Interreg Baltic Sea Region

Co-funded by the European Union

SMART GREEN MOBILITY
CITYAM

CITYAM empowers responsible urban air mobility

A.1.3: The path towards the use cases, landing sites and plan of implementation

City of Stockholm through CITYAM

Authors: Johanna Löfblom and Kristoffer Lundgren Thånell

15.01.2024

Summary

This deliverable report as part of the first work package of CITYAM aims to make clear why and how certain urban air mobility (UAM) use cases and landing sites solutions (LSS) are scalable to the partner cities, and beyond those, to cities within the entire Baltic Sea Region.

The basis of this report is a multitude of workshops, meetings, and information gatherings from a broad span of actors across the UAM scene, ranging over six cities in the BSR. A great number of actors such as drone operators, local and national public authorities, infrastructure and public service providers, interest groups as well as the medical sector have provided meaningful input and collaborations over this year.

How the three project cities of Stockholm, Helsinki, and Hamburg have handled the process of preparing an UAM solution is presented throughout the report. Clear learnings are that cooperation with a broad array of actors is absolutely necessary for this evolving mobility form. It is also apparent that when a city is willing to take the time to define a need and involve the essential stakeholders, the possibilities are large for a successful UAM use case that benefits the city and ultimately its citizens.

Regarding permit applications, all relevant and potential permits identified in Stockholm, Helsinki, and Hamburg could prove useful for other cities to look to as well. In almost all cases, a building and excavation permit is needed for the landing site and a camera surveillance permit for the flight operation. CITYAM assesses that most city-managed flight permits land under the specific category defined by EASA. Various types of operations already have predefined risk assessments (PDRAs), resulting in shorter flight permit approvals for many smaller operations. The Aviation Authorities optimistically encourage municipalities to apply for flight permits to prove a basis for potentially even more PDRAs.

Ultimately, CITYAM finds that use cases within the themes of data collection and visualization as well as medical and emergency operations are the most feasible and attractive use cases for cities within the BSR, in the near future. Already existing city-managed drone use cases in the six partner cities for various data collection and visualizations indicate that the feasibility of this theme is sound. The potential of a birds-eye view to collect and visualize data from a new perspective has the clear possibility of improving the efficiency of city tasks while also minimizing environmental impact. It is evident that these use cases are also efficient from a land management perspective, most often only needing one landing site location by a drone-in-a-box LSS with a surface footprint of no more than a few meters. However, data on existing use cases show that current data collection and visualization use cases are almost exclusively flown within vision line of sight (VLOS). To reach even larger city benefits, CITYAM sees beyond vision line of sight (BVLOS) flights to be the way forward, where drones can act and collect data autonomously.

As for the use cases within medical and emergency operations this theme was ultimately decided upon because of its benefits in both broad collaboration as well as public health. Currently, the most relevant LSS is the drone-in-a-box for smaller operations. However for scalability cargo hubs and/or droneports could prove valuable where different drone operators could use a joint landing site for multiple purposes, providing more efficiency and less land occupation. Furthermore, there is a clear incentive from the medical industry as early adopters of UAM, where municipalities in the BSR could greatly benefit by jointly collaborating and paving the way for the future of mobility.

1. Introduction to A.1.3

The development of urban air mobility and the use of drones is a fast-developing industry. There are already some ongoing drone operations in European cities such as inspections, mapping, and scanning. As the purpose of CITYAM is to prepare cities for an acceptable and sustainable up-scaling of the use of UAM (urban air mobility), activity 1.3 has aimed to work through the process of implementing a drone operation in Stockholm, Helsinki, and Hamburg. A lot of focus within the activity has been on including and discussing UAM with relevant stakeholders to widen the network and prepare for the use of UAM.

In more detail, activity 1.3 has consisted of the points below:

- Creating a summary overview of existing city-related drone operations in the pilot cities,
- creating an overview of relevant commercially available technical landing site solutions and their space requirements and costs,
- creating maps of each leading city with an overview of city-owned land or property (suitable for landing site locations) as well as potential landing sites based on technical requirements landing site providers,
- description of the complementary use cases (type of missions and accompanying landing sites) for A2.2 per pilot city, including an overview of essential stakeholders per use case,
- overview of input needed for permission applications,
- based on commonalities in Stockholm, Helsinki, and Hamburg, an overview of the most feasible and attractive use cases for cities in the entire Baltic Sea Region,
- functional specifications for the procurement of landing site infrastructure and drone operations,
- process description to be used for replication purposes in A3.2

The work in activity 1.3 has aimed to lay the foundation for an up-scaling implementation of drone operations in cities.

The CITYAM project aims to support and empower cities in facilitating a responsible and acceptable increase in urban air mobility via transnational Baltic Sea Region cooperation, in order to achieve a cleaner and more sustainable transportation system.

1.1 Outline of the Report

There are two major parts to activity 1.3; use cases and landing sites. These two major segments are divided into two distinct chapters; Chapters 2 and 3. Within these chapters, everything that's been learned about those topics will be covered. Before diving deeper into this year's research, both Chapters 2 and 3 start with a current situation analysis and overview. There, existing use cases in the CITAM project cities and current landing site solutions on the market are described. This should provide insight into the current situation and provide a basis for further reading. Thereafter in the upcoming subchapters, deeper findings are described. These chapters cover each of the pilot cities' preparations and planned pilot use cases, six pilots in total as well as landing site requirements for an eventual procurement of a drone operator. To sum up the use-case chapter, an overview of CITYAM's view on the most attractive and feasible use cases for cities in the Baltic Sea Region is

presented. These use cases are meant as a guide for cities that are willing to implement UAM. The landing site chapter is finished with a visualization and map of each pilot city, which describes where landing site locations could be located.

Following in chapter 4 an overview of permit applications in the Baltic Sea region is described in depth. This will prove useful for adopters since the permit application process is destined to be a substantial part of actualizing UAM.

In chapter 5 the entire process of preparing an urban air mobility solution is described, which should prove useful both for replication purposes as well as for implementation for CITYAM in the coming year.

1.2 Purpose and Target Group

This deliverable report is mostly addressed to cities/municipalities that want to implement a drone operation. The report can also give value to other public authorities and organizations such as infrastructure and public service providers or medical centers.

The purpose of the report is to serve as a handbook with guidance and a process description on how to implement a drone operation within a city.

1.3 Method

The method that has been used for the activities in 1.3 is mostly based on workshops and continuous meetings, both with the project partners but also with external stakeholders. Especially the identified use cases for the leading cities described in Chapter 1 below.

The general and existing use cases in the leading and replicator cities were developed through workshops with participants from each municipality. The participants were from departments such as the traffic department, building department, urban planning department and environmental department.

The information about available technical landing sites was developed by an external party, a student from Linköping University. The method that was used by the student was a literature study and desk research. The result was developed through an analysis based on the different existing landing site solutions, their use cases, and different attributes.

The maps of each leading city that is presented in Chapter 2 have been developed together with activity leaders for activity 1.4.

2. Use Cases

This chapter dives deeper into the project cities' UAM use cases. The three subchapters are divided by existing UAM use cases in the six project cities, the preparation of the pilot use cases in the three leading cities and an overview of the most attractive use cases for cities in the Baltic Sea Region.

2.1 Overview of Existing UAM Use Cases in the Six Project Cities

Before diving deeper into the three pilot cities' pilot use cases a current-situation-analysis will in this subchapter be described. Each of the six project partners has conducted workshops and done research on existing drone use cases in their cities. This chapter only describes city or other publicly owned UAM usage.

One takeaway is that in none of the six Baltic Sea region cities, UAM is broadly active. However, in four out of the six project cities, the municipality or its subsidiaries have already completed work with drones in one way or another. All six project cities had other publicly owned existing use cases.

Every city-related use case is described below by project city. These include use cases where the municipality has managed or at least partly managed the use cases. As for other publicly owned use cases that have taken place in the project cities, an array of differences were identified. One takeaway is that the Police and Rescue Services are two of the most active public actors in the UAM field. Some use cases in that field include Aerial photos of accidents and crime scenes, Monitoring of demonstrations and events, Search missions, and Surveillance. Some medical use cases were already in use, especially using drones to transport urgent medical goods between hospitals. Some UAM cases on state highways/motorways have taken place, for instance distance control. Another noteworthy use case was in Hamburg, where drones were used for search missions to identify deceased wild boars to prevent disease spread.

Existing City-Related Use Cases Helsinki

- Aerial photography covering the entire city to provide data sources and terrain models
- Managing the city's construction sites and logistics
- Aerial photography identifying where snow removal is necessary

Existing City-Related Use Cases in Tartu*

- Aerial photography covering the entire city to provide data sources and terrain models
- Visual inspection of infrastructure for construction and building maintenance oversight, aerial data integration, automation of data collection and analytics
- Road construction and maintenance monitoring
- Collection of traffic data to analyze and improve traffic management near public buildings such as kindergartens and school

*City-related use cases planned for the Tartu region, implementation in progress.

Existing City-Related Use Cases in Stockholm

- Capturing pictures before a construction project to localise an area
- Roadside assistance
- Educational and cultural activities with photography and film creation
- Aerial photography covering the entire city to provide data sources and terrain models
- Animal herding of geese to prevent pollution of Stockholm's beaches

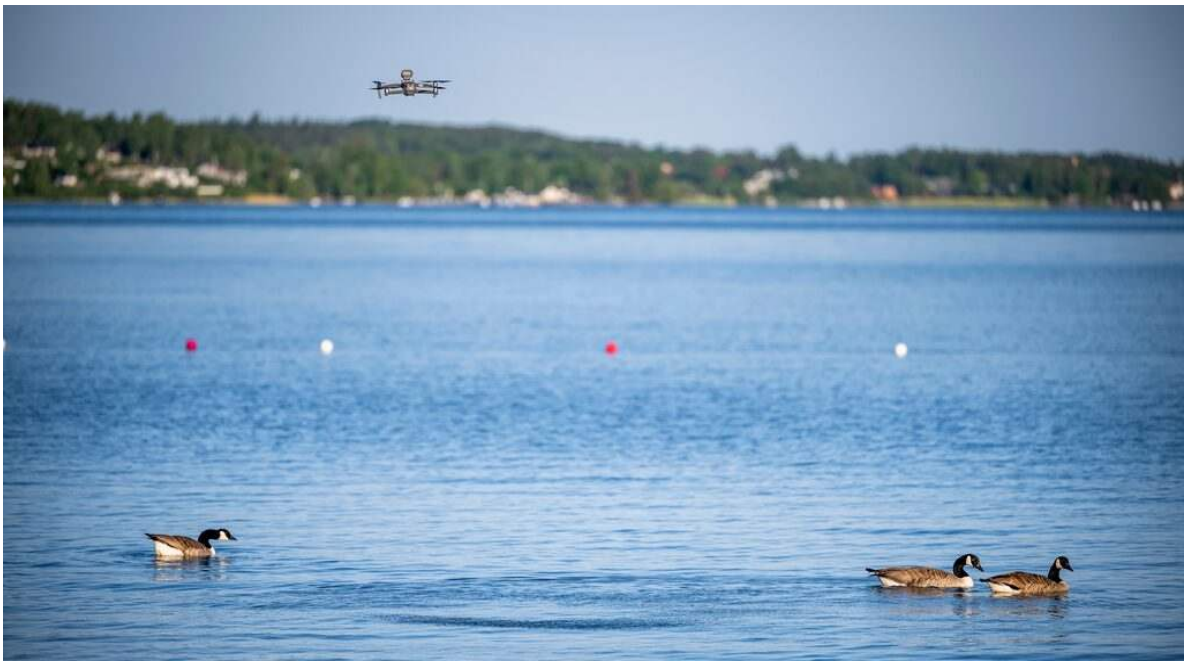

Figure 1: Active drone herding of geese in one of Stockholm's beaches, done by sound waves tailored for geese, which does not affect other animals such as ducks

- One of Stockholm's photographers captures recurring drone photographs and film of Slussen, that document the construction and evolution of one of Stockholm's largest projects

Figure 2: Drone photography of Slussen, Stockholm

Existing City-Related Use Cases in Riga

- Surveillance and Emergency Response, including search and rescue operations, event management and rapid response, monitoring compliance with road traffic rules, photo and video documentation in hard-to-reach locations, administrative infringement proceedings. These use cases are carried out by Riga's municipal police

Figures 3: The use of drones by the Riga police during the swimming season to assist in lifeguard rescue activities

- Environmental monitoring of forestry works, forest fires, mineral belts and large bird nests
- Visual inspection of various structures
- Difficult terrain and infrastructure inspection outside of the built environment
  - Monitoring of difficult areas for amelioration and water monitoring
  - Inspection of challenging terrains like ditches
  - Acquisition of remote research data on forest and natural values
- Drones equipped with cameras remotely monitor port activities and assist in emergency situations as well as providing access to hard-to-reach areas such as underwater structures

Figure 4: Drone used at the Freeport of Riga for various purposes

Existing City-Related Use Cases in Gdansk

- Monitoring of fumes from chimneys to prevent people from firing unauthorised materials in their heaters
- Monitoring of when septic tanks are suspected of being poured into a ditch
- Filming and photography for city media
- Drone use by City Guard during tourist season to prevent cases of illegal trading in the old town


Figures 5: Gdansk City Guard using drones during tourist season in the city

Existing City-Related Use Cases in Hamburg

- Ongoing CITYAM test flights for Hamburg's two use cases described in Chapter 2.2.3

2.2 Pilot Use Cases

Within the overarching activity to Identify use cases and potential landing sites, the use cases for the pilots have been developed in each leading city (Stockholm, Helsinki, and Hamburg). This was done in parallel with activity 1.1 part on the involvement of relevant actors. Each leading city has engaged with relevant stakeholders in their respective city to discuss needs and develop a use case relevant to the project and the city. Continuous meetings have taken place between the leading cities to learn from each other and develop the pilots so that they are complementary and relevant to the project. These discussions have also taken part in full groups on multiple occasions, where other activity leaders and replicator cities have provided meaningful input.

Each leading city has two distinctly separate use cases and none of the leading cities share a use case. However, there are some similarities between two of the leading cities' use cases; they are both focused on medical delivery and emergency operations, whereas Hamburg's use cases rather focus on the prevention of emergencies through management. Under the three following headings, each leading city's pilot use cases and potential landing sites are presented including an overview of essential stakeholders.

