensitive military zones that are not publicly mapped.

- **Technical Integration**

  The implementation of "U-space" and automated traffic management (UTM) is seen as essential for managing high-volume drone traffic and avoiding conflicts between multiple operators.

5.2 Region Jämtland

The workshop concluded that distance is the primary challenge for the Jämtland/Härjedalen region, making drone technology a vital solution for regional connectivity. A central finding was the need for a multi-purpose drone system; rather than specialized fleets, a single system should be capable of transporting mail, refilling medical equipment, and carrying blood samples simultaneously to maximize cost and time savings.

Technical discussions highlighted innovative airspace management strategies. Specifically, participants discussed creating "extra room" for drones by flying at heights of 70m over specific topographical features like islands and lakes. Furthermore, the group proposed the concept of "narrow corners" in airport-controlled zones. This would allow drones to fly beside or under manned aircraft corridors, ensuring that drone operations do not have to cease entirely when an aircraft arrives at the airport. The primary objective is not just specific applications, but the general enablement of drone technology to overcome geographical barriers.

5.3 Region VGR

VGR has established itself as a leader in drone-based medical emergency response, specifically through its Automated External Defibrillator (AED) delivery program launched in 2018. The results demonstrate that UAS (Unmanned Aerial Systems) arrive at emergency scenes a median of two minutes faster than ground ambulances, with a median response time of 4:03 minutes. Given that every minute saved increases survival rates by 10%, the health economic benefits are already evident.

However, several critical barriers were identified:

- Airspace Restrictions: Limited access to airspace made 40% of potential missions impossible.
- Regulatory & Technical Hurdles: Navigating the "regulatory complications" of permit processes remains a major challenge. Technical trials showed that while UAS are resilient in harsh weather, they lack a common altitude reference system and struggle with local weather variations that differ from airport MET reports.
- Economic Sustainability: Specialized systems focused on a single task are too costly. The workshop concluded that the future lies in transitioning to multipurpose UAS that can handle diverse logistical and surveillance tasks to share operational costs.

5.4 Region Stockholm

Key Findings and Strategic Results:

- Infrastructure & Urban Planning: A primary result was the identified need for integrated infrastructure, specifically vertiports. While a request for a dedicated vertiport building was initially met with a "no," participants argued that drones must be included in the master plans for central hubs like Stockholm Central Station. Furthermore, suburban areas were identified as high-potential zones where drone utility could drive new city planning initiatives.
- Geographical Advantages: Drones were seen as a solution to the "bridge bottleneck" in Stockholm. By utilizing "water ways" and flying over water, drones can bypass congested road infrastructure and provide services to islands, supporting the "15-minute city" concept.
- Regulatory and Safety Barriers: The "regulatory nightmare" of flight permits remains a central concern. Results indicate that routes must be considered from multiple angles (altitude, location, and geofencing) before demonstrations can occur. Specific safety concerns were raised regarding flights over sensitive areas, such as preschools and industrial sites like refineries.
- KPI Framework for UTM: To manage this integration, the workshops established a comprehensive Key Performance Indicator (KPI) framework. Success will be measured by:
    - Safety: Incident frequency and failure rates in densely populated areas.
    - Efficiency: Mission completion times vs. approval wait times.
    - Environmental Impact: Noise pollution levels in residential areas and carbon emission savings compared to traditional vans.
    - Societal Integration: Public acceptance, permit approval rates, and the ability of the system to adapt to changing regulations.

5.5 Results for Part 2

5.5.1 The UAM Planning Platform

The UAM Planning Platform was developed as an interactive, visual workspace to directly address communication gaps and the steep learning curve in complex drone projects. Built in Miro, it guides users from project initiation to operational planning, designed for diverse roles including end-users, operators, and authorities. Its structure comprises an Introduction, followed by four main phases: Phase 1: End User Goal Setting (for defining internal and external objectives, and initial parameters), Phase 2: Collaborative Sketching with Stakeholders (for mapping actors, drone specifications, responsibilities, and preliminary flight areas), Phase 3: Flight Procedure Planning (for detailed operational timelines and emergency protocols), and Phase 4: Debrief & Lessons Learned (for project reflection). Its visual design emphasizes clarity, multi-stakeholder input, and interactive elements.

5.5.2 Evaluation Findings (Platform):

Evaluations with the primary co-designer and municipal representatives highlighted significant strengths and areas for refinement.

Strengths: Users praised the platform's intuitive, step-by-step guidance and visual clarity, viewing it as a universal place for everyone to collect the material that creates a "mutual language" for complex planning. It was recognized for enhancing collaboration, supporting non-experts through regulatory processes, and serving as a risk mitigation tool through explicit verification steps.

