AiRMOUR

Integration of UAM services in sustainable mobility and transport planning processes and other relevant policies including co-modality

Deliverable 4.5

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Executive summary

This document provides an understanding of how Urban Air Mobility (UAM) can be integrated into the existing urban context as well as their evolving policies. The research aims and objectives, outlined in Chapter 1, provide a comprehensive framework for examining stakeholder roles, urban UAM domains, community perceptions, and the potential impact of UAM on local mobility governance. The subsequent chapters delve into specific aspects of UAM development, shedding light on transformative potential, regulatory frameworks, environmental considerations, and stakeholder engagement. Chapter 2 emphasizes the practical implications of UAM integration by focusing on medical use cases and emergency services. The collaboration between aviation stakeholders, public authorities, and non-aviation actors is acknowledged, aligning with regulatory frameworks such as the European Union Aviation Safety Agency's (EASA) Innovative Air Services (IAS) concept. The EU Drone Strategy 2.0 further sets SMART objectives, emphasizing safety, security, sustainability, privacy, and affordability.

Chapter 3 underscores the necessity for evolving urban policies and regulations to facilitate successful UAM integration. The absence of comprehensive regulations in critical domains, such as urban airspace, traffic management, zoning, land use planning, and infrastructure, highlights the need for a robust regulatory framework at various governance levels. Chapter 4 investigates the need for an evolving urban traffic management by integrating U-space, BVLOS drone transportation, and electrical Vertical Take off and Landings (eVTOLS). The U-space framework, governed by EU regulation, will push the engagement of the local actors. It will establishes standardized digital services, emphasizing the importance of collaboration between aviation and non-aviation entities, regulatory bodies, and local authorities. The engagement of citizens and the introduction of 'U-space coordinators' at different governance levels might increase societal acceptance and align U-space deployment with regional and local well-being.

In Chapter 5, the focus shifts to UAM's integration into urban planning policies, necessitating a comprehensive approach considering zoning, safety regulations, noise, environmental concerns, community impact, multimodal connectivity, and altitude restrictions. A responsible and participatory approach, encouraging open data exchange, public consultation, and future adherence to Sustainable Urban Mobility Planning (SUMP) principles, emerges as a crucial aspect of successful UAM integration. Chapters 6 to 8 address ground infrastructure, environmental dimensions, and stakeholder integration. Vertiports, drone ports and drone pads are highlighted as critical components, necessitating responsible planning and compliance. The environmental impact, including noise and visual impacts, is recognized, emphasizing the need for noise abatement planning and again community engagement. Stakeholder integration, involving local authorities, drone operators, citizens, and various actors, emerges as a crucial element for responsible UAM deployment.

In conclusion, the Airmour project underscores that the integration of UAM into urban environments is a complex yet transformative process that requires collaboration, regulatory frameworks, and community engagement. The report highlight the importance of responsible planning, adherence to regulations, and proactive measures to address challenges. As UAM becomes an integral part of urban ecosystems, the journey towards sustainability and inclusivity necessitates ongoing dialogue and strategic planning. The Airmour project provides valuable insights for urban planners, policymakers, and stakeholders as they navigate the evolving landscape of Urban Air Mobility.

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Abbreviations

Acronym/Term	Meaning
AAM	Advanced Air Mobility
ANSP	Air Navigation Service Provider
ATC	Air Traffic Controller
ATM	Air Traffic Management
BVLOS	Beyond Visual Line-of-Sight
CAA	Civil Aviation Authority
CISP	Common Information Service Provider
ConOps	Concept of Operations
EASA	European Union Aviation Safety Agency
EC	European Commission
EMS	Emergency Medical Services
EMT	Emergency Medicine Technician
EUROCAE	European Organization for Civil Aviation Equipment
EUROCONTROL	European Organisation for the Safety of Air Navigation
eVTOL	electric Vertical Take-off and Landing
FAA	Federal Aviation Administration
HEMS	Helicopter Emergency Medical Service
IAM	Innovative Air Mobility
ICAO	International Civil Aviation Organization
ISO	International Organization for Standardization
KPI	Key Performance Indicator
MaaS	Mobility as a Service
NASA	National Aeronautics and Space Administration
NGO	Non-governmental organisation
RTCA	Radio Technical Commission for Aeronautics
RPAS	Remotely Piloted Aircraft System
SDG	Sustainable Development Goals
SP	Service Provider
SUMP	Sustainable Urban Mobility Plan
UAM	Urban Air Mobility
UA	Unmanned Aircraft
UAS	Unmanned Aircraft System
UN	United Nations
USS	UAS Service Supplier
USSP	U-space Service Provider

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Introduction

Around 70 % of Europe's population lives in urban areas (European Court of Auditors, April 2019), traditional traffic infrastructure faces increasing challenges, particularly during peak hours and along routes to and from urban areas. The introduction of Urban Air Mobility (UAM) marks a shift into the third dimension—the airspace. AiRMOUR, a research and innovation project, focuses on exploring sustainable air mobility for emergency and medical services in urban contexts. The initial deployment of emergency and medical services using UAM has the potential to extend its benefits to other UAM service models over time. This deliverable aims to examine the insights gained from the AiRMOUR project and assess their implications for urban stakeholders and relevant policies. The project seeks to understand how the lessons learned can contribute to a more broader advancement of UAM in urban environments.