2.2.1 Stockholm's Pilot Use Cases

2.2.1.1 Defibrillator and Drone as First Responder

Stakeholders

Stockholm's first use case is in collaboration with its most essential stakeholders. These collaborative stakeholders are the Karolinska Institute (Center for Resuscitation Science), The Region of Stockholm, and AISAB. The Civil Aviation Authority, the Stockholm Rescue Service, and the Police Authority participate as passive stakeholders.

As one of Europe's largest medical universities, KI provides the project with meaningful research implications. Their main interest lies in cardiac arrests and how drones can be useful to minimize the time before a defibrillator arrives, and ultimately to save lives. The Region of Stockholm is responsible for all medical services in the greater Stockholm area and is interested in drones as first responders, where early captures of live images from an accident scene can be acquired. When these images are acquired, AISAB (owned by the Region of Stockholm and operating its ambulance services) can use the data as a deciding factor on initial resource allocation to the accident scene. As for CITYAM and Stockholm, the main objective and interest is the process of landing site allocation and ultimately the planning of the city's public space.

Type of mission

The mission of Stockholm's first use case is to fly for two separate use cases, with one drone operator, one drone, and one landing site. The drone will not have scheduled flights, but rather it will activate whenever an alarm to the SOS is registered. It will lift and complete its assignment according to the definition of the alarm; it must be within the correct geographic area and the alarm must consist of one of the three: ongoing cardiac arrest, fire in a building, or traffic accident with over five injured. The priority of the alarms follow that order. Meaning that an ongoing cardiac arrest will always be the prioritized mission. For the first alarm, the drone will be equipped with a defibrillator and fly to the location, tether the defibrillator down, and return. For the second and third alarms the drone will fly to the accident scene and capture live images, which are sent to AISAB. In both cases, the drones do not fly from point A to point B but rather from point A to N, since they do not land at their destination. Within the span of the project, which is planned to be conducted from June 1st, 2023 to May 31st, 2024, the estimate is one flight per day which would amount to a total of approximately 350 flights. All operations are BVLOS and autonomous and are planned to be conducted in a geographic span of 8 kilometers, which will preliminarily reach 100,000 - 200,000 citizens.

Landing site

The applications and permits for the potential landing sites are still ongoing. The drone operator has not yet been fully procured. As for the geographic placement of the landing site, the current suggestion is in Farsta, Southern Stockholm, where GIS analyses have concluded that historically many cardiac arrests have been reported. The City of Stockholm aims for the landing site placement to be on ground level, on city-owned property, to be able to learn from these processes.

2.2.1.2 Drone as a Service

The initial plan

Stockholm has since the first phase of planning the use cases gone in the direction of doing a second use case together with stakeholders such as the Police Authority, Rescue Services, and the Region of Stockholm. After including them in workshops and continuous meetings for CITYAM it was decided that Stockholm would be doing a use case as a drone as a first responder.

The Police Authority, Rescue Services, and Region of Stockholm are all first responders. They all share an interest in generating early captures of live images from an accident scene. By combining all three first responders the hope was that the live images could be shared with all three before they physically arrived on the scene. The goal was that the operation would mitigate risks on site, provide support on resource allocation, and ultimately save lives. As for CITYAM the main objective and interest is the process of landing site allocation and ultimately the planning of the city's public space.

The type of mission was therefore planned to focus solely on alarms like fire in a building and traffic accidents with over five people injured. The period of pilot was planned for a more limited period than the first use case and was planned for approximately 1-2 months during September-November. As the stakeholders were concerned about safety a lighter drone would have been used, equipped with a camera.

Since Stockholm's main goal is to determine the processes of establishing the landing sites, the landing site of this use case pilot was planned to be established on another type of surface than the first use case. Therefore, the drone operator would be instructed to look into suitable landing sites on either roofs or other relevant sites.

However, during the year, the City of Stockholm has realized that it will be challenged with a use case where the owner of the need is another authority and where the stakeholders can not 100% fully engage in the CITYAM project. There are legal issues and challenges with sharing data from drones between authorities, which would have resulted in challenges getting a permit for this and being able to go through with the operation. The city of Stockholm concluded that the city itself should be the owner of the operation. Stockholm sees a lot of benefits in doing a city-owned use case and being able to test the whole process to open up the possibilities to up-scale such operations in the future.

New plan in progress

After deciding to change the mission of the second use case the process started with looking internally at the different operations that the municipality is responsible for. As the project leaders work in the traffic office, the focus was to look into the traffic office's responsibilities and operations. Overall, the traffic office's main responsibility is public space, such as operational activities on the city's streets, use and maintenance of the public space, and development of pedestrian and cycle paths (a few of many responsibilities).

The internal overview of our responsibilities landed in a list of different operations and ongoing projects that could be interesting for testing in a drone operation. The list is mostly

based on operations for data collection. The main question that has been asked is “How can this operation be motivated to do with a drone instead of the usual way?”. The list of different operations of the traffic office must be worked through more and developed to be able to land in an actual use case, which is planned to be done by an internal workshop at the beginning of 2024 with participants such as traffic planners, expertise in parking regulation, operational expertise. The mission of the use case will most likely be data collection in either of the points below:

- Parking inventory
- Mapping and analyzing traffic flows
- Map and identify problems accessibility of streets

The use case is aimed to be operated in the central part of Stockholm. There are some ongoing politically important developing projects in the city area of Stockholm which is one of the main reasons why it would be interesting to have the use case around that area. Another reason why we want to fly over the city area is because there is a restricted area in the airspace of the central part of Stockholm. In that way, we can test the process of flight permits over restricted areas and have dialogues with the aviation authority and Bromma airport tower. We aim to apply for a BVLOS flight, but plan B is VLOS since there is a challenge with getting a permit for BVLOS in restricted areas.

Since the use case is planning to be data collection we will most likely use a drone-in-a-box solution as a landing site. We want an autonomous drone operation where the drone operates by itself through an A-A flight route. In that sense, the drone can fly from its landing site, collect the data we want, and then fly back to the landing site to charge before the next planned flight. Because of the A-A flight route, our operation only requires one landing site. To be able to test the permit applications and its processes and how it eventually differs depending on the type of surface, we aim to have the landing site on the rooftop of a city-owned building. When the mission is fully decided we will plan the actual flight route and decide on how many flights we want to get the data that we need. The flight route will be planned in the first quarter of 2024.

The stakeholders for Stockholm's second use case will mainly be different internal departments from the city of Stockholm such as the traffic planning department and the urban environment department. When the actual mission of the use case is decided, more internal departments can be identified as relevant stakeholders as well, such as the urban planning department for example. Other than internal stakeholders the Swedish Aviation Authority will be our stakeholder in this use case. They will participate as support in planning the use case and the flight route according to the airspace.

2.2.2 Helsinki’s Pilot Use Cases

2.2.2.1 Healthcare Logistics

Stakeholders

The main use case to be piloted in Helsinki is related to healthcare logistics and was selected based on the future needs of the city and its subsidiaries. It is viewed as pandemic preparedness for the city after having experienced a need for a complementary, fast logistics chain during the COVID-19 pandemic. On this basis, the main stakeholders that play an essential role in formulating and actualizing this use case are Stara (the Helsinki city-owned

maintenance and infrastructure provider, taking care of city-internal logistics) and SOTEPE Logistics (the Helsinki city-owned healthcare logistics coordinator).

Stara is the largest logistics provider in the city with a large fleet of vehicles, including 11 drones. Despite the fact that these existing drones are mainly used for monitoring purposes and not yet for (healthcare or other) deliveries, Stara contributes essentially to the pilots planned to take place in Helsinki with its technical know-how and previous experience with drones. They would also be the organization implementing the use case and/or scaling the drone operations upon a successful pilot.

One of Stara's responsibilities lies in delivering healthcare products to public hospitals and city health centers based on the product orders from SOTE Logistics. SOTE Logistics is responsible for coordinating transport services, such as the distribution of healthcare products to public hospitals and city health centers based on their needs. Both of the above-mentioned city subsidiaries are essential for the use case piloted in Helsinki. They are interested in enhancing their logistics chain with drones for pandemic preparedness and also, for more efficient and cost-effective healthcare deliveries in the future.

Type of mission

The intention and plan within the scope of the CITYAM project is to deliver drone healthcare products between two city-owned facilities. The healthcare items to be delivered are considered non-urgent but still essential in a future pandemic crisis: they can be disinfection products, surgical masks, protection gloves, or other items of the list of 20 products that were identified by the city's healthcare department as essential to have available immediately in case of another pandemic.

Regarding the payload, the drone is to carry at least 1 kg, but this can be more depending on the capabilities of the selected drone operator. It is noteworthy that many of the foreseen healthcare items can be generally considered lightweight but yet voluminous. The exact type of healthcare products to be delivered alongside their size and quantity will be based on a previous analysis of the current deliveries to the selected end destination for the drone, as well as the cargo capabilities of the selected drone operator.

The initial plan for the route and its challenges

The initial plan for the drone pilot was to deliver healthcare products from the central warehouse of the Helsinki city-owned infrastructure provider (i.e. Stara) to a public hospital's rooftop. The route over which the drone would fly was approximately 2.7 km (see Figure 1). The area itself was considered urban but had a low population density. It was situated within (but at the edge of) controlled airspace, not far away from the Helsinki-Vantaa airport. The drone operations were planned to be BVLOS (Beyond Visual Line of Sight), meaning that the drone would have flown out of sight range from A to B. In particular, the drone would have been first loaded with healthcare items at the central warehouse of Stara and then would have started its approximately 5-minute journey from there to the public hospital's rooftop as its final destination.

Figure 6. Initially planned drone flight route from the central warehouse (on the left) to the public hospital (on the right).

On its way to the public hospital, the drone would have crossed a highway and due to safety reasons, the flights would most probably have not occurred during rush hours. This highway is also the route along which the HEMS helicopters fly (Medi-Heli) from their base at Helsinki airport towards the city center. Therefore, in relation to both ground and air risks on this particular route, discussions have been held with the Civil Aviation Authority, the Finnish Air Navigation Services, the border guard, and the FinnHEMS medical emergency helicopter base situated at Helsinki airport.

New plan in progress

Despite the cautious optimism expressed by the Finnish Civil Aviation Authority (Traficom) and Air Navigation Services (Fintraffic) during the pre-feasibility discussions, the plan on the initial flight route was eventually abandoned after an uncompromising rejection by the air traffic controllers at the Helsinki-Vantaa airport. The air risk was considered too challenging mainly due to the restrictions imposed by the controlled airspace circumstances and proximity to the regularly used HEMS helicopter route. It is currently technologically difficult for helicopters to be able to see drones and vice versa, as it is not mandatory to have a responder or other communication device on the vehicles. The “see and be seen” capabilities between different types of aircraft at low altitudes are still very much under development in Europe, both technologically and from a regulatory perspective. This means that in some cases, extra efforts are needed from stakeholders such as air traffic controllers and HEMS operators. Clearly, they are not always willing to cooperate.

These unforeseen complications as described above indicate in the most striking way how essential the cooperation with other stakeholders (e.g. Air Navigation Service Provider, Air Traffic Control, HEMS operator, Border Control, Ministry of Transport) truly is during the formulation of the plan operations.

As a result of these complications along the way, the flight route needs to be redefined based on new and more easily accessible destinations for drone operations in Helsinki. The new plan continues to have at its base the initial aspirations for BVLOS (Beyond Visual Line of Sight) flights. The central warehouse (see Figure 2) serves as a critical point in relation to the flights as it is the place where all healthcare products are. For this reason, it remains on the table as the “home base” and drone take-off point in the new plan as well. It is worth mentioning at this point that the central warehouse is a city-owned property which might imply an easier permission process on the city side. Also, it is worth mentioning that the

final flight route is not known yet at the publication time of this document. It depends to a large extent on the cooperative spirit and operational flexibility that the relevant national entities are willing to show against the obvious challenges of operating BVLOS flights in urban environments.

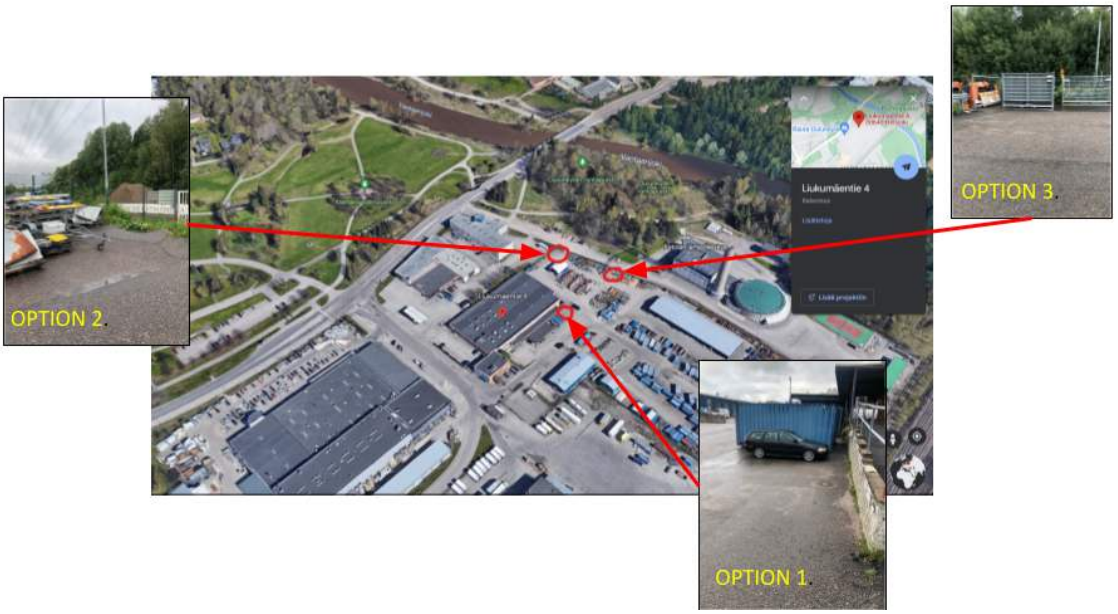

Figure 7. Potential take-off points at the central warehouse.

As concerns the new end destinations for the drone's journey, the new plan is being formulated on the basis of a couple of options. The feasibility of these new options is currently investigated in a spirit of close cooperation between the main stakeholders for the pilots presented above and relevant national authorities. Briefly stated the new options address public healthcare centers located in the urban Helsinki area. The landing site in particular for the drone will be determined after the pre-feasibility investigations of the flight route and suitability of available landing site options.