Weaknesses and Areas for Improvement: Feedback indicated a need for improved Miro usability for less tech-savvy users, more explicit instructions for certain inputs, and minor visual/interactive adjustments. Key content omissions included dedicated sections for financial planning, clearer definitions of deliverables, and detailed data handling protocols.

The Library of Explanatory Stories

The 'Library of Explanatory Stories' is a curated collection of short, animated videos visually depicting six diverse UAM use cases (e.g., "Pharmacy Delivery," "Traffic Accident Response," "Drone Light Show",). Each story employs a co-designed narrative structure to clarify complex UAM concepts, targeting aspiring drone operators and the general public.

Evaluation Findings (Stories):

Evaluations with the primary co-designer and drone operator students provided insights into the stories' pedagogical effectiveness.

Strengths: Students acknowledged the animated format's value for initial comprehension, particularly for novices, and its efficiency for delivering complex information. The stories were seen as effective in illustrating the "entire ecosystem" of drone operations, sparking curiosity, and fostering positive perceptions of UAM technology.

Weaknesses and Areas for Improvement: Students, often possessing advanced knowledge, found the content "too naive and simplified," highlighting a need for tiered content complexity. A significant critique concerned the credibility of AI-generated visuals, with a strong preference for "real life footage" to enhance trust. A foundational "what is a drone?" story was identified as missing, and minor visual inaccuracies or narrative pacing issues were noted for refinement.

Analysis of Feedback Regarding Sustainability (for both Platform and Stories)

Feedback consistently indicated that the sustainability of these co-designed tools relies not just on their inherent value but on their integration into existing work practices and organizational contexts. The platform's perceived "generic applicability" and Miro's flexibility were seen as strong enablers for long-term adaptation. However, successful adoption hinges on addressing organizational barriers (e.g., existing tool structures) and accommodating diverse digital literacies through careful onboarding and potentially hybrid digital-physical approaches. The ongoing debriefing was deemed crucial for embedding a continuous cycle of organizational learning, ensuring the tools remain relevant and actively contribute to evolving work processes.