Urban Air Mobility (UAM) is a concept that has the potential to revolutionize air travel, the way we move within cities, as well as transport goods. UAM has gained significant attention in recent years as a potential solution for addressing congestion and mobility challenges in metropolitan areas. (Anna Straubinger, August, 2020). UAM and or aerial vehicle concepts for passenger transportation promise a safer, more reliable, and more environmental alternative to alleviate congestion on transport networks (AirBus, 2017).

The earlier introduction of sustainable urban modes, such as cycling, carsharing, and bus rapid transport, along with the re-introduction of rail-based urban transportation like trams and light rail, has revealed that congestion is a more intricate issue. It is not solely addressed by the introduction of new means of mobility. While Urban Air Mobility (UAM) is not poised to replace most existing mobility and transportation services, the anticipation is that as the first commercial Beyond Visual Line of Sight (BVLOS) flights for goods become operational and initial demonstrations of people transportation with electric Vertical Take-off and Landing (eVTOL) aircraft are showcased, UAM will become a part of the modal choice. Eventually, it is expected to contribute to co-modality and become a component of multimodal transportation.

The introduction of U-space, a traffic management system for lower airspace, coupled with the evolution of Unmanned Aircraft Systems (UAS) also known as remotely piloted aircraft systems (RPAS) or drones, is anticipated to enhance the capacity of urban mobility and transport infrastructure.

For UAM to be a success, it will have to integrate into the wider city infrastructure. An integration that allows the provision of service levels both for personal transportation and for urban logistics. It should also offer quality and time savings over existing modes at a price point that individuals are willing to pay. For that policies and regulations have to evolve and service to be set up in ways that are acceptable to local communities. In addition, for any public authority to allow for such services, it will need to be assured that there is a real social value of UAM and a contribution to the wider socio-economic impacts.

Considering the AiRMOUR Emergency and Medical Service (EMS) use cases for which usage of UAM was validated, this deliverable tries to establish a link to present U-space and UAM regulations, strategies and future urban policies. Secondly an analysis of different urban planning practices (e.g., sustainable urban mobility plans, urban development planning) will take place. Following will also be looked at other urban social, noise and environmental policies at the urban level to allow for EMS UAM services. Therewith a multidimensional map of stakeholder interests and citizen engagement strategies that allow for public acceptance.

Based on the quantitative data collected on public acceptance, perceptions of risks, safety, noise, visual pollution and privacy, as well as the gathered qualitative feedback from the workshops organized in the frame of the AIRMOUR live validations in Helsinki, Kassel, Stavanger and Luxembourg it is possible to provide an insight on the impacts for each of relevant urban policy domains.

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Chapter 1 Research aim and objectives

This report is a deliverable within the EU-funded AiRMOUR project. The aim of this research is to investigate the multifaceted role of UAM within the context of urban policies, its seamless integration within SUMPs and other relevant urban policies. This document will first provide insight into relevant regulations, possible organizational frameworks, environmental challenges, and public acceptance and engagement strategies to incorporate UAM into the urban transportation system of both passengers and goods. To achieve this, we carried out the following activities:

- Defining the role of main non-aviation stakeholders such as city authorities, urban planners, and infrastructure providers to effectively collaborate and to make successful integration of UAM into urban/regional areas.
- Defining the criteria for a meaningful UAM EMS use case integration in urban transportation and related utilization of resources, i.e., infrastructure, and land use.
- Understanding how to involve stakeholders and communities in deciding where to locate and structure aerial mobility network vertiports/drone ports, corridors, AiRMOUR and routes in line with AiRMOUR EMS UAM use case needs considering the present UAM and U-space regulation, yet especially also the need for evolving urban policies and regulations.
- Understanding the awareness among local community members and their perceptions of possible benefits, risks and requirements for a successful introduction of UAM in the urban environment and transport network, disclosing the spatial consequences in relation to the urban development plans, and overall municipal goals in terms of protecting their citizens from noise, visual pollution, assure their safety and privacy, understand the impact on climate and wider social-economic impacts.
- Reflecting on how UAM could be an important building block towards a new future of local mobility governance that involves urban air mobility respecting the need for sustainable urban transport and mobility planning.

This deliverable begins by identifying the envisioned role of local and regional authorities in current Urban Air Mobility (UAM)-related EU strategies and regulations. It will then outline effective strategies for integrating UAM into urban planning processes and other pertinent public policies, including considerations for integration with various transport modes. The document will explore diverse urban policies such as Sustainable Urban Mobility Plans (SUMPs), urban planning, and environmental and social policies.