Experiencing the actual service in diverse weather conditions necessitates a longer-term pilot, during which there will be the opportunity for the various stakeholders within the city to be engaged. Therefore, the aim is to execute a minimum number of flights over a span of a few weeks to a few months. The minimum is still to be set, but will likely be around 40 flights. The duration of pilots and maximum number of flights depends on the budgets and offers of the suppliers. The flights in Helsinki are aimed to take place between April and September 2024.

The flight service and landing site solution will be tendered at the beginning of 2024. While being at the pre-tendering phase, there have been some initial discussions with relevant city departments concerning permissions necessary for the pilots to be executed in Helsinki. The Finnish Civil Aviation Authority and Air Navigation Services have also been engaged in discussions as mentioned above with the main stakeholders on the pre-feasibility of the previously selected and new flight routes currently under investigation, have given and continue to give their preliminary opinions on the new plans and follow the progress with

interest. A dozen drone operators throughout Europe have already been contacted to inform them about the upcoming tender. We received much interest.

Landing sites

At the take-off and landing site location at Stara's warehouse, a suitably sized piece of ground will be made available where the drone operator can install its landing infrastructure and potential charging facilities. Charging can possibly also take place inside the warehouse and there are also storage facilities available if the service procurers so agree with the drone operator.

As regards the primary plan for the drone's landing site at the hospital end, there were some specific elements that were taken into consideration for indicating the initially selected hospital's roof as a potentially safe landing site for the drone. Firstly, it was renovated recently meaning that the structure was solid and thus, the ground risk was minimal. Secondly, the roof was easily and safely accessible. Thirdly, the roof access was next to an elevator that could have facilitated the distribution of the incoming deliveries to the hospital's different floors. A temporary fence would have been put up for the duration of the pilot to maximize ground safety. If the landing site on the new route is also on a rooftop, we will make sure similar safety features are in place.

In addition to safety that applies in all cases, the flights will be scheduled upon consultation with the property manager of the end destination of the drone flights for better resource allocation and effectiveness. When the drone reaches its final destination it will be unloaded by the personnel of the selected city-owned facility. The personnel will receive relevant training for this. Through the close involvement of the SOTE Logistics colleagues in this pilot, the cooperation of healthcare staff can be secured.

2.2.2.2 Delivery of Floating Devices for Water Rescue

Stakeholders

The secondary use case to be piloted in Helsinki within the scope of the CITYAM project is related to water rescue missions and the delivery of floating devices to people in distress at sea/lakes. Frequently occurring water rescue incidents have activated an eager interest and also a need to test the efficiency of drones as lifeguards by the local rescue emergency services. In particular, the use case in question will be piloted in close cooperation with the Helsinki City Rescue Department (Pelastuslaitos). This specific local department is the only first response organization in Helsinki and holds the responsibility of providing and operating rescue and emergency medical services in the hospital district of Helsinki and its greater region. Even though the Rescue Department has already deployed drones to some extent in its operations (analysis of fires in buildings), the delivery of floating devices for water rescue has not yet been tested.

Type of mission

The intention is to organize short-duration tests/demos with the Helsinki shoreline as the target area. Even though there is no specific timeline on the table at the moment, the pilots will most likely take place during April-June 2024 or September-October 2024. About permit applications and processes, the drone will fly within the sight range (which depending on the drone type, can be up to 2km) and consequently, the flights will be VLOS (Visual Line Of Sight). In this way, no specific permit applications are required by the Finnish Civil Aviation

Authority (Traficom) that smoothes the way towards the operations. The flights will most likely take place in uncontrolled airspace, which also makes the process easier.

Landing site

For this type of mission in general, there once the drones can fly beyond visual sight in an urban area, they could take off from e.g. the main fire station (a pre-set, fixed take-off location). Before that is the situation, the drone, and floaters could be carried on board of a fire truck and deployed nearer to the accident scene. This is now also the case with the drones used for fire assessment.

For the CITYAM pilot in particular, we will select a few suitable flight areas on the Helsinki shoreline from where the drone can take off.

Figure 8: Example of a drone in a fictional setting delivering floating device for water rescue

2.2.3 Hamburg's Pilot Use Cases

2.2.3.1 Infrastructure Management

Stakeholders

One of the two main use cases to be tested in Hamburg is related to the control of roads, streets, and structures and was selected based on the needs of the city and its subsidiaries. It is seen as a significant time-saver and thus a cost-saver for the city. The Hamburg Port Authority's Structural Inspection Department will play a major role in the formulation of this application.

From a liability point of view, all paths, roads, and structures must be inspected regularly today to detect damage at an early stage and avoid liability claims arising from this damage. The structures to be inspected also include a large number of bridges. Hamburg has more bridges than Venice and many of them belong to the City of Hamburg and are therefore subject to inspection by the Hamburg Port Authority. A goal of this use case is to investigate whether the use of drones and the evaluation of the resulting data represents a time and cost saving.

Figure 9: Way control (i.e. inspection of harbor area roads and bridges)

Type of mission

To this end, the CITYAM project intends and plans to regularly fly specified routes and structures with a camera drone. The damage to be inspected is chipping in the road surface (tar), cracks in the masonry, and fatigue in reinforced concrete. A drone image can provide an initial insight and then send a building inspector to the damaged area to assess the damage and arrange for repairs / new construction. The first test at the beginning of the project is the selection of the camera. Several models are available and test flights are made to determine which resolution, zoom factor, transmission quality, and stabilization are necessary to generate a suitable image for evaluation.

The first evaluation can be made directly on the screen during the flight, or later by viewing the photos or video sequences. In a later step, the use of an AI is also conceivable, but for reasons of cost and time, this will not be investigated in the CITYAM project. The advantage of a drone-based control is that it can be stopped after damage detection and both photos and video recordings can be made from different angles. A regular flight along pre-programmed routes ensures that the temporal course of damage is documented and that damage that has been detected is regularly inspected.

The route and its challenges

Flights are to take place throughout the port area. The harbor in Hamburg is 27km² large and represents a very big challenge. In addition, the flight routes are in the urban area above commercial, industrial, and residential areas. Two airports in the city area and the associated Delta and Echo control zones, as well as federal waterways, motorways, and railways, show the complexity of this task. The plan is to start with VLOS flights and in consultation with all those involved, to gradually undertake longer flights beyond visual range. Even though we, as the Hamburg authorities, enjoy more freedom than others, a special level of safety is required, especially for us, who are in the focus of public interest.

Observing all safety aspects, the best possible level of training, and safety mechanisms in software and drones should make the flights as safe as possible.

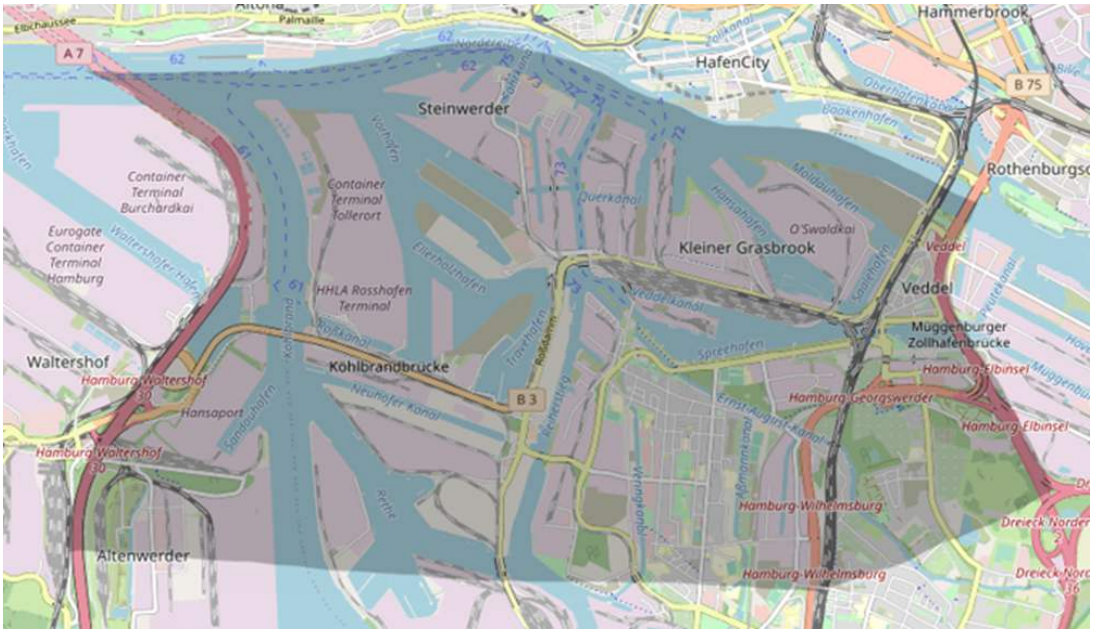

Figure 10: Complete harbor area of the Port of Hamburg, 27 km²

Landing site

The city's property at Niedernfelder Ufer 2 was chosen as the central launch and landing site. There were several sites to choose from, but the favorable location in the heart of the Port of Hamburg tipped the scales in favor of this property in the end. The location of the residential area at Grasbrock was also favorable to work on the second part of the CITYAM project regarding the acceptance of drones. At the Niederfernfelder Ufer site, the HPA set up a drone port that can be used as a central landing and take-off point for all drone projects of the Hamburg Port Authority. Another advantage is that the building inspection is also located on this site. The aim is to create a drone airport where work is being done step by step on teleoperated drone flights, even beyond visual range (BVLOS). Storage and charging infrastructure are available and will be further expanded. A settlement of other stakeholders is also planned and considered to benefit from synergy effects.

2.2.3.2 Catastrophic Prevention Management

Stakeholders

The second use case, which is to be tested in Hamburg as part of the CITYAM project, is about flood protection and the control of the associated protective measures. Hamburg is directly connected to the sea via the Elbe and the tides, which depend on the moon, are part of everyday life here. However, if certain weather conditions and moon phases coincide unfavorably, so-called spring tides and high water levels can occur. Several such floods have been documented in Hamburg's history. Some of them caused considerable damage to people, buildings, and infrastructure. For years, Hamburg has been divided into 39 polders that can be sealed off in the event of imminent flooding. A polder is enclosed by dikes and sheet pile walls and large flood gates can be closed in the event of an imminent flood.

The port's disaster management staff (HASTA) has the floodgates closed if necessary. Whether the gates are securely closed is checked today by volunteers and employees of the City of Hamburg. This involves considerable effort and only works if there is an unbroken chain of reporting. With a fast and powerful drone (VTOL), all floodgates can be checked for their condition. The flight routes are reproducible and can be flown teleoperated from DronePort.

Figure 11: Polder Control in Hamburg for disaster/flood prevention

Type of mission

Initial short test flights are planned to two tide gates close to each other. These flights are to take place in different weather conditions and also at night. As such missions are usually ordered at short notice and cannot be planned. A special challenge is the flight and the recognition of the floodgates at night or in bad weather. Here, too, different cameras will be tested and the radius gradually extended from the initial VLOS flights until we can carry out BVLOS flights at all flood gates in coordination with the authorities. We hope to achieve flight times that can combine all floodgates in one mission. The drone manufacturer is talking about flight times of up to 120 minutes.

Landing site

The city's property at Niedernfelder Ufer 2 was chosen as the central launch and landing site. There were several sites to choose from, but the favorable location in the heart of the Port of Hamburg tipped the scales in favor of this property in the end. The location of the residential area at Grasbrock was also favorable to work on the second part of the CITYAM project about the acceptance of drones. At the Niederfernfelder Ufer site, the HPA set up a drone port that can be used as a central landing and take-off point for all drone projects of the Hamburg Port Authority. Another advantage is that the building inspection is also located on this site.

Table 1: Decision Matrix for suitable Drone Port Site in Hamburg

	homePORT	Niederfelder Ufer	Metha	Kattwyk
Company premises		x	x	x
Fenced property	(x)	x	x	x
Area for landing pad		x		
Central location in the harbor	x	x	x	x
Connection to the test environment	x	x		
Fixed and heated operating and storage structures for the drone systems		x	x	
Hangar-like building with gate		x		
Workshop infrastructure	x	x		
Proximity to structural testing (personnel and technical)		x		
Office infrastructure for project management		x		
Accessibility to waterways, federal waterways (for flight paths)	x	x	x	x
Connection to public transport, accessibility, parking spaces	x	x		
Little public traffic/tourism		x	x	x

*the(x) in parentheses means not a permanent fence

The aim is to create a drone airport where work is being done step by step on teleoperated drone flights, even beyond visual range (BVLOS). Storage and charging infrastructure are available and will be further expanded. A settlement of other stakeholders is also planned and considered to use synergy effects.

2.3 Most Feasible and Attractive Use Cases for Cities in the Baltic Sea Region

During work package 1, a lot of effort has been put into defining use cases. Especially during January through April the pilot cities conducted multiple workshops; internally, externally, and within the project group. The primary goal of these workshops was to identify the most feasible and attractive use cases for urban air mobility in their cities. What issues did the municipality or other public organizations have that drones could prove useful in solving? What could be use cases for entirely new benefits? And lastly, could these be feasible now or in the near future (in about 5 years)?

The first few months of 2023 were the most intense of workshopping and information gathering, however, learnings and new input were provided during the entire year. Especially, when in the beginning of fall the replicator cities started the same work, when the process had been outlined by the pilot cities.

These workshops were as mentioned mostly for identifying general use cases, but since the discussions started these types of workshops proved invaluable for defining and narrowing down the pilot use cases (described in Chapter 2.2). Surprisingly, when compiling all of the input from the six different project cities, many of the use cases were similar, at least in theme. The last part to finalize the work was done in 2023's last consortium meeting in Hamburg. There the entire consortium gathered and narrowed down which of all these use cases are the most feasible and attractive for cities in the Baltic Sea Region. This resulted in two distinct themes.

One key takeaway prevalent for both themes was that some type of camera was necessary for almost every use case. Either it is traffic measurement or drone as first respondent.

Two major urban air mobility themes for cities in the Baltic Sea Region

1. Data collection and visualization
2. Medical and emergency operations

Before diving deeper into these two themes we will shortly mention the delivery theme. Out of the use case themes, deliveries are arguably the most versatile. Everything that today is transported by land, water, or air, could potentially be a UAM use case. Noteworthy also is that the private sector is highly interested in this theme. CITYAM expects that cities within the Baltic Sea region will become more frequently contacted by private UAM operators in the coming years. However, the abundance of potential use cases does not directly imply that all are attractive to cities within the BSR. For instance, commercial use cases could be of interest to cities. The defining reason if a commercial use case should be attractive to a city is if it provides public service or a major societal benefit. One example of an attractive commercial use case for cities could be rural deliveries of food or other supplements. This would work towards equal treatment of citizens regardless of their geographic location within the municipality.