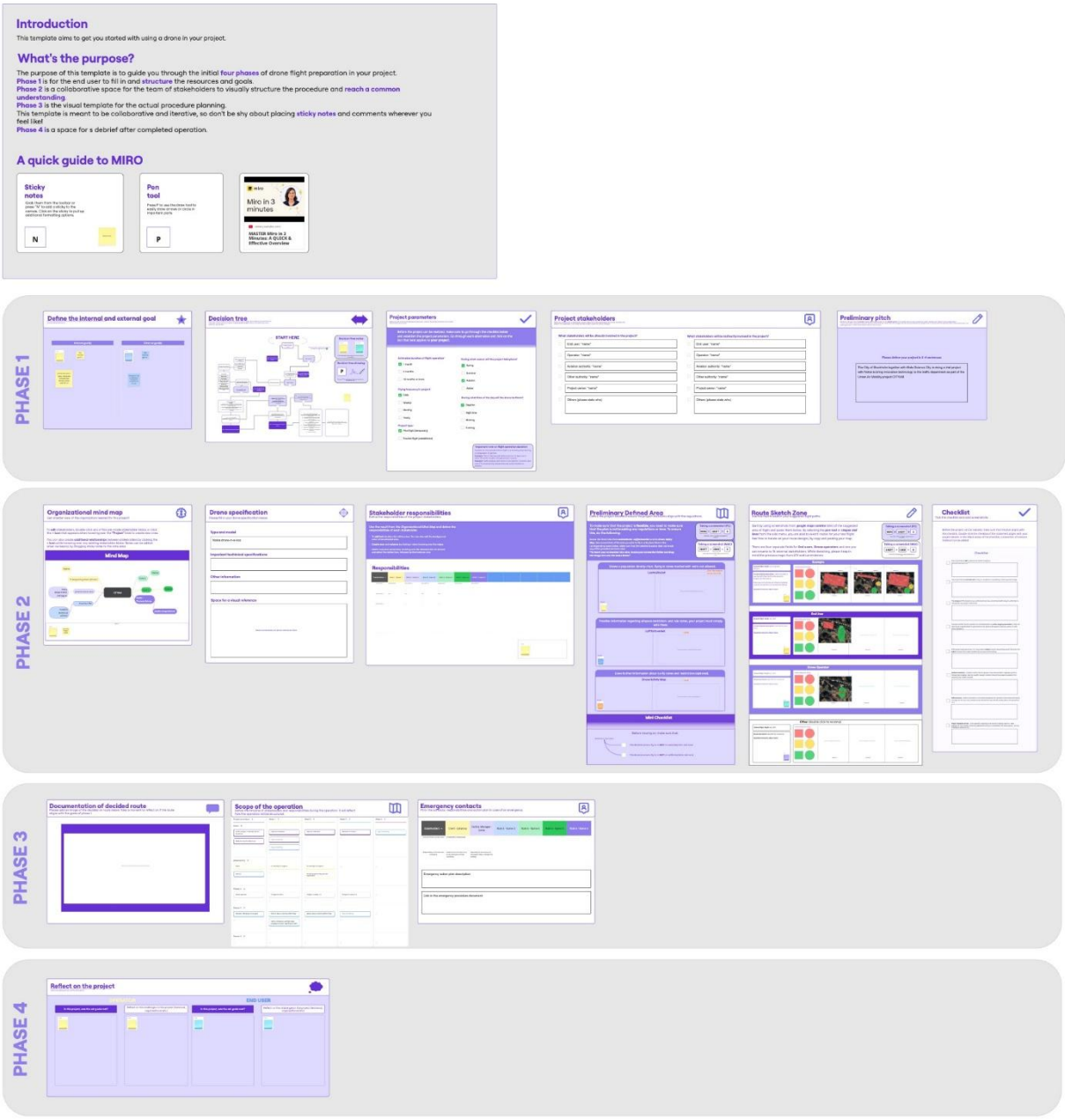

Figure 3 Planning platform with four phases: structure the resources and goals; collaborative space for a common stakeholder sketching; actual procedure planning; debrief after completed operation.

5.6 Service provision R10 drone desk-top workshop results

The results from the workshop is an increased awareness of drone deployment in each region and a model of Use Cases both within the current regulations as well as future regulations. An important aspect was vertiports and discussions on possible landing sites. One common discussion is usually roof tops with is deemed to be tricky place for a drone to land and depart from as the surface seldom is flat, this with the possibility to reach good delivered on roof tops. Another result on vertiports is the security of such an area. Goods onboard the drone could be expensive or of sensitive matter wherefore more controlled areas need to be investigated for each region deploying drones as part of the chain of logistics.

The impact of deployment has large possibilities, this with a more autonomous system with a central control of drones performing deliveries to rural regions. One area covered was the possibility to have the delivery

system as part of an open market with regions as customers, similar to daily usage of goods as part of the long-distance busses.

Following images present possibilities discussed during the desk top simulation using current regulations with future USSP´s (UTM airspace corridors).

Figure 4 Use Case Lycksele U-space corridor

Image above present a feasible solution to deploy a corridor for UAS between the airport and the regional hospital with considerations to current SORA regulation.

Figure 5 Use Case Skellefteå U-space corridor

Image above was the result of possibilities in a more populated area such as Skellefteå with a possible corridor between the airport and downtown region.

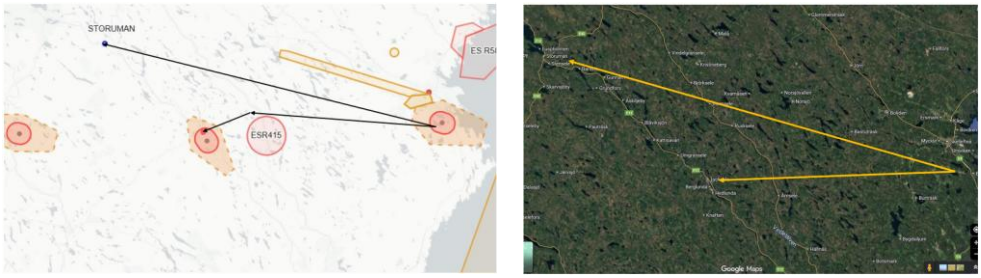

Figure 6 Use case long distance corridor

Images above present the results on a discussion to create possibilities for drone usage over longer distances from a larger city in the region to smaller more rural cities.

6 USE CASE

Following Use Cases has been identified based on the discussions in the different regions.

6.1 Skåne Proposed Use Cases:

The workshop explored several high-impact use cases, categorized by their application:

6.1.1 Emergency Medical Delivery

- Time-Critical Medicine. Delivery from ambulance stations to emergency sites to shorten response times.
- Organ Donation. High-priority transport between Malmö, Lund, and Sturup Airport, noting that only a few specialized teams currently conduct this service in Sweden.

6.1.2 Laboratory & Hospital Logistics

- Medical Sample Network. A primary route between Malmö and Lund hospitals. The group compared a "railway route" (to minimize urban risk) against a "direct route" utilizing high-speed drones (100–200 km/h) for emergency samples.
- Regional Healthcare Network. Connecting local primary care centres to large-scale laboratories at central hospitals via a network of straight-line drone routes.