Taking into account aspects like noise, visual and environmental impact, and privacy considerations, the deliverable aims to create a multidimensional map of stakeholder interests and citizen engagement strategies. By addressing these topics, the objective is to provide a resource for city planners, policymakers, and stakeholders who aim to leverage the potential of UAM as a transformative element in their local and regional contexts.

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Chapter 2 Introduction of UAM in an urban context

UAM holds profound significance in the context of cities/regions representing a transformative shift in transportation. Urban Air Mobility is the term used to describe the development of ground-breaking airborne technology that allows for the efficient use of cost-effective aircraft to move people and products in both urban and rural settings in new, ethical, and sustainable ways (James Raymond). UAM has been widely discussed in many academic research as a promising solution to urban congestion and transportation challenges. UAM also helps to transform emergency medical services (EMS), disaster relief, and transportation for underserved areas.

The European Union Aviation Safety Agency (EASA) has introduced a concept termed "Innovative Air Services" (IAS) to encompass these emerging service types. IAS is further categorized into two distinct classifications: "aerial operations" and "Innovative Air Mobility" (IAM). In the context of IAM, a subset within the traditional definition of Urban Air Mobility (UAM), the primary focus is directed towards the transportation of goods or individuals. Given the increasing dynamics of the transport sector around IAM (Advanced Air Mobility (AAM) the US term), Unmanned Aircraft Systems (UAS) and, Remotely Piloted Aircraft Systems (RPAS) aircraft technology, various countries are assessing appropriate regulatory and standards frameworks to ensure that aircraft and supporting infrastructure technology can be incorporated effectively.

UAM has gained significant attention in recent years as a potential solution for addressing congestion and mobility challenges in metropolitan areas (Pons-Prats et al., 2022). UAM refers to the use of small aircraft or drones for transportation purposes in urban environments. While UAM holds promise for improving transportation efficiency and accessibility, its integration into existing urban transportation systems is still in the early stages of. By leveraging technological advancements in batteries, electric propulsion, and eVTOL capabilities, UAM could enable point-to-point flights and bypass ground congestion.

UAM has the potential to address several critical challenges in the urban context. Nevertheless, in developing areal-based mobility services in urban environments, there will be many factors that will have to be taken into account from a societal perspective, including safety, noise, visual pollution, wildlife protection, inclusion, affordability, life cycle assessment topics and privacy. Cross-sectoral several mostly aviation stakeholders already work and are now searching to engage with public authorities, on-aviation actors, entities and other private actors, including citizens, to ensure that UAM services are responsibly developed, understood and embraced as a relevant and meaningful new form of mobility and transportation of goods.

As part of the AiRMOUR project, we conducted demonstrations to validate personal air vehicles designed for transporting doctors and medical supplies. These demonstrations took place in various locations, including Stavanger (Norway), Helsinki (Finland), and the Nord-Hessen region (Germany), and simulations were conducted in Luxembourg.

Throughout the project, we identified and defined four generic Urban Air Mobility (UAM) urgent medical use cases. These use cases were distinguished based on the type of vehicle used, whether for logistic carrying or passenger carrying eVTOL aircraft, and the nature of the service provided. The service types included interfacility transportation (from point A to point B) or transportation from a known take-off point to an ad-hoc location (from point A to point N).

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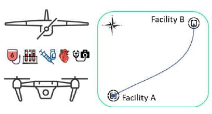
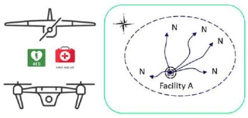
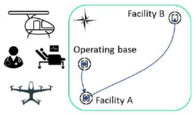
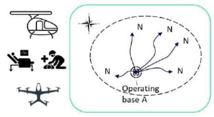
For each of the four use cases, we established functional requirements aimed at offering guidelines on how to set up and operate these scenarios to maximize their value proposition. These requirements were categorized into four groups: infrastructure, aircraft capabilities, regulatory/knowledge-based infrastructure, and operational requirements. Further details on these requirements can be found in ‘Functional requirements for selected manned and unmanned UAM EMS scenarios’ (AiRMOUR, 2022).