Similar to the medical and emergency operations sector, the private sector has valuable knowledge of UAM, where cities could benefit from collaborating. The private sector often has a lot of technical knowledge, whereas the cities need to bring their knowledge of land

management and city life to bring value into the equation. Regarding all this, CITYAM urges cities to be prepared and enthusiastic about the evolving industry, but also to adopt a cautious view of what benefits deliveries and other private use cases could provide.

CITYAM expects that cities within the Baltic Sea Region will become more frequently contacted by private UAM operators in the coming years. However, the abundance of potential use cases does not directly imply that all are attractive to cities within the BSR.

2.3.1 Data Collection and Visualization

Data collection was the most common theme from all six project cities. In quantity, most potential use cases were identified within this theme. These types of use cases have the potential benefit of improving existing work done by the municipality. For instance, traffic measurements are often carried out by municipalities and UAM could improve its efficiency, and environmental impact as well as being able to measure new things. Data collection with drones could also potentially address entirely new benefits, however, most use cases within this theme aimed to improve upon existing issues. This theme focuses mainly on the municipality as the main stakeholder, but other organizations could also benefit from data collection and visualization use cases.

As for existing use cases described in 2.1, one takeaway is that most current data collection use cases are VLOS. Those types of use cases are less complex regarding permission application and technology but also limit the amount of efficiency and amount of data collection possible. Most use cases identified as the most attractive and feasible for cities in the Baltic Sea Region are therefore BVLOS-flights, where drones can act and collect data autonomously. Another benefit of data collection's feasibility is that for most use cases an A-A flight is sufficient, where only one landing site is required. This requires less infrastructure for a city to implement. Since the city would be the direct beneficiary and owner of these types of use cases, they become less complex regarding stakeholder involvement and could rather be issued quite independently.

Ultimately this theme was chosen for its attractiveness for cities. A large benefit that a drone adds is the potential to get a birds-eye view to collect and visualize data from a new perspective. Current projects could be improved upon, and ultimately result in less car traffic, more time for employees, and more nuanced data for the city officials to make decisions that benefit the city and its citizens.

Potential Data Collection and Visualization Use Cases for Cities in the Baltic Sea Region

- Inspections of work sites and dangerous inspections of tunnels and bridges etc.
- Surveillance of parking, public vehicle charging, traffic, nature areas, etc.
- Inventory of parking lots, parks, etc.
- Measurements of traffic flow (vehicle, bicycles, micromobility, pedestrians), traffic intersections, etc.
- Visualization for media purposes of work sites over time, birds-eye-view of the city, photography, and films for cultural and educational purposes
- Production of city-needed material, orthography maps, topography maps, etc.

2.3.2 Medical and Emergency Operations

Medical and emergency operations were also noted by all project partners. Both Stockholm and Helsinki decided upon use cases within this theme: Defibrillator, Situation awareness, Healthcare logistics, and Delivery of floating devices for water rescue. For cities within the Baltic Sea Region, UAM use cases within medical and emergency operations could prove valuable to start with. Stakeholders such as the Rescue Services, Police, and Healthcare within this theme are expected to be early adopters and already have prior knowledge of UAM. Therefore, many learnings and synergies could prove valuable when cities get more involved with their expertise in land management and processes.

The city is also highly involved in assessing the requirements for infrastructure and can prove as a facilitator for other public stakeholders. One clear benefit of the feasibility of this theme is that as a facilitator of public-owned land, the city can bring different use cases together within one landing site, therefore occupying less land. Another is that from earlier studies, the public acceptance level of urgent or emergency response is high.

This theme was ultimately chosen for its benefits in collaboration. Since medical and emergency operations stakeholders are indicated to be the first adopters of UAM, cities could benefit greatly by getting involved in these projects.

Potential Medical and Emergency Operations Use Cases for Cities in the Baltic Sea Region

- Emergency medical services (defibrillator, insulin, adrenaline, blood products, tourniquets, pressure bandages, etc.)
- Search and rescue missions (AI-trained thermal cameras to identify drownings, avalanche, landslide, etc. victims)
- Drone as first responder (first at accident/disaster scene and capture live images, video transfer to alarm center)
- Deliveries of supplies between hospitals or other public agencies

3. Landing Sites

This chapter presents the summary of technically available landing sites and the most suitable landing site solutions matched with the attractive and feasible use cases in the Baltic Sea Region. The chapter will also present standard procurement requirements that can be used as guidance when procuring a drone operator and landing sites. Maps over each leading city that illustrates city-owned land and property suitable for potential landing sites are also presented in the last part of the chapter. The maps have been developed together with activity leaders for activity 1.4.

3.1 Description of Technical Available Landing Sites

Landing sites come in different sizes and shapes and can have a big impact on land use and urban planning. With help from a student from Linköping University, as part of his bachelor's thesis[1], information about available technical landing sites from all over the world has been gathered. Through literature study and desk research available landing sites have been categorized into six categories. The different categories were developed through an analysis based on the different existing landing site solutions, their use cases, and different attributes. The categories with attributes such as battery solution, space requirements, and costs will be described in this chapter. If the table cells are left blank in this chapter, it means that the information has not been available.

The industry of drone operators is a fast developing industry, so we do want to pay attention that some of the companies presented below may not be active by the time this data is published.

3.1.1 Category 1 - Basic Landing Site Solution

In the first category, seven landing solutions were available with similar attributes. This category defines the landing solutions that are the most basic, in terms of both cost and infrastructure. These landing sites are referred to as smaller landing spots for smaller drones that can perform vertical takeoff and landing. The seven available landing sites in this category are presented in Table 1. Landing site solutions are described as "LSS" in the tables.

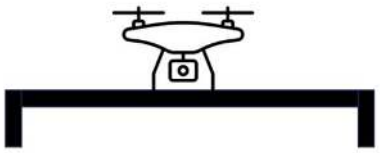

Figure 12: General illustration of a LSS in Category 1

[1] A, Mitry. 2023. *Urban Air Mobility - Landing Site Solutions for drones and their possible locations in Stockholm City*

Table 2. Companies in Category 1.

Company	Drone provider and/or LSS	Country	Name for solution	Battery solution	Hangar /nest?	Cost and size (L x W x H)	Weight
Skycharge	LSS	Germany	Bolognini 1	Charging	No	480 x 480 x 140 mm	17 kg
Drone delivery hub	LSS	US	Landing pads		No		
Stableonboard	LSS	Norway	The stable		No		
EVA	Drone provider/LSS	Germany	Vertipad	Charging	No		
Heisha	LSS	China	Heisha DPAD	Charging	No		
Divisek	LSS	Spain	Wireless charging station	Charging	No		
Edronic	LSS	Spain	Charging station	Charging	No		

3.1.2 Category 2 - Tethered Station

The second category includes drones that are physically connected to their base station or landing station through a wire. This solution is mostly suitable for surveillance in smaller areas, rescue operations, and firefighting. The wire provides the drone with constant electricity and in some cases data connection. Tethered stations imply limited mobility since the drone is attached to a wire. The location of the base station is also more critical. Four similar landing solutions are available in this category that are presented in Table 2.

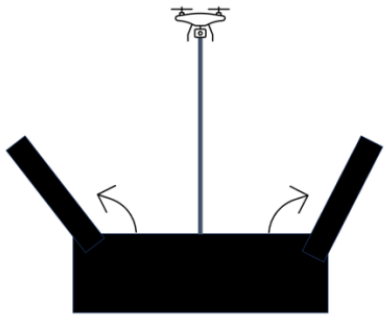

Figure 13: General illustration of a LSS in category 2.

Table 3. Companies in Category 2.

Company	Drone provider and/or LSS	Country	Name for solution	Battery solution	Hangar /nest?	Cost and size (L x W x H)	Weight
Elistar	Aerial 31urveillance technology	France/US	Safe-T 2 Tether station	Charging while flying (tethered drone)	No		
Heighttech-nologies	Drone provider/LSS	Netherlands	Albatros SAMS-T	Charging while flying (Hybrid)	Yes		
Easy Aerial	Drone provider/LSS	US	Easy guard vehicle (EGV 50)	Charging /tethered charging	Yes	1170 x 1170 x 620 mm	150 kg
Fotokite	Drone provider/LSS	Switzerland	Transport case	Charing/ tethered charging	No	504 x 352 x 230 mm	9kg

3.1.3 Category 3 - Drone in a Box

The landing site solution within category three is a drone in a box. This implies that the drone is secured in a box while it charges/swaps the battery or waits for the next mission. This type of solution is a technology that allows drones to move and return from self-contained landing boxes. When the drone is supposed to take off, the roof opens and the drone can take off. This solution typically contains a box containing the drone, a charging solution for the drone, communication tools, and a control unit. Many different companies have developed their solutions in this category, both regarding the charging solution but also the design of the box.

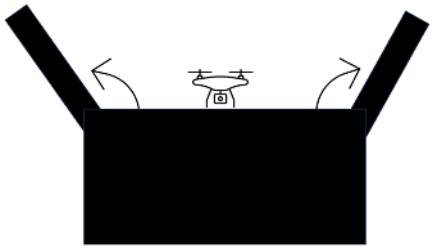

Figure 14: General illustration of a LSS in category 3

.

Table 4. Companies in Category 3.

Company	Drone provider and/or LSS	Country	Name for solution	Battery solution	Hangar/ nest?	Cost and size (L x W x H)	Weight
Percepto	Drone provider/LSS	Israel / US	Percepto Air Max	Charging	Yes	4500 x 4500 mm	350 kg
Dronehub	Drone provider/LSS	Poland	Dronehub docking station	Battery swapping	Yes	5000 x 5000 mm	
Beagle	Drone provider/LSS	Germany	Baegle Hangar	Charging	Yes		
Skycharge	LSS	Germany	Drone box hangar - DP5	Charging	Yes	702 x 753 x 1071 mm	150 kg
H3Dynamics	LSS	France/US/Singapore	DBX-G7	Charging	Yes	2780 x 1960 x 1420 mm	450 kg
Volatus Aerospace	LSS	UK	AERIEPORT DRONE NESTING STATION	Charging	Yes		
Encata	LSS	US/Georgia/Estonia	Autonomous drone station	Charging	Yes		
Icaros	Drone provider/LSS	US	Easy Guard	Charging	Yes	1170 x 1170 x 620 mm	90 kg
Heighttechnologies	Drone provider/ LSS	Netherlands	Raptor SAMS-H	Charging while flying (Hybrid)	Yes		
Tective	Drone provider/ LSS	Netherlands	Skyhive	Swapping	Yes		
DJI	Drone provider/ LSS	US	DJI Dock	Charging	Yes	1000 x 1000 mm	105 kg
Airscort	LSS	Israel	Flyt mini docking station	Swapping	Yes	2040 x 770 mm	87,3 kg
Sensyn Robotics	LSS	Japan	Sensyn drone hub	Charging	Yes	1890 x 1770 x 800 mm	149 kg

Asylonrobotics	LSS	US	The drone sentry	Battery swapping	Yes		
Azur drones	Drone provider/LSS	France	Skeyetech connected base	Charging	Yes		
Drone Matrix	Drone provider/LSS	Belgium	Yacob	Charging	Yes		
Skydio	Drone provider/LSS	US	Skydio dock			600 x 600 mm	28 kg
Heisha	LSS	China	Heisha D50 drone in a box	Charging	Yes	916 ×700 × 685	55 kg
Heisha	LSS	China	Heisha D80 drone in a box	Charging	Yes	1067 x 890 x 515 mm	75 kg
Heisha	LSS	China	Heisha D135 drone in a box	Charging	Yes	1645x1290x1575	275 kg
Hextronic	LSS	US	The Atlas	Battery swapping	Yes	1400 x 1100 x 1000 mm	180 kg
Dpendent	LSS	Switzerland	D-log One	Battery swapping	No		
Horstkemper	LSS	Germany	Skyport drone hangar	Charging	Yes		
Dronus	Drone provider/LSS	Italy	Nest 250	Charging	Yes		
WIPO	LSS	South Africa	Wiport	Charging	Yes		
Atlasuas	Drone provider/LSS	Latvia	Atlasnest	Battery swapping	Yes	2500 x 1100 x 520 mm	75 kg
Idiployer	LSS	UK	Nexus	Charging	Yes		
Hexatronic	LSS	US	The Universal	Battery swapping	Yes		40 kg
Foxit	LSS	South Africa	FoxIT Response Unit		Yes	940 × 1000 × 1200 mm	112 kg

Strix drones	Drone provider/LSS	US / Israel	Strix 1600	Charging	Yes	1700 x 1700 x 1700 mm	
Strix drones	Drone provider/LSS	US / Israel	Strix 2100	Charging	Yes	2463 x 2270 x 1937 mm	
Sunflower labs	Drone provider/LSS	Switzerland	Beehive	Charging	Yes	980 x 800 x 630 mm	35 kg
Drone Base	Drone provider/LSS	Italy	DBASE	Charging	Yes	1037 x 800 x 898 mm	52 kg
Nando	Drone provider/LSS	Israel	Docking station	Charging	Yes	1650 x 2400 x 2300 mm	

3.1.4 Category 4 - Cargo Hub

The solutions within category four include a raised landing platform, a stock system for load handling, and the possibility of charging or swapping drone batteries. This category is similar to category three in that some solutions in category four provide the drone-in-a-box solution. However, all solutions in Category four contain a built-in loading system. The solutions can work as a central hub where drones can land, receive, or drop off packages and then continue to fly to the next destination.

This solution is suitable for various use cases such as transporting medical equipment between hospitals or in e-commerce, where the landing spots are strategically placed for people to claim their packages.

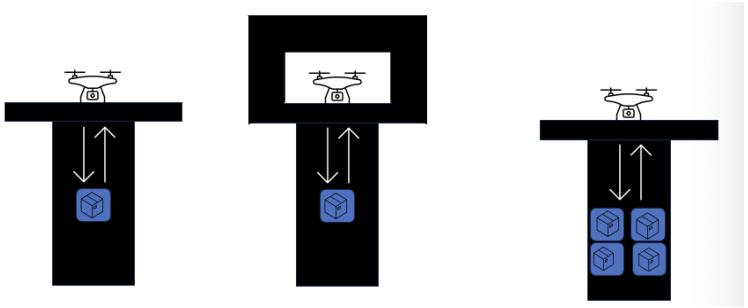

Figure 15: General illustration of the three different LSS in category 4

Table 5. Companies in Category 4.