6.1.3 Cross-Border & Regional Logistics

- International Cooperation. Investigating resource exchange between Region Skåne and Rikshospitalet in Copenhagen. This requires navigating Kastrup Airport's airspace and avoiding wildlife protection areas.
- E-commerce & Parcel Delivery. Hub-to-hub services from industrial areas like Norra Hamnen to residential or innovation hubs (e.g., in Lund).

6.1.4 Long-Distance & Industrial Freight

- Airport-to-City Links. Transporting parcels from Malmö Airport to industrial harbours, with potential expansion for long-distance routes to Stockholm, necessitating close coordination with the military regarding protected airspace.

Figure 7 overview of use case "extended rörpost" two route options between Malmö hospital and Lund hospital. Straight live vs routing via waterways out of Malmö, over the central station and along the railway tracks to Lund

6.2 Jämtland Proposed Use Cases:

6.2.1 Medical and Healthcare Logistics

- Assisting or replacing the "Slingbil" logistics network, which currently involves 400 cars, to deliver healthcare materials between care centres (*vårdcentralen*).
- Point-to-Point (P2P) Transport. Rapid delivery of lab samples and medical materials between healthcare facilities.
- Unified Delivery. Integrating regular mail delivery with emergency medical refills and blood sample transport into a single drone route.

6.2.2 Emergency and Search & Rescue

- Fire-flight, using smaller drones equipped with heat sensors to scan for forest fires, potentially employing locals as operators.
- Assisting search and rescue in dense forests by providing light and locating lost persons.
- Hiking Trail Support, delivering food or emergency supplies to remote cabins along the Sankt Olof Leden trail for hikers in distress.

6.2.3 Infrastructure and Airport Operations

- Runway Maintenance. Using multiple drones at airports to autonomously check for snow, animals, fence breaches, or unauthorized personnel.
- Infrastructure Monitoring. Scanning regional roads and public infrastructure to identify damages and maintenance needs.
- Urban Mapping. Deploying heavier drones over populated areas to produce high-resolution data and city maps.

6.2.4 Regional and Commercial Transport

- International Trade Corridors. Utilizing ancient transit routes (Sundsvall–Östersund–Trondheim) for cross-border business and goods delivery between Sweden, Norway, and Finland.

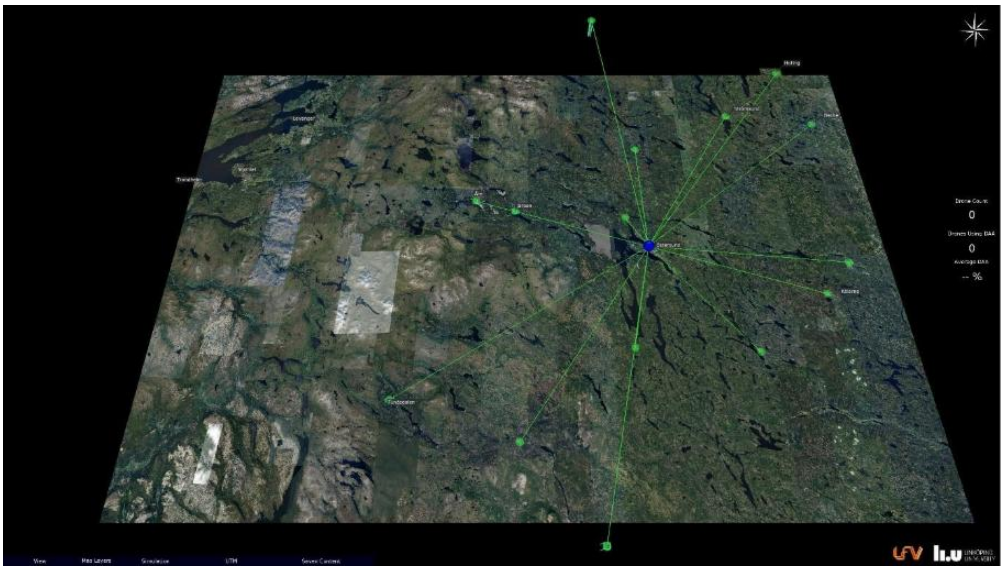

Figure 8 The simulator sketch of medical logistics that is a common challenge and a possibility for the regions to facilitate on drones. The have several cars that is driven between elderly people living in remote areas. One driver could put 500km in the car to deliver small packages.

6.3 VGR Proposed Use Cases:

6.3.1 Inter-Hospital Logistics

- **Sahlgrenska to Östra Hospital:** This high-frequency route (20+ times daily) currently takes 20–60 minutes by car. Drones could reduce this to 6–7 minutes. Key challenges include coordinating with HEMS (helicopter) approaches and navigating residential areas.
- **Organ and Blood Transport:** Investigating the possibility of unmanned organ transport and maintaining centralized blood stocks.