Table 2.2: Overview of functional requirements per AiRMOUR use case (Deliverable 2.2)

Use case I	Use case II	Use case III	Use case IV
			
Infrastructure requirements			
Airspace infrastructure - Access to airspace	Airspace infrastructure - Access to airspace	Airspace infrastructure - Access to airspace	Airspace infrastructure - Access to airspace
Physical infrastructure – Vertiport capabilities	Physical infrastructure – Vertiport capabilities	Physical infrastructure – Vertiport capabilities	Physical infrastructure – Vertiport capabilities
Physical infrastructure – Vertiport location	Physical infrastructure – Vertiport location	Physical infrastructure - Operating base location	Physical infrastructure - Operating base location
		Physical infrastructure – Vertiport location	
	Integration into 112/SOS systems		Integration into 112/SOS systems
Aircraft capabilities requirements			
Key aircraft capabilities	Key aircraft capabilities	Key aircraft capabilities	Key aircraft capabilities
Weather capabilities	Weather capabilities	Weather capabilities	Weather capabilities
Environmental footprint	Environmental footprint	Environmental footprint	Environmental footprint
Level of autonomy	Level of autonomy	Level of autonomy	Level of autonomy
	Manoeuvrability		Manoeuvrability
Regulatory/knowledge-based infrastructure requirements			
Public acceptance	Public acceptance	Public acceptance	Public acceptance
EASA aviation regulations	EASA aviation regulations	EASA aviation regulations	EASA aviation regulations
National regulations	National regulations	National regulations	National regulations
Industry standards	Industry standards	Industry standards	Industry standards
Training for healthcare workers			
Operational requirements			
Operational availability	Operational availability	Operational availability	Operational availability
Transport conditions	Transport conditions	Transport conditions	Transport conditions
Handling processes	Handling processes	Handling processes	Handling processes
Authorization of flight plan	Authorization of flight plan	Authorization of flight plan	Authorization of flight plan
Priority in airspace	Priority in airspace	Priority in airspace	Priority in airspace
Flight route	Flight route	Flight route	Flight route
Track and trace system		Track and trace system	
	Payload release		
	Support of receiver		

As is shown, there is within the minimum viable service provision no direct reference to the need for local and or non-aviation-related regulation, policies and organizational procedures. Nevertheless, some involvement of the local and non-aviation stakeholders might be required in numerous topics such as:

- Alignment on the initial flight corridors and dynamic airspace access in accordance with the physical buildings and constructions on the ground, as well as exchange during ad-hoc emergency situations or events gathering of large crowds;
- Definition, planning, authorizing and functioning of the vertiports located outside of the present helicopter decks, airfield and airports;
- Environmental footprint in terms of levels of visual and acoustic impacts on the urban environment both the urban aerial vehicles and overall urban air network in place;
- Alignment on the integration of some of the urban air mobility services with the local 112/ SOS system, and guarantee in the citizen’s right on privacy;
- The need for a more general assurance that the airworthiness, safety and risk levels set at the level of manned aviation are aligned with the risks and transport safety objectives of the non-aviation transport authorities;
- Assurance of high levels of public acceptance and active involvement in the development and execution of citizens engagement strategies;
- Assurance of a contribution of the UAM services to the wider public policies (e.g. on climate, equity), transport policies in the case of introduction of UAM into the person and goods transport networks, and wider social economic impacts and equity.

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These questions served as the foundation for AiRMOUR's work in Task 4.5, specifically focusing on the role of local stakeholders in Urban Air Mobility (UAM) and associated policies. At the European level, the development of regulatory frameworks, guidelines, industry standards, and roadmaps for UAM is primarily driven by the European Commission.

The EU Drone Strategy 2.0 outlines a clear vision for advancing the drone sector and establishing a thriving, sustainable drone ecosystem within the Union (EU, November 2022). The document envisions the European drone services market reaching a value of €14.5 billion, with an anticipated annual growth rate of 12.3%, and the creation of 145,000 new jobs by 2030. The strategy emphasizes the importance of ensuring that all drone services prioritize safety, security, sustainability, privacy, and affordability, aligning with citizens' expectations and addressing their concerns.

Furthermore, the strategy underscores that drones utilized for transporting people and goods should be geared toward achieving publicly accessible services, thereby generating benefits for citizens and local communities. This vision for 2030 has been developed with the support of the Drone Leaders' Group (Commission, April 2022)., which has defined a set of SMART objectives. Some of these objectives are particularly relevant for city authorities and merit some consideration.

Relevant theme cities/ regions	**SMART UAM objective proposed**
How many cities/ region in the EU	Number of cities/regions that will be served by IAM regular commercial services (Target for 2030: at least 45 in the EU and at least one per Member State)
Type of services	Number of Member States where emergency health services (medical samples, defibrillators, air ambulances) will be provided using drones (Target: services used in at least 20 Member States)
Number of flights	Use of European U-spaces Airspace by commercial drone flight operations (Target: at least 100.000 a day)
U-space	Number of EU Member States where advanced U-space Services (additional to those defined in the current regulatory framework) are operational in at least one U-space. (Target: at least 6 Member States)
USSPs operators	Number of USSPs designated in each U-space airspace (Target: at least 2)
Safety levels	Safety level achieved (Target: the ratio between the number of accidents vs the number of drone flights is as low as required for manned aviation)
Safety levels	Aerodromes falling under the EASA Basic Regulation, cities with over 100.000 inhabitants, and critical infrastructures will have assessed the security risk related to drone incidents and put in place procedures and measures that will protect them from such incidents proactively and reactively (Target: 100%)
Environment	Carbon emissions of urban and regional IAM operations (Target: 0%)

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It's important to highlight that these are potential targets and might represent a more conservative perspective as several industry experts have also proposed more ambitious targets. The actual market and feasibility of the UAM object are still subject to debate. Nevertheless the current list provides some foundational understanding of the expected scope, thematic importance, and significance of UAM.