Company	Drone provider and/or LSS	Country	Name for solution	Battery solution	Hangar/ nest?	Cost and size (L x W x H)	Weight
Zipline	Drone provider/LSS	US	Landing dock	Charging	No		
Antwork	Drone provider/LSS	China	Antwork RH1	Battery swapping	Yes		
Matternet	Drone provider/LSS	US	Matternet station	Battery swapping	Yes		
Valqari	Landing site provider	US	Landing station		Yes		
Dronehub	Drone provider/LSS	Poland	Cargo Hub	Battery swapping			
Gadfin	Drone provider/LSS	Israel	Automated Ground Station	Battery swapping	No		
EVA	Drone provider/LSS	Germany	Multimodal transfer station	Battery swapping	Yes		
Dronedek	Landing site provider	US	Dronedek		No		
Heisha	LSS	China	Heisha R80 Robot charging station	Charging	Yes		

3.1.5 Category 5 - Droneport

Droneports can act as a distribution center for drone delivery services and serve as a base for logistics. The solutions in this category can be seen as an airport for drones, but the concepts of these solutions are still in the early stages and evolving. This type of solution requires the most land area of all the solutions that are presented. They include autonomous landing stations with necessary landing infrastructure, charging technology, and payload exchange.

Table 6. Companies in Category 5.

Company	Drone provider and/or LSS	Country	Name for solution	Battery solution	Hangar/ nest?	Cost and size (L x W x H)	Weight
Swoop Aero	Drone provider/LSS	Australia	Aviary	Charging	Yes		
EVA Labs	Drone provider/LSS	Germany	Hyper station	Battery swapping	Yes		
Urban Air-port	Landing site provider		City Box XS			16 x 16 m (scalable)	
Urban Air-Port	Landing site provider		City Box XXS			8 x 8 m (scalable)	

3.1.6 Category 6 - Agile Cargo

The landing site solutions in the sixth category do not require a landing site at the delivery point since the drones in this category all wire down or drop the cargo. The drones have their landing site at their base and have the ability to deliver cargo free of obstruction.

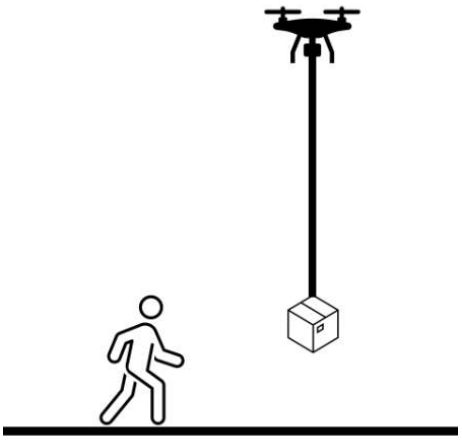

Figure 16: General illustration of agile cargo drone in category 6.

Table 7. Companies in Category 6.

Company	Drone provider and/or LSS	Country	Name for solution	Battery solution	Hangar /nest?	Cost and size (L x W x H)	Weight
WING	Drone provider/landing site solution	US		Charging	No		
Skydrop	Drone provider (CARGO)	US					
Zipline	Drone provider/landing site solution	US	Landing dock	Charging	No		
Skyways	Drone provider (CARGO)	US		Charging			
Volocopter	Drone provider (CARGO)	US		Charging	No		
Drone delivery Canada	Drone provider (CARGO)	Canada		Charging			
Aerit	Drone provider (CARGO)	Sweden					
Flytrex	Drone provider (CARGO)	US					

3.2 Matching Landing Site Solutions with Attractive and Feasible Use Cases

As presented in the chapter above, the project in work package 1 has identified two major urban air mobility themes through workshops that CITAM assesses to be the most feasible and attractive use cases in the Baltic Sea Region. The use cases identified as the most feasible and attractive are data collection and visualization and also medical and emergency operations.

For the theme data collection and visualization, the use cases would usually include an A-A flight route where the drones can act and collect data autonomously. This implies that only one landing site is required to function as a start and return site after the drone has flown its route. According to the identified categories for available landing site solutions, the most suitable solution would be companies within category three, drone in a box. This solution typically includes a box containing the drone, a charging solution, communication tools, and a control unit. Using a drone-in-a-box solution can therefore create an autonomous and efficient use case for different types of data collection. When choosing a location for this solution the options increase since the sizes for the boxes are quite small and are surface

effective. Many of the companies offer solutions that are between the smallest 0,7 m to the widest 2,5 m. Using a drone in a box solution implies that the location can either be on the ground or even on a rooftop. Landing sites within category three would also require less infrastructure and support systems to establish since most of the support systems are included in the box.

For the theme of medical and emergency operations, including various use cases described in the chapter above, landing sites within categories three, four, and five could be suitable for these types of use cases. The suitability depends on the purpose and the extent of the use case. For drone operations that require some type of emergency where the drone is supposed to fly out for a mission (A-N route) a landing site within category three or five would be suitable. In this way, the landing site can act as a start and landing site while it's waiting for its next mission. These landing sites can therefore be a drone in a box if the operation requires a smaller drone or a drone port if bigger drones are needed.

The solutions categorized as four and five could also be the most suitable for upscaled drone operations in the future where different drone operators could use the same landing site, such as a drone port or a raised landing platform. This might be feasible further ahead when urban air mobility and the use of drones are more tested and accepted. These solutions can then be used as a joint landing site for different drone operators and serve as a base for logistics with the possibility of charging. A city could provide the drone market with these types of landing sites on public land or city-owned properties. These solutions are also the landing sites that require the biggest land area because of their big design and the infrastructure they require. Therefore these landing sites should be seen as more permanent solutions.

3.3 Requirements for Procurement of Landing Site and Drone Operator

Within the project, the leading cities are led by different organizations and have identified different types of use cases. This implies that the procurement processes and the need for procurements look different in each city.

The city of **Stockholm** has not procured the drone operator and landing site solution themselves because of how the partnerships are structured. For the use case with defibrillators, the procurer is Karolinska Institute, because they are the need owners of the project. Stockholm's other use case for drone as a service is Kista Science City responsible for procurement with help from an experienced consultant.

In **Helsinki**, it is Forum Virium that procures the drone operator and landing site solutions themselves, for both of their use cases. This means overall that it is the procured drone operator that is a registered and licensed operator for the use cases in both Stockholm and Helsinki.

Hamburg, however, does not have to procure a drone operator or landing site solution since the HPA (Hamburg Port Authority) owns drones and is a licensed drone operator within the organization. Within the project, the HPA is responsible for flight operations and setting up the ground infrastructure while Hamburg Aviation is responsible for the area of "acceptance of drones" with all the different activities.

As the HPA has drones that are customized for various applications and also employs its operators, a lot of money is saved initially as no additional drones need to be procured for the project. As an authority, the HPA enjoys slightly different rights, which makes it easier to obtain authorization from the aviation authority. The HPA takes a slightly different approach to the use of drones. While Stockholm and Helsinki commission an operator with appropriate drones from the private sector for drone flights, the Port of Hamburg Authority itself owns a fleet of drones and a DronePort from which the aircraft can be flown. Hamburg Port Authority's requirements that were used when buying their drones are presented in the tables below.

Because of the different authorities/organizations participating in the project, it's proven that use cases and responsibilities can look very different, and therefore the possibilities of using urban air mobility increase. Unfortunately, the procurement documents were not ready for Stockholm and Helsinki use cases before the report was due. However, we have gathered general requirements for drone operators and landing sites with help from our respective drone experienced consultants that are being presented in this chapter instead of individual requirements. The general requirements can still be used as guidance for cities to use or consider in procurement documents if procurement of drone operators and landing sites is needed. They can also be helpful as guidance if purchase of own drones to a municipality is relevant.

Requirements from Hamburg

Special requirements for drones
EU standard certification of drones, control center and software
EU standard certification of drones, control center and software
Transponder (ADSB) (optionally also FLARM and/or Mode S)
Maximum possible safety in terms of ground risk and air risk
Automation of the process chain for creating and flying a flight route

Special requirements for landing site solution
Size of the landing pad suitable for all drone sizes
Landing pad lighting
Central location
Site already in the HPA's area if possible
Storage and office capacity available or possible to create
Good network coverage

Requirements from Helsinki

Flights	Ground operations	Logistics specs	Logistics applications
Mission characteristics	Charging / safety at landing sites	Maximum size drone	Shipment ordering
Maps 3D model with the prototype mission	Drone hangar location	Maximum weight	Shipment reception
SORA calculation baseline	Access to supporting infra at the landing site location	Frequency of shipments	Insurance and liability
Population density information		Other requirements (temperature control, vibration etc.)	
Airspace / air risk mitigation information			
Special considerations			

Environmental preparedness	Command and control	Other requirements
Weather considerations	Permit to use mobile network in the air	Drone inspection
Wind limits		Drone recharging
Precipitation		Drone storage
Temperature		Cargo handling
		Order management

General requirements from Stockholm

General requirements	Comments
Legislation and regulations	Ensure that the drones and their use comply with applicable laws, ensure applicable certifications are mentioned in the procurement and that the operator is registered with the Transport Agency
Safety and risk management	Include drones with high safety standards and reliable risk assessments to secure operations in urban and high-risk environments
Technical capabilities	Choose drones with appropriate technical specifications for detailed data collection and mapping, such as high-resolution cameras and stability in different video conditions
Ease of use and training	Prioritize drones that are easy to use and maintain, and ensure access to adequate training for remote pilots
Privacy and Data protection	Ensure that the use of drones does not require personal privacy and that data handling meets GDPR requirements

Cost effectiveness	Analyze total cost including purchase, maintenance and potential cost savings in various municipal areas
Insurance and liability issues	Ensure that appropriate insurance is in place to cover potential risks and damages when using drones
Supplier competence and experience	Choose suppliers with proven industry experience, including documented reference assignments and certifications
Procedures and Manuals	Determine that the drones support the development of operational procedures and manuals for safe and effective use

During the consortium meeting in Hamburg 2023-12-04 - 2023-12-06 there was a workshop held about how each leading city should document learning experiences during the pilots in 2024. The workshop resulted in a list of KPIs, developed by all the project partners, that the leading cities have committed to document during the pilots so that it can be measured and evaluated in 2025. The workshop was an open discussion where all the project partners contributed with thoughts on the KPIs. The list is presented below.

- Average flight times:
- Type of drone (technical characteristics such as fixed-wing, weight):
- Max. altitude (measured from ground level)
- Max. speed:
- Number of flights planned:
- Number of flights completed:
- Number of incidents reported:
- What kind of incident may have occurred (i.e. landed next to landing sites):
- Technical failures/need for maintenance:
- Average distance:
- What routes (type of route A-B):
- Type of flight: BVLOS….
- Delays, and cancellation of flights:
- Drone take-off place and drone landing place:
- Weather conditions during the flight:
- Average costs of flight per hour:
- Weight of cargo (if applicable):
- Use case-specific KPIs:

3.4 Map of Each Leading City

Together with the project partners Aalto University and Finnish Geospatial Research Institute, maps over the three leading cities have been developed and will be presented in this part below. The maps aim to give an overview of city-owned land and properties that could be suitable as landing site locations. This part will also present a first analysis of potential landing sites based on technical requirements of landing site providers, but during 2024 the project will be piloting the developed GIS landing site tool which can be read more about in the deliverable report of activity 1.4. The pilot of the GIS tool will result in a more accurate analysis of the potential landing sites.

The maps of Stockholm and Hamburg illustrate city-owned properties, however, it was difficult for the city of Helsinki to obtain the data due to legal restrictions on publishing property ownership. Therefore the map of Helsinki will illustrate city-owned streets and green areas. Other factors that need to be considered when doing drone operations and choosing landing site locations are also illustrated in the maps such as restricted and prohibited areas and heliports. We also want to point out that each drone operation requires an individual investigation of the landing site location since the suitability of location can differ depending on the mission of the operation.