6.3.2 Archipelago and Rural Connectivity

- **Island Logistics:** Utilizing drones to transport medical samples from the Northern and Southern archipelagos (Öckerö, Hönö, Björkö, Styrsö). This bypasses time-consuming ferries and car travel. Existing landing sites in Öckerö Municipality facilitate this transition.
- **Rural Service Parity:** Providing the same level of care to sparsely populated areas through drone-based delivery of small packages, replacing traditional delivery vans.

6.3.3 Emergency Response and Industry

- **"Injury Site" Overviews:** Equipping drones with thermal cameras to provide rescue services with immediate situational awareness at accident scenes.
- **Industrial Surveillance:** Implementing UAS for monitoring critical infrastructure like the ST1 refinery and the Rågården forensics facility, potentially modeled after the Port of Rotterdam's surveillance system.

6.3.4 Regional Infrastructure

- **Drone Highway:** Sketching a dedicated corridor following the E6 motorway towards Norway to facilitate regional trade and transport.

6.4 Stockholm Proposed Use Cases (2 workshops + co-design):

6.4.1 Medical and Emergency Services (High Priority)

- **Point-to-Point Hospital Network:** Establishing dedicated flight corridors between major medical centers, including Karolinska to Nacka Hospital, Huddinge to Södersjukhuset, and Dalen to St. Göran. These routes aim to transport samples and materials in 6-7 minutes, compared to 20-60 minutes by car.
- **Emergency Inspection (Blue Light):** Placing drones at strategic city points to be deployed for immediate inspection of fires or accidents, providing first responders with situational awareness before they arrive on-site.
- **Life-Saving Beach Patrols:** Equipping drones with floating devices to be deployed to individuals in danger in the water, alongside monitoring for illegal oil spills.

6.4.2 Urban Safety and Environmental Monitoring

- **School Route Monitoring:** Using drones to monitor and ensure the safety of school routes, though this requires balancing public safety with privacy concerns regarding flying over preschools.
- **Environmental Zone Management:** Utilizing drones to monitor traffic patterns and measure air pollution in real-time within newly established environmental zones. This data helps the municipality adjust traffic flow and inform the public.

- **Wildlife Management:** Deploying AI-equipped drones to identify and use "loud sound dynamics" to scare geese away from public beaches and recreation areas.

6.4.3 Infrastructure and Maintenance

- **Bridge and Site Inspection:** Automating the inspection of bridge conditions and monitoring snow coverage. Drones are also proposed for construction site surveillance to ensure permit compliance and rule follow-up.
- **Crowd and Traffic Optimization:** Monitoring main squares to count people and analyze traffic density. This data is intended to help the municipality optimize the urban environment and improve public space design.

6.4.4 Regional Connectivity and the 15-Minute City

- **Island Service Delivery:** Ensuring that residents on Stockholm's islands can receive all necessary services and cargo without relying on scarce bridges or ferries. This supports the goal of making island living sustainable on a permanent basis.
- **Interoperable Logistics:** Moving toward a "multipurpose UAS" model where a single drone system can serve several needs such as delivering cargo while simultaneously collecting sensor data for city planners to ensure the economic viability of the infrastructure.