For instance, the target of at least 45 urban air mobility (UAM) services in the EU, with at least one in each Member State, demonstrates the geographical coverage and accessibility of UAM services. This widespread reach signifies an increased acceptance and integration of UAM services throughout the EU. Similarly, aiming for at least 100,000 daily flights BVLOS reflects the anticipated scale and frequency of drone operations in designated U-space airspaces, necessitating a high level of maturity in U-space infrastructure.

It's worth noting that thousands of drone flights occur annually in the open category for private individuals, illustrating the prevalence of ad-hoc flights. For instance, Finland has over 2,500 registered organizations and approximately 12,600 individuals engaged in drone activities. That result in an estimated 140.000 drone flights in whole Finland in 2023 based on the local registration system, of which 30.000 in Helsinki. About 99% are presently VLOS. One sees a clustering of drone flights above large construction sights. In the city of Amsterdam detected around 13,500 drone flights (note Visual Line of Sight, VLOS) using the CRT system[1].

Regarding safety, it is expected that cities with over 100,000 inhabitants will assess security risks associated with drone incidents and implement proactive and reactive measures for protection. The goal of zero carbon emissions from urban and regional UAM flights underscores the significance of environmental considerations. The EU Drone Strategy 2.0 provides a number of recommendations on how to involve the non-aviation transport actors. The following can be considered most relevant.

Recommendation 52. Local communities, cities, regions have a deciding role for ensuring the alignment of Innovative Aerial Services with the needs and preferences of their citizens. They have a key role in deciding to what extent drone operations can be conducted in their territories. For example, they are in a good position to assess which critical infrastructure should be protected, whether operations should be allowed in day or night-time, what should the measures in place be in terms of noise and visual abatements…..Tools such as the Sustainable Urban Mobility Plans (SUMPS) should be leveraged by Member States as a mechanism to integrate alternative delivery solutions offered by Urban Air Mobility in urban mobility planning and help to address mobility challenges for the entire functional urban area, including synergies with spatial, energy and climate plans.

Recommendation 53.The role of municipalities is also pivotal in terms of regional planning in urban and rural areas and creation of dedicated infrastructure to accommodating vertiports or take-off and landing sites. Local administrations should be involved and be able to convey a message of certainty and transparency to society about what, how, when and where Innovative Air Mobility will be deployed. Citizens' participation in regulatory sandboxes, living labs and demonstrations should be encouraged to include local/regional aspects in the final decision regarding Innovative Air Mobility deployment.

The location of the required new enabling infrastructure (e.g., vertiports, telecommunication and energy distribution equipment, including for new energy supplies such hydrogen) in the urban environment should be systematically analyzed, finding a balance between location requirements, affordability and other aspects, such as nuisance to neighbors and visual pollution

[1] https://www.ilent.nl/documenten/transport/luchtvaart/drones-rpas/factsheets/factsheet-drones-2023 (last check 07/12/2023)

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to avoid jeopardizing social acceptance….Connectivity to local airports and other modal hubs, including with public means of transport, should be prioritized.

Recommendation 55. Noise mitigation measures to avoid or limit the impact on over-flown citizens, houses, quiet and natural areas should be fully taken into consideration by drone operators and local authorities when designing routes, procedures, and other operational practices.

To effectively engage in Urban Air Mobility (UAM), local communities, cities, and regions must be empowered and gain a comprehensive understanding of how UAM could impact their operations and policies. The upcoming chapter will delve into various policy domains associated with UAM and explore the currently envisioned methods for local authorities to participate actively.

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Chapter 3 Identifying the UAM relevant urban policy domains and airspace regulation

Numerous European cities, including those featured in the AiRMOUR validation sites (i.e., Stavanger, Helsinki, the North Hessen Region, and Luxembourg) are actively exploring the potential of UAM. As described earlier, the development of urban regulations that could facilitate regular service provision for AiRMOUR Emergency Medical Services (EMS) scenarios remains incomplete. The specific areas where urban-level policy and regulation developments are deemed essential are outlined in Table 3.1.