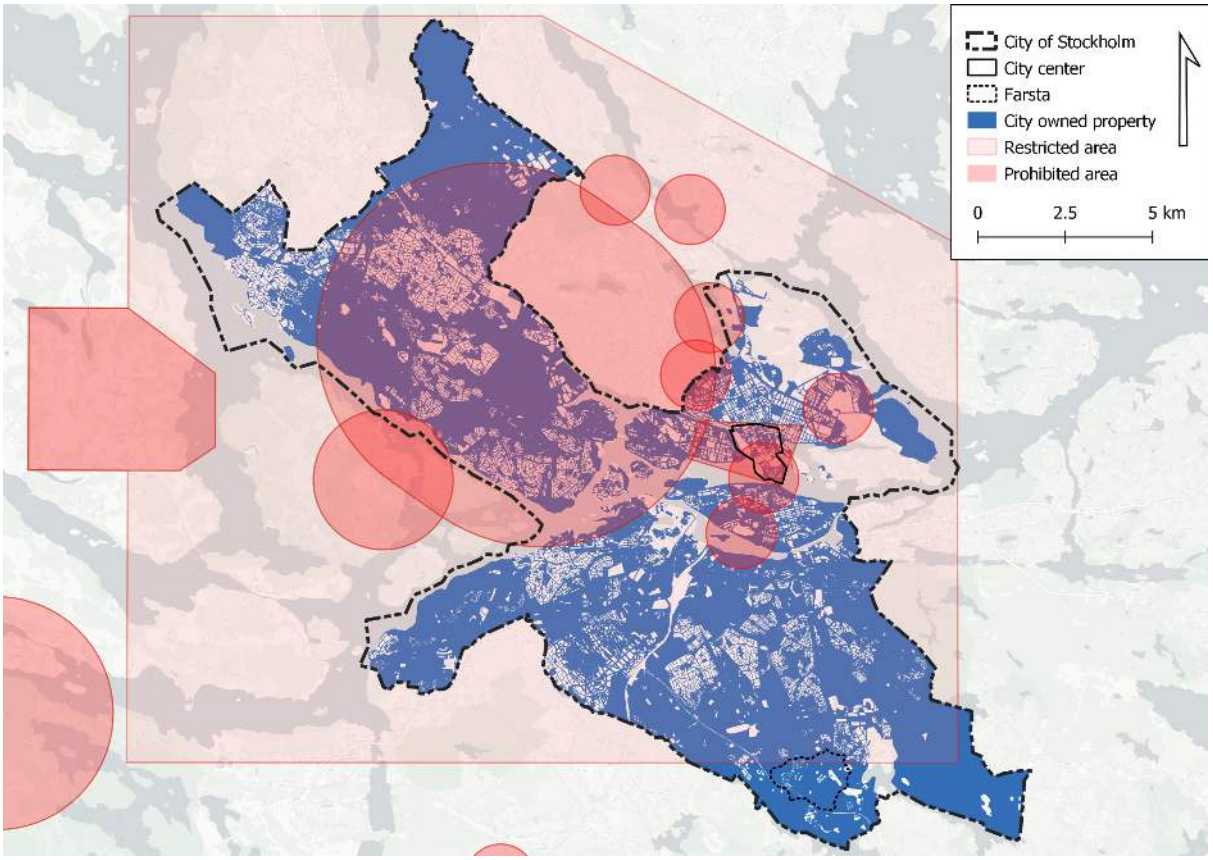

Figure 17. Map over Stockholm

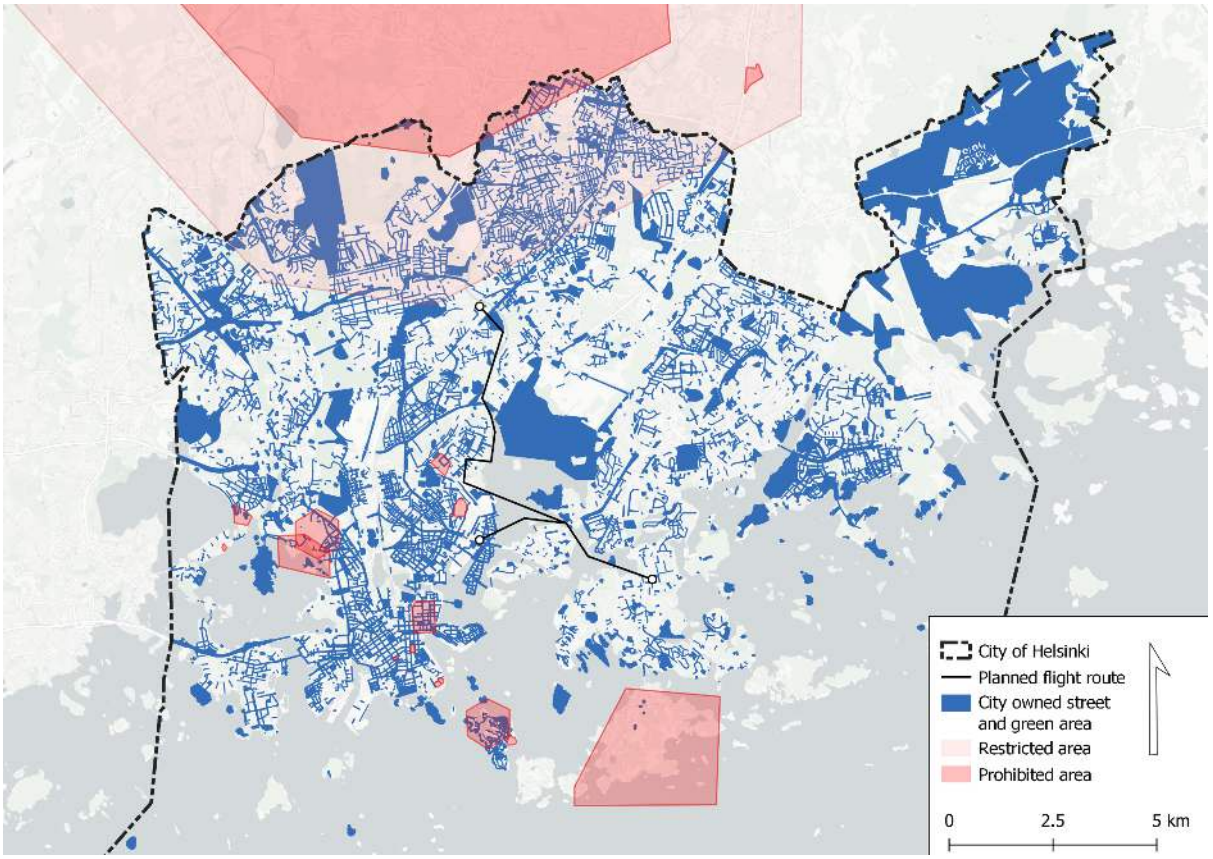

Figure 18. Map over Helsinki

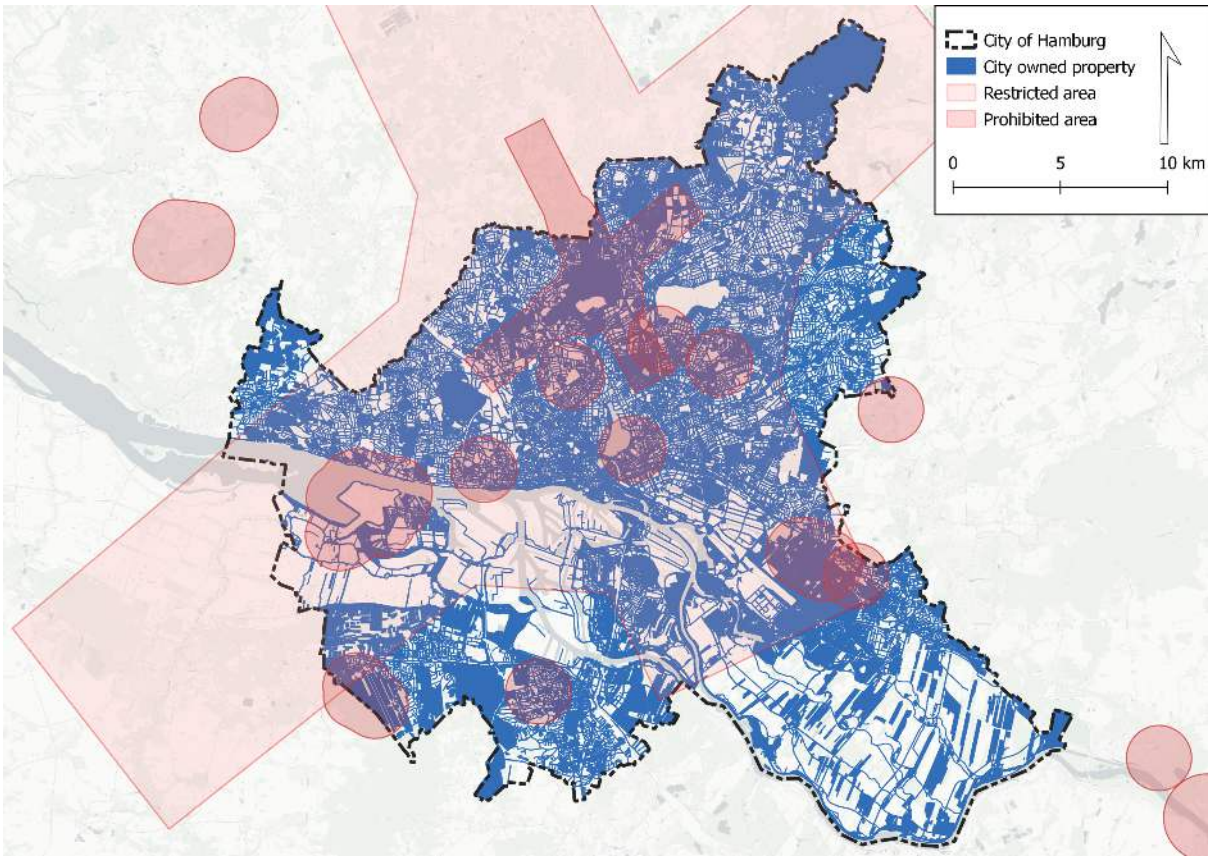

Figure 19. Map over Hamburg

The blue-marked areas in the Stockholm and Hamburg maps illustrate all city-owned land and properties in respective municipalities. It illustrates both public land and streets but also private land and properties owned and managed by the municipality. Within the municipality, it is different departments that own and manage the different land types. In Stockholm municipality for example, it is the Transport Department that owns and manages public land, private land is owned and managed by the City Development Department and city-owned properties are managed by the Real Estate Department. As the maps illustrate, there are a lot of areas owned by the city that could be suitable for landing sites. In Helsinki, there are also a few public green areas that could be suitable as a location for landing sites. But the restricted and prohibited areas affect the choice of location. The CITYAM landing site planning tool, which will be tested in 2024, will help narrow down possible or optimal locations.

The largest prohibited area illustrated in the Stockholm map shows the area of 5 kilometers around Bromma airport. There are also smaller prohibited areas around the city area that are heliports of the different hospitals in Stockholm. The northern part of Helsinki is included in a restricted area due to the airport of Helsinki. Otherwise, the rest of Helsinki is pretty spared from restricted areas compared to Stockholm. Hamburg also has an airport located centrally in the city, which affects the possibility of getting permits for flying and having a landing site within these areas because of its restricted and prohibited areas. To be able to fly within a prohibited area the drone operator must have permission from the aviation authority/transport agency. In restricted areas, however, drones are allowed to fly up to 50 m altitude without permission. Therefore, the landing sites should be located outside of the prohibited areas.

Since the city areas of the leading cities are densely built and populated, a solution within category one or three (basic landing solution and drone in a box) according to the available landing site solutions would be the most suitable to establish around that area. These solutions are surface effective and could be located at a city-owned building on the rooftop or within a property. Solutions within category four or five (cargo hub and droneport) would be more suitable in the outer city areas since they require a larger ground surface because of their higher and bigger design and construction.

4. Permit Applications

This part of the report presents an overview of permit applications that the project has been learning from developing use cases and inputs from each Aviation Authorities. The chapter will present a summary of identified different permits that are often needed for flying drones and for establishing a landing site. This chapter also describes the permit application processes including the various roles in the processes depending on who's responsible for the applications.

4.1 Flight Permits

Flight permits are issued by the Civil Aviation Authority or the National Transport Agency of a country, based on EASA regulations and a thorough assessment of ground risks and air risks. The European Aviation Safety Agency (EASA) has developed a set of regulations for drone operations and it divides the operations into different categories based on the risk level. The regulations developed by EASA are common and apply to all European countries. The regulatory framework requires that all operators of drones have to be registered and that the remote pilots need to pass training for flying drones. This implies that municipalities can register as operators themselves if the organization has its drones.

The training of remote pilots must be carried out at an entity designated or recognized by the competent authority. The permits are applied to the national transport agency or aviation authority. The categories developed by EASA are presented in the image and description below.

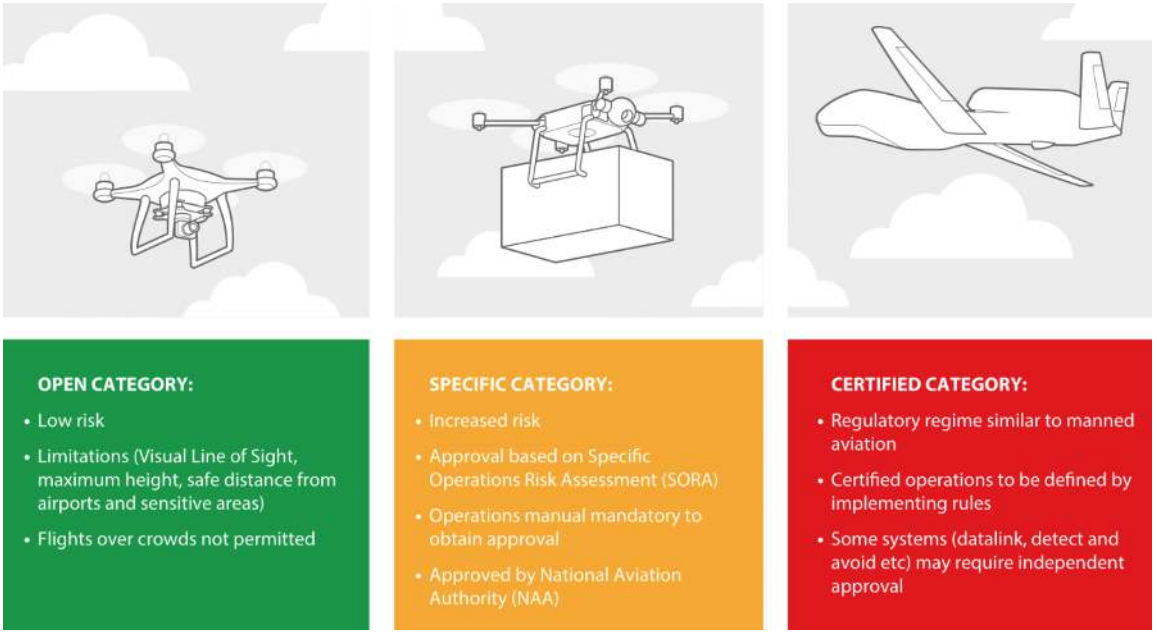

Figure 20: Drone categories, source: EASA.

4.1.1 Open Category

This category is assessed to have the lowest risks. The drone operator does not need a permit from the transport agency/national aviation authority if the drone:

- Does not weigh over 7 kg
- Fly within the vision of line sight
- Fly maximum 120 m over ground without obstacles
- Does not fly over public gatherings

4.1.2 Certified Category

This category implies flights with high risks and demands both certification and registration of the drone. If the cases presented below are fulfilled, a permit within the certified category is needed:

- Flying implies transport of people/persons
- Flying implies the transportation of dangerous goods that can imply a high risk for people if an accident occur
- The drone is 3 meters or more and shall fly over people's gatherings

4.1.3 Specific Category

Within the Specific category there are three different types of permits, depending on the operation:

1. PDRA (Pre-Defined Risk Assessment)
2. SORA (Specific Operations Risk Assessment)
3. LUC (Light UAS Operator Certificate)

For the CITYAM use cases, the drone operations will most likely be assessed to be in the specific category. For example, requirements for the specific category can be flying beyond the vision of line sight, higher than 120 m over ground, or above people gatherings. The specific category is also applicable when an operation needs to use drones heavier than 25 kilos.

Pre-Defined Risk Assessment

For commonly occurring activities within a drone operation with low risk, the category PDRA (Pre-Defined Risk Assessment) can be applicable. PDRA means applying simplified rules in the form of standard scenarios, developed by EASA. There are four generic, predefined scenarios currently that have different established requirements that need to be fulfilled for flying a type of operation. PDRA's include risk analyses of recurring drone applications. Using PDRA makes the permit application for the drone operator easier. Even if PDRA is used, a regular operative permit is needed as well.