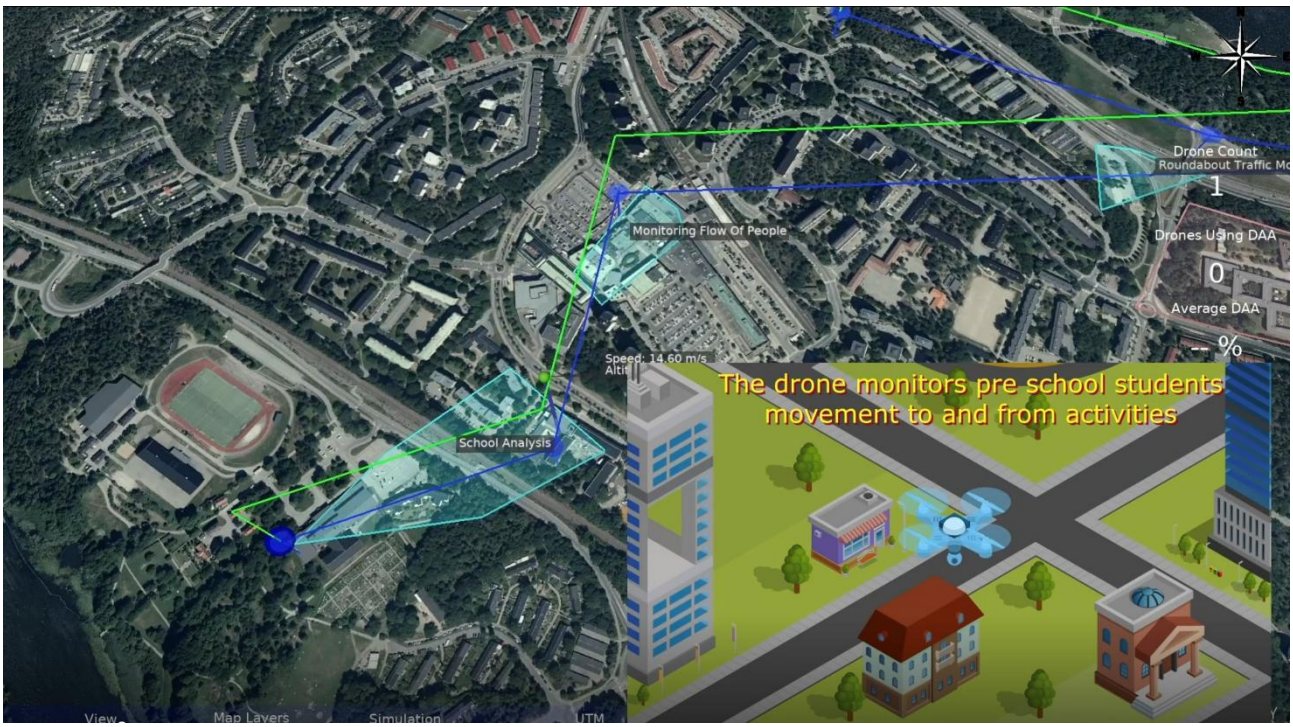

Figure 9 simulator and storytelling sketch of crowd monitoring use case in Farsta, Stockholm

Figure 10 simulator and storytelling sketch of environmental zone monitoring in Stockholm

Co-design use cases (stories):

- **Urban Pharmaceutical and Emergency Aid Delivery:** Utilizing Vertical Take-Off and Landing (VTOL) drones for rapid, time-critical transportation of medications or first-aid supplies within city environments or to remote highway accident sites. This addresses logistical challenges and enhances emergency response.
- **Infrastructure Inspection:** Employing multirotor drones for safer and more efficient examination of critical urban infrastructure, such as railway bridges and high-rise building façades, to detect wear or damage. This minimizes human risk and operational disruption.
- **Geospatial Mapping for City Planning:** Leveraging fixed-wing drones to capture high-resolution geospatial images for creating updated 3D models of urban and semi-urban areas, supporting city development, public services, and environmental management.
- **Public Safety and Traffic Accident Response:** Deploying multirotor drones to provide immediate overview and critical information at traffic accident scenes, complementing traditional first responder services by enhancing efficiency and situational awareness.
- **Drone Light Shows:** Showcasing the modern, positive application of drones in entertainment through choreographed aerial displays, addressing public misconceptions about drone technology by highlighting its creative and non-surveillance uses.