Table 3.1: Status of AiRMOUR-relevant urban regulations for the EU and AiRMOUR project-participant countries[2]

Category	Domain	EU	FI	DE	LUX	NO
UAS	Noise worthiness	None	None	None	None	None
	Lifecycle analysis	None	None	None	None	None
Passenger eVTOL	Noise worthiness	None	None	None	None	None
	Lifecycle Analysis	None	None	None	None	None
Airspace	U-Space Airspace / UTM	AMC and GM to implementing regulation (EU) 2021/664	Follows EU Regulation			
Privacy & Security	Privacy and Data Protection	GDPR	GDPR			
Ground Infrastructure	Vertiport	Prototype Technical Design Specifications for Vertiports	None	None	None	None
	Drone port	None	None	None	None	None
	Charging infrastructure	None	None	None	None	None
	Communications	None	None	None	None	None
Urban Planning	Aviation Infrastructure in Urban Planning	None	None	None	None	None
	Land Use	None	None	None	None	None

[2] Extracted from Armour Deliverable 3.1

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The present established UAM regulatory framework encompasses specifications for aircraft, ground control, vertiport requirements, U-space airspace management, noise and visual pollution management, as well as delineating the rights and responsibilities of users and service providers.

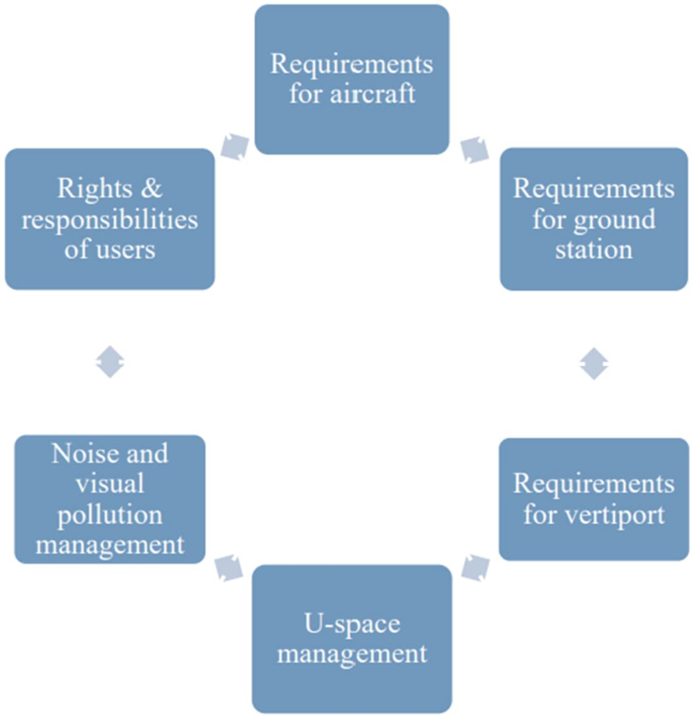

Figure 3.1 Requirements to be covered in related U-Space and UAM regulations

Regulations play a crucial role in transforming UAM operations from concept to reality. The table 3.1 highlights the absence of current regulations in various domains pertaining to the convergence of urban planning, urban mobility, and aviation within the context of UAM. To meet the nuanced policy demands a comprehensive framework is essential at the national, regional, and local levels.

Apart from aircraft-related considerations, all the other aspects of the UAM introduction demand careful attention that the local and regional urban perspectives are also integrated in the reflections. The incorporation of UAM into cities holds significant implications for various urban regulations. Key areas of urban policies that are likely to be influenced by UAM include:

1. U-space airspace regulations: Existing airspace regulations will have to be adapted to accommodate low-altitude flights of urban air vehicles. This includes defining specific corridors or zones for UAM operations and addressing issues related to air traffic management in urban environments; the local authorities will need to be consulted on this matter;
2. City traffic management: Cities will need to consider how to integrate UAM into existing traffic management systems, including ground and air traffic coordination;

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3. Zoning and Land Use Planning: UAM infrastructure, such as vertiports, emergency landing sides, and landing pads will require appropriate zoning and land use considerations. Cities have to update their urban planning regulations to integrate UAM infrastructure seamlessly into the existing urban fabric;
4. Urban infrastructure policies: policies relating to the construction and maintenance of UAM infrastructure, including vertiports, charging stations, and other facilities, would need to be established and integrated in present urban planning and building permits;
5. Noise Regulations: UAM vehicles, especially those using vertical take-off and landing (VTOL) capabilities generate noise. Local urban noise regulations will have to be revisited or updated to address the impact of UAM on urban soundscapes;
6. Environmental Regulations: UAM aircraft should be compliant with the environmental regulations, even if they are electric or hybrid. Cities most likely will need guidelines for environmentally sustainable UAM operations;
7. Urban safety and security regulations: Regulations related to safety standards, emergency procedures, and security measures need to be agreed upon with the relevant authorities and/or revised to ensure the safe integration of UAM into urban environments;
8. Insurance Regulations: The introduction of UAM would likely impact insurance policies in place. New policies and coverage considerations will need to address the risks associated with the presence of the general public, buildings and other urban infrastructure;
9. Privacy Regulations: UAM vehicles equipped with sensors such as cameras could raise privacy concerns. Cities will need to assure that the UAM applications of UAS or eVTOL aircraft and their operations are in line with the public privacy regulations to ensure that UAM operations respect and provide the guarantee to its citizens that individual privacy rights are respected.