The existing four PDRA are listed below (and several more are in the making) but for more information about the requirements we refer to EASAs website or the Civil Aviation Authority of your country:

- PDRA S-01 – Agricultural works, short-range cargo ops

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

Specific Operations Risk Assessment

Other operations and flights that do not have a predefined scenario need a complete risk analysis for the application. The analysis has to be done according to the SORA methodology (Specific Operations Risk Assessment). The SORA analysis decides in which type of risk level the operation should be in. The information that needs to be included in the SORA analysis is:

- Operation description of the flying
- Route area
- Airspace
- Operational limitations
- Type of drone
- Organization and competence

Within the SORA model, the analysis investigates ground risk and air risk. The model assesses the risk to people on the ground based on the specific operation and it also looks at the risk to other aircrafts in the airspace. Potential risks are assessed for the entire drone operation, route and landing. The risk level might differ between the different phases of the flight operation. Therefore, mitigations for each phase of the flight operation are required and should be planned accordingly by the drone operator.

Light UAS Operator Certificate

The third type of permit within the specific category is LUC (Light UAS Operator Certificate). This permit is given to an organization or a company with special privileges. The privileges can be to fly according to PDRA without applying for a permit at the transport agency. To get this permit the organization needs to develop a safety management system that presents the organization's competence to implement risk analyses and decide if the flying can be implemented safely.

Remote Identification

A noteworthy update about the specific category is that the remote identification of drones becomes obligatory from 1 January 2024 onwards. All drones falling under the specific category in EASA member states will soon be required to operate through an active and updated remote identification system. The drone operator will be required to upload to the remote identification system the UAS (Unmanned Aircraft System) operator registration number received during the registration process. In case the operator owns multiple drones, the same UAS registration number must be uploaded to all drones. EU states may identify geographical zones where the remote ID is not obligatory. Citizens may detect the remote identification information through a dedicated application on their smartphones. However, only the enforcement authorities will be able to interrogate the database and associate the UAS operator registration number with a name.

4.1.4 Estimated Timeline for Flight Permit Applications

Sweden - Through several workshops and meetings with the Aviation Authority, their input is that a flight permit application can take up to 6 months before an approved permit. Therefore it is important to plan when to apply for the flight permits in good time before the estimated time for flying. The application process can be shorter if the application is complete and includes all the documents and information the transport agency requires. If it is a bigger operation with bigger drones there is probably more for the transport agency to assess, so if the planned operation is smaller with a smaller drone the application process will probably be shorter.

Finland - The indicated processing time for a custom flight permit application (SORA in particular) to the Finnish Civil Aviation Authority (Traficom) is currently around four to five months. Nevertheless, the processing time might get shortened depending on the designated inspector's workload, or prolonged if there is incomplete or unclear information in the application. Cross-border applications are typically handled within a few weeks. In any case, though, the flight permit application should be filled in cautiously and submitted on time. This is done by the drone operator.

Germany - Through several workshops and meetings with the Aviation Authority, their input is that a flight permit application can take up to 6 months before an approved permit. Therefore it is important to plan when to apply for the flight permits in good time before the estimated time for flying. The application process can be shorter if the application is complete and includes all the documents and information the transport agency requires. If it's a bigger operation with bigger drones there is more information for the transport agency to assess, so if the planned operation is smaller with a smaller drone the process will likely be shorter.
In Hamburg, anyone wishing to fly a drone outside the open class must undergo the national approval procedure. As a rule, this is done by the drone operator. The operator must look at which flight bans could impact the planned flight route and justify in this procedure why you would still fly and what you have done to minimize the risk in the air and on the ground.

4.2 Permits Related to Landing sites

This section describes the permits that the three leading cities have identified for landing sites. It aims to contribute with input on what type of permits that can be needed for a landing site. We do want to address that these types of permits can differ depending on national and local regulations and laws. It is also good to note that municipalities may need to adapt their permit forms, permit processes, or criteria to make them suitable for this new category of transport. The differences and similarities between the leading cities about current permits are also described below.

As the city of **Stockholm** itself is a project partner in CITYAM, the project leaders have been able to investigate the permits needed internally at the municipality. The project leaders of Stockholm do also have a lot of knowledge in different licensing of permits in the city that have been helpful in the process. In addition to a similar internal investigation, the project leaders of **Helsinki** have also organized and facilitated workshops with different departments

of the municipality, as well as other relevant stakeholders (such as the police) on drone-related local permits. **Hamburg** is a unique case when it comes to permitting since Hamburg is a city-state. It is therefore on an equal footing with other federal states (such as Bavaria or Lower Saxony). For this reason, there are only state authorities and no municipal offices and rules that play a role in our project. When acquiring a building permit to construct buildings at the landing site such as a control center or a landing pad, then of course it is necessary to obtain the proper building permits. In Germany, a building permit is required for a structure larger than 1m². In the Hamburg use cases, the HPA commissioned an engineering firm to acquire the permits via the HPA's building inspection department.

It is important to investigate where the landing site should be placed depending on the type of drone operation. Since the landing site often needs to include some sort of control zone for the drone when it leaves the landing site, usually the location should have free space around it with no access for citizens.

Factors to consider when planning a landing site:

1. In what geographic zone is it the most suitable to have the landing site according to the flight route?
2. What type of surface (ground, roof?)
3. What type of land/real estate - public, private?

The investigation of the location for the landing site can be discussed internally with different relevant departments if the municipality itself or one of its subsidiaries is doing the drone operation. For example departments like the traffic department, building department, urban planning department, environmental department, or facility department. For more information on planning the landing sites and the selection tool that is being developed in the CITYAM project, please see Deliverable 1.4 (insert link).

It is important to note that more permits might be needed from various entities in the future. These permits are not listed in this report as there is currently an ongoing process of applying for no-fly zones or restriction areas to the Civil Aviation Authorities. In Finland for instance, a large number (and a variety) of organizations have already applied for establishing a restriction or no-fly zone over their premises. The number of applications received by the Civil Aviation Authority this year has tremendously increased by around 70% compared to the previous year. Especially in the case of restrictive UAS (Unmanned Aircraft System) geo zones, it should be mentioned that they are under specific conditions worthy to be taken into consideration. Some of them give authority to the UAS geo zones owner to approve/reject a potential drone flight over the premises (e.g. Defence Forces, Border Guard). When such a restriction zone is established, it automatically implies that (either the zone should be circumvented or) a permission request to fly over the established zone needs to be submitted in some cases to the related (public or private) entity.

4.2.1 Building and Excavation Permits

Stockholm

A typical permit that is required in Sweden for almost every built thing is a building permit from the building department at the municipalities, according to the Planning and Building Act. This also applies to drone ports, vertipads, or other landing infrastructure. You send in

the application to the building department and the application should usually include information and documents such as:

- Drawings on the landing site that present measurements, location, and address.
- Illustrated drawing/picture of the landing site
- Documents that describe the drone operation

The application process takes up to 10 weeks to get approval for the permit. More detailed information about how this process looks can usually be found on each municipality's website. The application normally requires clear and quality-assured drawings and documents. A building permit is required regardless of the different types of land or property. The permit can be given as a permanent or temporary depending on the operation.

If the landing site services and support system require excavation in public ground, a permit for the digging is required from the traffic office. This permit is applied directly to the traffic office usually and has an administration time between 5-15 days. In relation to the excavation permit, there can be a need for a traffic arrangement plan permit if the excavation work affects the accessibility for pedestrians, cyclists, or vehicle traffic. The traffic arrangement plan must report and illustrate how the affected road user is to be redirected during the excavation work. The traffic arrangement plan is a different permit from the excavation permit but is often applied to the same unit at the traffic department.

Helsinki

A permit from the building control department of Helsinki City is required when there is the intention to build a base (launch and landing site) for the drone. The permit issued by the city might be temporary or valid for a longer period. The approval or rejection of the permit application relies entirely on the planned operations and location. The necessity for such a permit is dependent on whether the drone infrastructure (on the roof or the ground) needs any measures to be taken by the Building Control Services. If a permit for the building is considered to be necessary, the property or land owner is required to submit the respective permit application and hire external designers for this task. The duration of the permit process depends highly on the given information regarding the operation and more specifically, whether this information is sufficient or not.

The following considerations related to the respective permit should be taken into account when planning drone landing infrastructure in Helsinki. These considerations affect how essential it is to apply or not for a permit for building in the City of Helsinki.

- Consider whether it is a city- or privately owned land, where there is an intention to build / mine/excavate. Permission from the city and its Building Control Services is essential in the case of a city-owned area. A rental agreement for the land might be additionally required in this case by the Area Use Control department of the City. In the opposite case of a privately owned area, an agreement should be initially made with the property owner of the land. This sort of agreement is required for using the land and being engaged in related activities, such as building, mining, and excavating.
- In case there is a building on the grounds of the landing site, there is a need to figure out who is the owner of the existing building. In case the owner is the city itself or one of its

subsidiaries, permission from the city is also viewed as essential. Furthermore, another permission from the city is needed when the drone operation or even the maintenance of the drone(s) results in making changes to existing buildings.

- Consider whether the landing site solution in mind will be temporarily built or not. In case there is an intention to install a permanent landing site solution for the drone, permission by the city's Spatial Planning Unit might also be necessary. In this way, it is checked whether the ground intended for the landing site is involved or not in Helsinki's land use plan. A rental agreement for the land might also be required by the Area Use Control department of the City.
- With relation to drone landing sites and charging points on a property's roof, the durability of structures should be considered. Therefore, the property owner holds the responsibility to apply to the Building Control Services for the necessary permit regarding changes on the rooftop.
- Consider whether or not the planned building / mining / excavation activities require temporary traffic arrangements. If so, an additional permit from the respective city department is required for these arrangements.
- Define who is going to build the landing site solution for the drone operations and whether a tendering process needs to be also planned and activated. This particular piece of information is relevant for filling in the relevant city permit applications as well.

Hamburg

As the buildings and the landing pad are larger structures, a building application must be submitted to the municipal building authorities. The Hamburg Port Authority itself is responsible for the building application. As a landing pad is an aeronautical structure, the state aviation authority must also be involved in the process. Upon inquiry, however, the state aviation authority denied the application and did not need to be involved after all.

The assessment is that this authorization procedure can take up to 3-6 months. The permit approval depends on how complete the application is and how quickly the applicant can get all the required documents and certifications from the drone manufacturer.

As the buildings and the landing area are major structures, a building application must be submitted to the municipal building authority. The Hamburg Port Authority itself is responsible for the building application. As a landing site is an aeronautical structure, the State Aviation Authority must also be involved in the process. However, when asked, the state aviation authority rejected the application and did not need to be involved at all. The necessary planning permission has now been granted and the containerized facility around the DronePORT is in place.

Conclusion

The conclusion from the part above is that in all three leading cities, it is required with some type of building permit from the city for using a land surface. It also concludes that constructing a landing site would require an excavation permit, also from the city if digging in public space. However, the national laws and policies can differ from country to country and it is therefore important to investigate the permits and what applies to the current planning drone operation.

4.2.2 Environmental and Noise Permits

Stockholm

The current assessment from the environment department at the City of Stockholm is that there is no need for any specific permits from the environment department for drone operations. Specifically, a permit for noise disturbances has been assessed to not be needed in these particular use cases. If the operations would give rise to complaints it may be subject to supervision.

Helsinki

In general, an environmental permit is required by the city of Helsinki for industrial or similar operations that potentially cause environmental pollution or irreparable environmental harm. Potential noise impact is considered as well in this sort of permit. About drone operations particularly, an environmental permit is required in the case of the construction of larger vertiports, designed for passenger drones (eVTOLs). For now, small drone pads or drone-in-a-box solutions do not automatically require an environmental permit. This may change in the future, depending on the number of such drone pads that will appear, the number of complaints received by the city, research results on environmental effects, or other, yet unknown, factors.

Thus, drone flight operations per se do not automatically require environmental permits from the city. However, there might be a few determinants (e.g. scope/duration of drone operations, number and frequency of drones, and decibels that they emit) that might affect the necessity of applying for an environmental permit in the City of Helsinki. As there are currently no drones in large numbers or frequencies, such a particular permit dealing with drones has not yet been provided or needed.

When the application for the permit becomes an absolute necessity, the process duration is strongly related to how cautiously the application has been made. The process can generally last from a few weeks up to several months depending on whether the information on the scope and importance of the operations is reflected in the application or not. The more thorough information is provided in the application, the faster the process becomes. As environmental permits (including noise aspects) about drones, their landing sites, as well as flight operations, are so new, processes may take longer than usual. Municipalities may at some point need to adapt their permit forms, permit process, or criteria to make them suitable for this new category of transport.

Hamburg

The current assessment from the environment department in the city is that there is no need for any specific permits from the environment department for drone operations. Specifically, a permit for noise disturbances has been assessed to not be needed in these particular use cases. If the operations would give rise to complaints it may be subject to supervision.

The upper and lower environmental authorities only come into play when we fly over a nature reserve, landscape conservation area, or national park. Then it's about the impact on birdlife (especially ground-nesting birds) that might mistake a drone for a predator. These

effects are currently the subject of much controversy. An expert report is currently being prepared. But it is not yet clear when the results will be available.

Noise is about how many dBA reach the citizen. The permitted value varies. Depending on whether you are flying in a residential, commercial, or industrial area. By using different types of drones, flight altitudes, speeds and special propellers, the operator can directly influence the noise on the ground.

Conclusion

The conclusion about environmental and noise disturbance permits is that there are no permits directly related to drone operations in place. However, there have been indications that the environmental departments are looking into the consequences of drone operations and are monitoring the issue.

In Helsinki, there is a general environmental permit that can be required in cases of constructing larger vertiports, designated for passenger drones. Potential noise impact is considered in the permit. Currently, there are no requirements for this permit for smaller drone pads or drone-in-a-box solutions. But we do want to address that this may change in the future as the drone business increases. In Hamburg, an environmental permit can be required when flying over a nature reserve, landscape conservation area, or national park. But no noise permit is known. Since Stockholm has got the assessment that there is no need for an environmental or noise permit this differs from the countries.

4.2.3 Police Related Permits

Stockholm

In Sweden, there is a national law that regulates the use of public space. According to the law, you need a police permit if you want to use public space. If the landing site is aimed to be located on public space/ground, this police permit according to the law of using public space can be required. This permit is applied to the police department and according to the law, the city shall always be asked in the process, which the police does. This permit process can take up to 2-4 weeks for the permit to be approved.