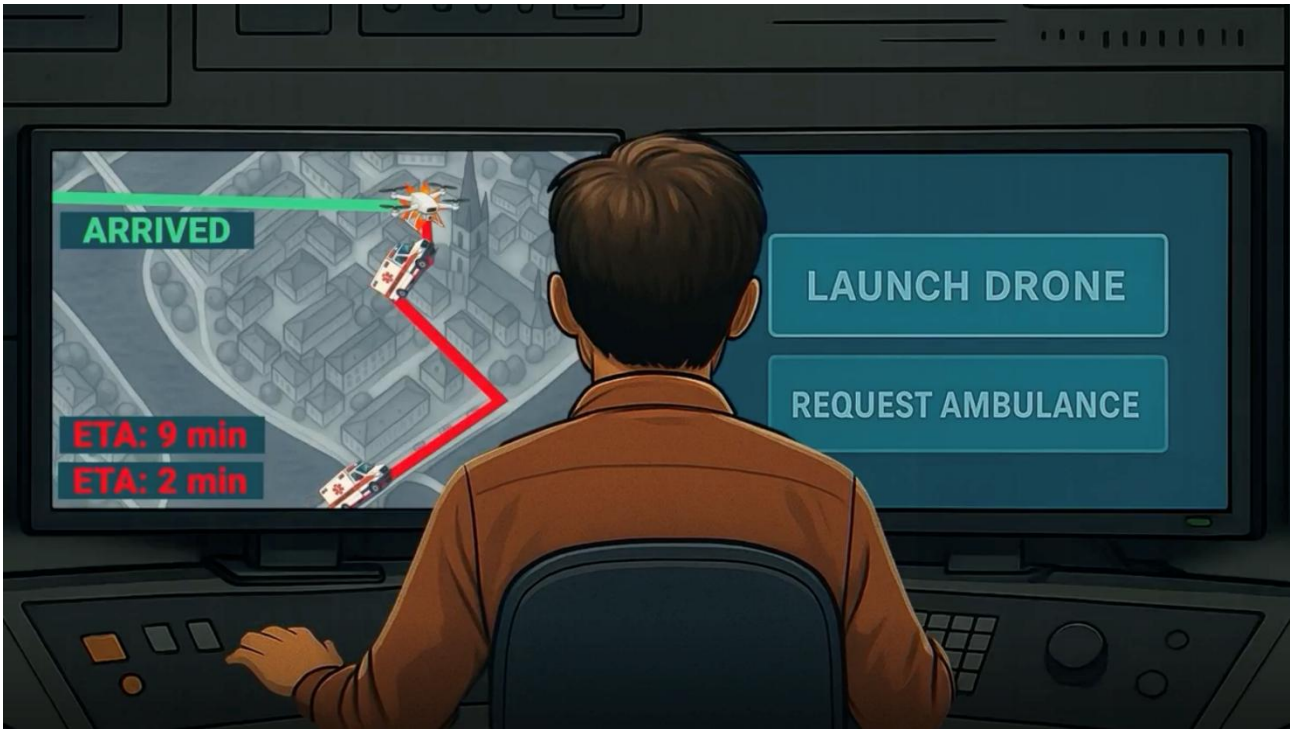

Figure 11 visual story example about emergency aid on highway showcasing VTOL drones delivering emergency aid to highway accident sites, emphasizing rapid response and safety protocols.

CONCLUSIONS AND RECOMMENDATIONS

Chapter 6 transitions from the project's methodology and use cases to present the final conclusions and recommendations derived from the regional workshops. This section distils the overarching findings regarding the integration of Advanced Air Mobility (AAM), or drone services, across the different Swedish regions investigated: Skåne, Jämtland/Härjedalen, Västra Götaland (VGR), and Stockholm.

The analysis confirms the substantial benefits that drones offer, particularly for medical logistics and enhancing connectivity in rural and island communities. A recurring conclusion across regions is that the future lies in transitioning to multipurpose Unmanned Aerial Systems (UAS) to maximize operational efficiency and ensure economic viability, rather than relying on specialized, single-task systems.

However, the chapter highlights a set of significant, shared challenges or "pain points" that currently impede widespread AAM adoption. These primarily involve navigating the complex and often prohibitive regulatory environment, including difficulties in obtaining flight permits and managing extensive "no-fly" zones. A critical systemic issue identified across all regions is the prevailing lack of a cohesive national strategy and ambiguity regarding which authorities (regional or municipal) are responsible for building and managing necessary infrastructure like vertiports.

Ultimately, the following subsections detail the specific conclusions and localized challenges for each participating region, offering insights that are vital for crafting the strategic recommendations outlined at the end of this chapter.

7 CONCLUSIONS – OVERVIEW BY REGIONS

7.1 Stockholm Region

Main Conclusions

- The region's waterways are natural corridors for drone "highways," potentially good for social acceptance and safety
- Medical logistics and "Blue Light" (emergency inspection) services are the only viable goals for 2030; commercial delivery (food/e-commerce) is not a priority.
- Drones are beneficial for 15 min city concept and for providing permanent island residents with the same level of service and cargo access as those in the city centre.

Pain Points

- Requests for dedicated vertiport buildings have been met with a "no," and drone integration is currently missing from major plans like the Central Station redevelopment.
- There is significant hesitation regarding flight paths over sensitive areas, specifically schools and densely populated residential zones.
- Crowded island environments and rooftop building permits make finding viable landing zones difficult.
- B2B problems with planning drone operations due to lack of tools and still persistent stereotype about drones being toys and not something that is regulated.
- Lack of national strategy or national responsibility

7.2 Skåne Region

Main Conclusions

- The railway line between Malmö and Lund is identified as the safest "middle-ground" route, providing a straight path with minimal risk to unprotected pedestrians.
- There is a strong interest in resource exchange with Rikshospitalet in Copenhagen, provided international airspace can be managed.

Pain Points:

- The island of Saltholm and other wildlife protection areas create significant "no-fly" zones that require route adjustments.
- Navigating the proximity to both Kastrup (Copenhagen) and Sturup (Malmö) airports requires intense coordination.
- Mapping data for hospital sites is often outdated due to ongoing construction, complicating the precise location of laboratory landing zones.
- Lack of national strategy or national responsibility, unclear who's responsible for what between region and municipality.