Considering the first point it is worthwhile to examine firstly the control over airspace. Operational airports in/near the cities often makes the airspace of the city controlled airspace. Near most of the towns, if there is no airport close it will be uncontrolled. Then, other airspace areas exist, such as restricted, prohibited and military operations areas.

Controlled airspace is designated airspace where air traffic control services are provided. The starting point of controlled airspace may vary and is determined by factors such as airport locations, airways, and controlled airspace classifications (Class A, B, C, D, etc.). Controlled airspace often begins at specific altitudes above the ground. Different classes of airspace have different starting points and altitude restrictions. For example Class G airspace, which is often uncontrolled, starts at the surface and extends to a certain altitude. Class E airspace typically starts at a designated altitude above the surface. Class D, C, and B airspace have specific dimensions and starting points based on the type of controlled airspace. iIt is worthwhile noting that not all airspace classes exist in each country.

The starting point of airspace and its ownership is a complex legal and regulatory concept that takes into account safety, air navigation, and the need for coordination between different users of the airspace. Local and regional authorities, as well as landowners, have limited say on how the airspace is organized. It is worthwhile to note that there is a lot of variation on this topic between the EU member states. Landowners have in certain EU Member States some say over the use of airspace over their property, nevertheless not on all topics. For example, in Germany, landowners have the right to control the airspace above their property, yet this is subject to certain limitations and regulations. It is the German government, through its aviation authorities, that has jurisdiction over airspace for anything that relates to aviation purposes. In Finland, only the Civil Aviation Authority (CAA). On the contrary, in Norway, landowners have unqualified say in the use of airspace over their property. In the EU, even though landowners may have certain

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rights over the airspace above their land, these rights are often limited to allow for a reasonable use of the airspace, and these rights do not extend to activities that may interfere with air travel or violate aviation regulations.

Cities and police might also be able to restrict drone traffic for security reasons. Presently, when flying at lower altitudes, there are several options to do so. This will become more organised with the introduction of U-space airspace. This will initially only be in small volumes of airspace below 150 meters above ground/sea, in areas with little manned air traffic and with little UAS traffic.

When enabling UAM, wherewith flights will take place at lower altitudes, a re-examination of airspace ownership will need to be considered. Specifically, the introduction of U-space in the different member states will have to foster this process. In the following chapters will be looked at the possible UAM-Urban policy integrations of urban zoning, transport planning and traffic management in relation to the creation of U-space from a land transport point of view (e.g.; integration of vertiports into the urban infrastructure regulations. Following also the topic of noise, visual and environment considerations from an urban perspective will be examined, as well as public acceptance and management of stakeholder engagement.

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Chapter 4 Traffic management and UAM

Urban traffic management involves planning, organization, coordinating, and regulating traffic in urban areas. It consists of the implementation at the operational level of diverse transport, mobility and traffic strategies, technologies, and policies to guarantee a more efficient use of the urban road infrastructure and optimised used of all modes. Through the use of traffic management centres, software and hardware, it manages the flow of vehicles and various modes of transportation. In general, traffic management policies aim at easing congestion, boosting safety specifically for cyclists and pedestrians, and enhancing the overall efficiency of transportation networks in the urban setting. Urban Air Mobility will represent through the introduction of U-space, upcoming BVLOS UAS and eVTOL operations as new elements of the overall urban transportation network.

Since the first drone applications, this new use of airspace and its associated technology has been posing challenges to regulations and legislation. First trials and business models tested around BVLOS demonstration flights show that in time, there is a need for a more effective integration and cooperation between aviation and non-aviation organizations, industry, agencies, and local authorities, regions and cities. Specifically, the imminent introduction of U-space is expected to trigger reflections on integration with the urban traffic management system.

U-space consists of a set of services and protocols designated to guarantee the secure and efficient management of a considerable number of drones in the airspace managed within that U-space. This so called U-space airspace is expected to be established below 500 feet (150m). The U-space airspace are geographical zones designated by Member State as areas where UAS operation will be allowed with the support of U-Space services.

An U-space airspace enables Unmanned Aircraft Systems (UAS) to routinely operate beyond the visual line of sight. In order to do so, it will rely on advanced levels of digitalization and automation. The EASA's Implementing Regulation (EU) 2021/664 framework can, in this respect, be considered as one of the most relevant regulations in identifying the role of local and regional authorities. The EU regulation for instituting U-space airspace came into force on January 26, 2023.