Helsinki

In case there is an intention to promote the drone operation as a public event, a separate permit is required from the Helsinki Police Department. It is worth mentioning that not all events require this specific permit. This applies mostly to large events that require the presence of security guards and special traffic arrangements to be made. It also applies to events expected to evoke a strong response from the general public, which might be relevant for certain drone operations.

Closely related to the traffic arrangements that could be potentially made as part of a drone operation, the Helsinki Police Department requires an additional permit. This permit refers especially to temporarily closing a road due to the planned drone operation.

Hamburg

For Hamburg, these permits do not apply because Hamburg is a city-state (one of 16 federal

states in Germany) and because of this has the same rights as a federal state. Police-related permits are not required in this city-state.

4.2.4 Agreement Deal with Property Owner

Stockholm
If the landing site is planned to be located on private land or property owned by the city, an agreement deal can be needed with the Development office or the Property department at the city. Except for the building permit, this agreement gives the right to use the private property/land between the drone operator and the owner of the land.

If the location is at a private property or land owned by a private property owner, an agreement deal can be needed with the private property owner. Except for the building permit, this agreement gives the right to use the private property/land between the drone operator and the owner of the land.

Helsinki
An agreement deal with the property owner is regarded as a necessary step to be taken in both city- and privately-owned cases. In the case of a city-owned area, a rental agreement for the land is required by the Area Use Control department of the City. When the area in question is privately owned, an agreement with the land owner should also be made. This sort of agreement is required for using a particular piece of land as a landing site for the drone in both cases.

Hamburg
If the landing site is on private property, you must ask the owner for permission. Since the Hamburg Port Authority owns the land that the landing site is on for their planned use case, an agreement deal will not be required for their landing site in Hamburg.

4.3 Other Permits

Permit for Camera Surveillance

Sweden
If an authority is to conduct camera surveillance over public space, a permit is required from the Privacy Authority. The input that has been given from stakeholders is that this permit process can be very long. In a case in southern Sweden, it took almost 15 months for this permit to be approved.

Hamburg
In Hamburg flying with a camera is considered more problematic for data protection reasons than flying without a camera. For safety reasons, no authority will authorize a flight without a camera. At the very least, an FPV camera that ensures a "pilot's view" will be mandatory. A very high safety standard must be guaranteed here and personal rights must be protected. This issue must be dealt with transparently from the outset. The following topics must be considered here:

- Encryption

- Server location
- Data abroad
- Deletion routines

State of Dispersal in Sweden

If a drone is equipped with a camera and the purpose of the operation is to gather material such as aerial photos or other geographical information from the air, a state of dispersal can be required from the authority of the Land Surveyor. This Land Survey is an authority whose mission is to secure the ownership of real estate, make geodata available in society, and lay the foundation for a functioning social economy. The state of dispersal is a permit if the operation aims to share, publish, or sell the gathered information from the drone. The purpose of the permit is to protect important or confidential information related to the defense forces or military.

Permits for Protected Objects in Sweden

Examples of protected objects could be buildings, facilities, or areas to which the state has ownership or right of use and which are disposed of by the state or buildings, facilities, and areas that are intended for police or military operations. If a drone were to fly over a protected object it is considered to violate the Protection Act. If there is a need to fly over a protected object, the drone operator needs to apply for a permit (or at least have a dialogue) with the owner of the protected object. It needs to be clarified with the owner of the protected object if it's okay to image with the drone or blur the image.

Event Permit in Helsinki

A so-called ''event permit'' is required by the City of Helsinki when there is an intention to use public space for holding an event. As its name implies, it relates to the case where drone operations are used for a showcase, promotion, or as part of an event. The event permit is not needed for permanent drone operations, but rather for shorter-term pilots, demonstrations, or tests. The information required by the City for filling in the permit application depends on the event type. It is worth noting that the event permit might imply the need for taking care of waste management, emergency rescue, and special traffic arrangements for which additional permission from the related city departments is needed.

5. Process of Implementation and Replication

As for activity 1.3: identify use cases and potential landing sites in WP1, the process of preparing solutions has been quite similar between the three leading cities. At the beginning of the CITYAM project, the cities of Helsinki, Hamburg, and Stockholm had to take some time to evaluate what needs existed in their respective cities. This was done both by internal discussions and workshops, as well as external involvement.

After identifying and defining the needs and use cases each city had to concretize a process and start thinking about the actual drone operation and landing sites. Hamburg Port Authority were themselves certified drone operators and did not have to go through extensive procurement processes, whereas Stockholm and Helsinki had to procure their operations. This changes the trajectory of the process, which is described in the step-by-step process guide as follows in Chapter 5.1.

The process of preparing an urban air mobility solution will differ depending on what stakeholder initiates the action. For the overarching process described just below the assumption is that your organization is the initiator. However, it might be the case that another private or public organization initiates contact with you and that your organization is a stakeholder in their solution. In that case, as a municipality, the most important point to regard is if their solution brings benefit to the city, and ultimately its citizens.

5.1 The Process of Preparing an Urban Air Mobility Solution

The figure below describes how the process of preparing an urban air mobility solution could look. It is based upon the practices and learnings of how Helsinki, Hamburg, and Stockholm have tackled the process this year. The absolute first thing to tackle was to identify and define a need. For the process to run smoothly, and for stakeholders to stay involved, an identified and important need is crucial. Without a solid need for a use case, the process might lag, and the ultimate benefit could be subpar. CITYAM emphasizes to truly take some time to identify and define an important and useful need.

Another noteworthy takeaway regarding identifying the need is that the process is closely intertwined with involving stakeholders. To identify and define a need you need to involve stakeholders and to know which stakeholders you must involve you need to identify and define your needs. This might seem like a paradox, but rather it is collaboration, workshopping, and discussions that lead this process forward. Involving stakeholders in identifying and defining the need of course opens up the possibility for entirely new needs and use cases to arise. The chances are then that the decided use case will be beneficial for more parties, ultimately creating more benefits.

Step 2 in the process is to concretize a process. In most cases, this step of the process is important, especially if there are stakeholders involved in the need. However, if the city is the sole stakeholder and owner of the need, as is the case for Hamburg's pilots (see Chapter 2.2), the concretization of a process is more limited. However, it is still needed to concretize the process and timeline as well as to receive internal approvals.

Step 3 of the process is what will differ most depending on what route your organization will take. There may be reasons for municipalities to build up their operations with drones. It

provides opportunities for the future in terms of the need for digitalization and can create conditions for development. If the operation is planned to provide a sole need for your organization, this option might be preferred, for instance for a data collection use case of traffic measurement. The second option is to procure a drone service, which is a more all-in-one solution and suits well for more complex flights, needs, and use cases. For instance, in Stockholm's first pilot use case Defibrillator and Drone as First Respondent, the need and use case are rather complex, which the City or its stakeholders would not be able to manage themselves by 2024. Therein lies the decision to procure the service.

Lastly, for preparing an urban air mobility solution, there are permission applications. This process will also differ depending on whether the organization has procured a drone service or not. If the organization has procured a drone service, the possibility also arises to procure the permission applications. If the organisation on the other hand will operate the drone internally, they would usually handle the permission applications.

Following is a step-by-step guide that could be followed if your organization plans on preparing an urban air mobility solution.

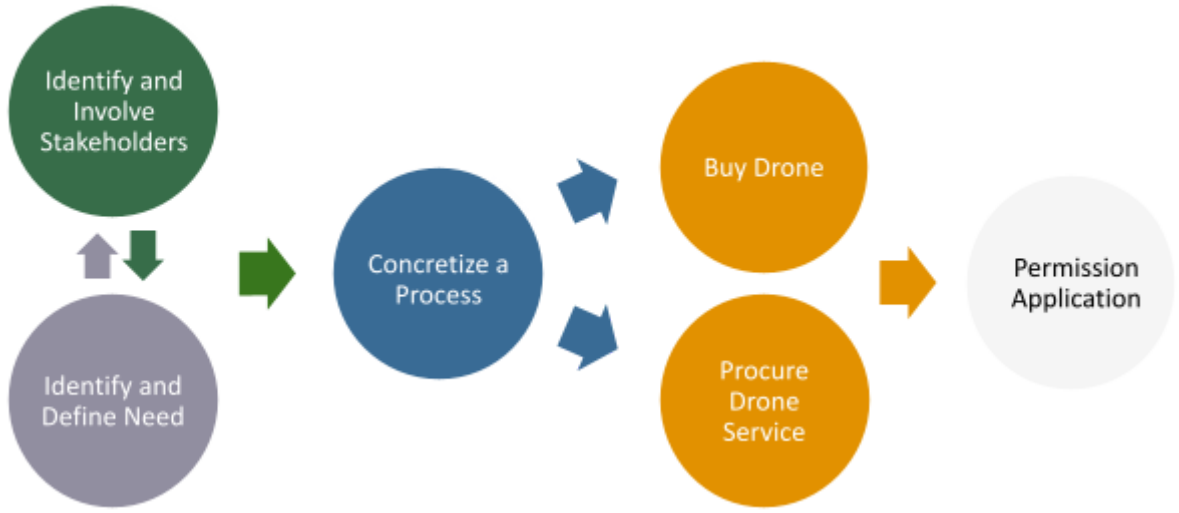

Figure 21: Simplified process of preparing an urban air mobility solution

1. Identify and Define Need & Identify and Involve Stakeholders

Estimated time: Somewhere between 1 and 3 months, depending on the complexity of the wanted use case. These two processes can and should be performed simultaneously, to the extent it is possible.

In Chapter 2.3, some of the most attractive and feasible use cases for cities in the BSR are presented, which could prove as useful input for defining a need.

1.1 Identify and Define a Need

- Discuss and workshop internally on what potential use cases could prove valuable for your organization/city. In some cases, a need that can be solved by a drone clearly

presents itself. But often defining the best use cases for your particular city and circumstances needs internal discussion within and between departments.

- Which issues could a drone service help solve? Could a drone service replace an operation that currently is performed by car e.g.? Could a drone service bring entirely new benefits?
- What could be additional benefits? Time savings? Cost savings? Efficiency? Decreased need for road transport? Increased sustainability? Equal treatment (for instance deliveries to rural areas)?
- Are there any examples from other cities that already have this use case implemented? Were they successful?
- Active drone time. For how long will the operation take place?
- Make a rough estimate of the potential geographic area and flight route. Rural, semi-urban or urban?
- Make a rough estimate of potential landing site locations. Public or private land? Rooftop, ground level, or other?
- Make a brief overview of available landing sites and drone operation solutions. Does your wanted use case solution exist on the market? (This process continues in step 3)
- Are there any direct issues that could prevent this use case? Restricted air space (exemplified in Chapter 3.3)? Nature protected area? Do we have internal support from the organization?

1.2 Identify and Involve Stakeholders

- Workshop and map out internally who could be affected by your planned use case:
  - Which regulatory actors are there? Transport agency? Aviation authority? Municipality?
  - Responsible actors for air restriction areas, for instance, a nearby airport or a hospital with a helicopter pad?
  - Are there any universities or other research facilities that could be of interest?
  - Citizen: Define within what geographic location citizens might be affected
  - Other public or private organizations
- Decide which stakeholders require immediate involvement
  - Involve stakeholders and discuss your plan, what opportunities and obstacles they see, and try to answer the following questions:
    - Is it feasible and possible to fly within the wanted geographical area? (hold pre-feasibility discussions about this route with the CAA and ANSP, if possible)
    - How can we add additional benefits to the other stakeholders?
    - Do the stakeholders have previous experiences with UAM?
    - Estimated budget: How much would this cost, and how much funding is needed? This depends on 1.1, time period, available solutions on the market, etc.

2. Concretize a Process

Estimated time: Depending on the number of stakeholders the timeline could vary. If step 1 has been managed thoroughly, step 2 could go swiftly. To concretize a process an estimated time is somewhere between 1 and 3 months.

- Sort out the financing:

    - Do we have internal funds for this type of project? Do we have the internal support to allocate the needed working hours?
    - Are there any funds that can be applied for (e.g. innovation funds, EU funds)?
    - Can any of the directly affected stakeholders provide funding?
- If needed, enter into a cooperation agreement with relevant stakeholders where you establish the division of responsibilities, some key notes:
    - Who is responsible for procuring the drone service or purchasing the drone operation?
    - Who is the main owner of the use case?
    - Who will receive what data from the use case?
    - Who is responsible for potential risk/crisis communication?
    - How can outward communication be made? Can every stakeholder communicate about all results?
- Create a timeline
- Finalize the use case
    - Specify the flight route
    - Preliminary landing site location(s)
    - Duration of use case
    - Flight frequency
    - Establish data needs and KPIs (see Chapter 3.3 for inspiration)

3. Buy Drone or Procure Drone Service

Estimated time: Finding the most suitable drone solution could take some time, especially if procurement is involved. An estimated time of step 3 is therefore between 1-3 months.

In Chapter 3.3 a description of how the leading cities approached the drone operation is presented, which could prove useful input for step 3 of the process.

3.1 Buy Drone

- Who will fly the drones?
- Are any of the stakeholders a certified drone operator? Do any of the stakeholders have suitable drones already?
- Do we have an available landing site solution?
- Market analysis of available drone operation solutions (see Chapter 3 for inspiration)
- What are the needed functional and technical requirements of the drone? Weight, size, etc. affect the permit application described in Chapter 4

3.2 Procure Drone Service

- Who will fly the drones?
    - Research which could be potential drone operators for this specific use case. See Chapter 3 for inspiration.
    - Does the drone solution include a landing site or must this be procured separately?

- Determine functional and technical requirements of the drone and landing site
- Write a tender document and procure the drone operator. Follow internal and EU procurement rules

4. Permission Application

Estimated time: Depending on the needed permits the estimated time will of course vary. However, an absolute minimum of 3 months should be regarded since almost all use cases will fall under the specific category, and therefore need a flight permit.

See Chapter 4 in its entirety for inspiration, which describes potential permits that could be needed depending on the use case and operation.

- Flight permit
  - The drone operator is always responsible for applying for the flight permit (who this is, depends on step 3)
  - The drone operator must investigate what type of flight permit is needed for your drone operation (who this is, depends on step 3)
    - Within what category (specified in Chapter 4.1)?
- Landing site permit(s)
  - Determine if any infrastructure, such as landing sites, needs to be built for this use case
  - Determine who is responsible for the permit application process (city, drone operator, other)
  - If applicable, investigate which permits are needed for the landing site infrastructure (see Chapter 4.2)
    -
- Other permits
  - Investigate which other permits are needed for your specific operation (see Chapter 4.3)