7.3 Västra Götaland (VGR)

Main Conclusions

- AED (defibrillator) drones are a success, arriving 2 minutes faster than ambulances and significantly increasing survival rates.
- Specialized drones are too expensive; the region must transition to a single system that handles logistics, medical refills, and surveillance simultaneously.

Pain Points:

- Currently, 41% of missions are impossible due to limited airspace access and "no-fly" restrictions.
- The permit process with the Transport Agency is a major bottleneck, often leading to few test flights despite long testing periods.
- Standard airport MET reports often don't match local coastal conditions, leading to unnecessary flight cancellations when local weather is actually within safety limits.

7.4 Jämtland/Härjedalen

Main Conclusions

- In this vast region, drones are a critical tool for overcoming geographical isolation in mountain and forest environments.
- Drones could potentially replace or augment the massive "Slingbil" logistics network (currently 400 cars) used for healthcare deliveries.
- There is a unique focus on Search and Rescue (SAR), using drones to provide light for lost persons and delivering emergency supplies to remote hiking cabins (Sankt Olof Leden).

Pain Points

- The extreme distances between medical centres and remote areas push the limits of current drone battery and signal technology.

- Managing drone traffic near regional airport is difficult; the current "closed zone" policy when aircraft arrive needs to be replaced with more flexible "narrow corner" solutions.
- Establishing who is responsible for the maintenance and flight of "Fire flight" or SAR drones (locals vs. authorities) remains an open question.

RECOMMENDATIONS

While regional approaches to U-space currently reflect a combination of shared commonalities and distinct variations, we contend that a high degree of harmonization is essential for the long-term success of the industry. These regional differences often stem from unique geographical, regulatory, and infrastructural landscapes; however, establishing a unified framework for U-space utilization is necessary to ensure cross-border interoperability and market scalability.

In identifying priority use cases, we advocate for a focus on applications that deliver significant public impact and tangible societal benefits. Prioritizing services such as emergency medical transport or critical infrastructure monitoring is a key driver for gaining the broad public acceptance and trust required to integrate these technologies into daily life.

Furthermore, future initiatives must address the complexities of designating U-space within dense urban environments. Achieving seamless integration between U-space services and existing controlled airspaces is a critical technical and operational challenge. We believe that developing harmonized methods for this integration—particularly in congested city centres—will be a cornerstone of future research and regulatory work, ensuring that unmanned operations coexist safely and efficiently with traditional aviation

CONCEPT AND ABBREVIATIONS

AGL	Above Ground Level
ATM	Air Traffic Management
BVLOS	Beyond Visual Line of Sight
EASA	European Union Aviation Safety Agency
eVTOL	Electric Vertical Take-Off and Landing
SESAR	Single European Sky ATM Research
SORA	Specific Operations Risk Assessment
UA	Unmanned Aircraft
UAM	Urban Air Mobility
UAS	Unmanned Aircraft System
UATM	Urban Air Traffic Management
UAV	Unmanned Aerial Vehicle
UTM	Unmanned Traffic Management
VTOL	Vertical Take-Off and Landing

PUBLICATIONS

PUBLISHED

Basjuka, J., & Fylkner, G. (2024). Understanding of urban air mobility through interactive visual storytelling. Sammanställning Av Referat Från Transportforum 2024, 436–437. Retriever from https://urn.kb.se/resolve?urn=urn:nbn:se:vti:diva-20773

Basjuka, J. (2026). ART Project: Co-Designing Storytelling Tools for Urban Air Mobility Lessons Learned and Next Steps. Sammanställning Av Referat Från Transportforum 2026.

Filipp Marcus (2025), Service provision report R10 drone workshop, https://www.aeroedih.eu/news/1708-2/

SUBMITTED

Basjuka, J., Löwgren, J., Westin, C., Lundberg, J. (2026). Towards Urban Air Mobility: Exploring how to support collaborative planning and communication in drone projects. CHIWORK, 2026.

PUBLIC TALKS

presentation to Transportstyrelsen with a first demo of interactive storytelling, October, Linkoping, 2023
Flygvapenmuseum presentation about ART project, Linkoping, November, 2023

presentation of ART during Innovation days organized by LFV, Kista, November, 2023

Transportforum presentation, Linkoping, January 2024

Storytelling symposium presentation, Malmö university, May 2024

FIC Creative Industries Festival presentation and workshop facilitation, Moldova, June 2024

Trafikverket event poster presentation, Stockholm, September 2025

WARA-PS demonstration week, poster presentation, Västervik, September 2025

PARTNERS

Funded by Trafikverket, in collaboration between LFV and LiU.