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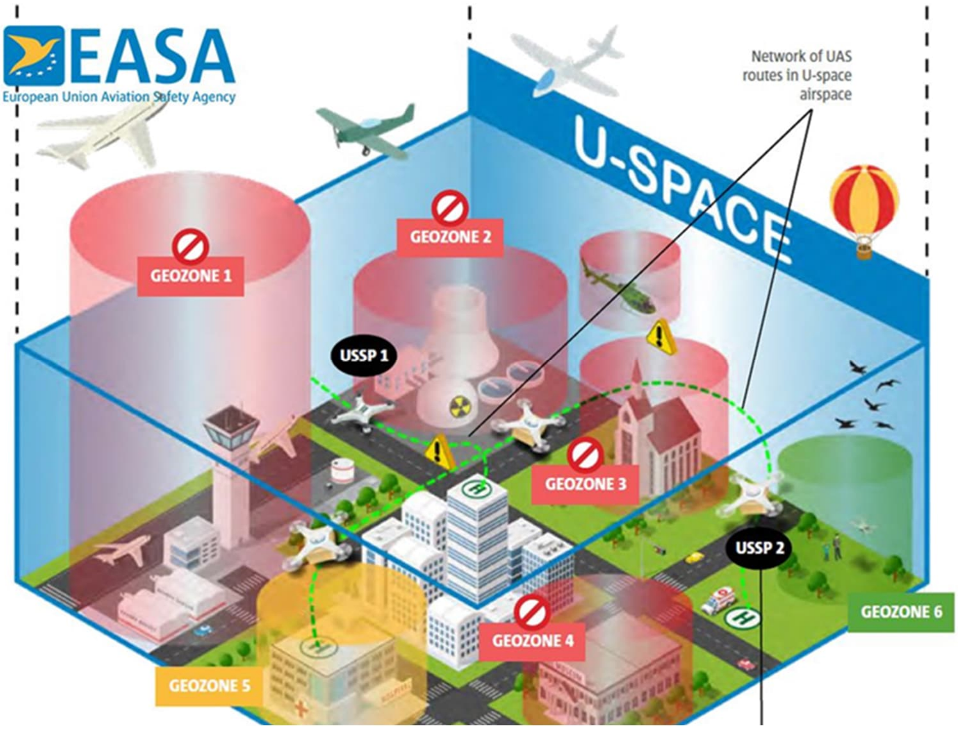

Figure 4.1: graphical representation of U-space (EASA)

As pictured in the figure above UAS service will be allowed in the U-space airspace yet there might be also certain areas forbidden to be entered and/ or restricted. The U-space regulation structures for all stakeholders involved in civilian drone usage, operators, service providers, companies, communities and citizens representatives the framework for the set up, planning, management of UAM.

The introduction of standardized digital services, termed "U-space services," is obligatory. U-space service providers (USSPs) are entrusted with delivering four essential services to UAS operators within U-space areas. These USSPs must possess a European certificate issued either by the national authority of a European State or by the European Union Agency for Aviation Safety (EASA).

Within U-space, the following four indispensable services must be furnished by USSPs to UAS operators:

1. Network ID Service: This service facilitates the continual processing of UAS network identification, operator registration, and the dissemination of information regarding their operations, encompassing the positions of both the drone and the remote pilot.

2. Geo-awareness service: UAS operators receive information through this service about relevant operating conditions in U-space and airspace constraints. This includes potential alterations to the space configuration in which they are cleared to fly.

3. UAS Flight Authorization Service: USSPs grant flight authorizations to UAS operators based on interference with U-space constraints and other aviation activities in the operating area. This service also entails the periodic review or potential suspension of each authorization in response to evolving conditions within U-space.

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4. Traffic Information Service: Aimed at furnishing UAS operators with information regarding discernible air traffic, including manned aircraft, operating in proximity to the intended position or route of the UAS flight. This enables operators to take necessary measures to avoid collision risks.

Two optional U-space service are the provision of weather information and conformance monitoring. In regard to the development of U-space and its linkage to local and regional authorities, it is worth mentioning the regulatory framework for the U-space ((EU) 2021/664) of 22 April 2021, and more specifically article 18F “tasks of the competent authority/ coordination with other authorities and entities”. It states that the responsible authority should coordinated with all the other entities, including the ones at local level. The imposed coordination should consist of:

1. The establishment of an mechanism to coordinate with other authorities and entities, including at local level,
2. the designation of U-space airspace,
3. the establishment of airspace restrictions for UAS within that U-space airspace; and
4. the determination of the U-space services to be provided in the U-space airspace;

Other authorities will have a role in a coordination mechanism at the initial stage of the development of the U-space and the definition of what the U-space airspace will be (EASA, December 2022). In the planning, and operational execution phase the other authorities including cities and regions will need to be involved in jointly defining both the permanent restrictions for UAS, yet also ad-hoc restrictions that might occur due to a foreseen event (e.g. a national event taking place in certain areas), as well as possible unforeseen events (e.g. manifestation, fire, security situations) that would request for a temporary closure of the U-space airspace.

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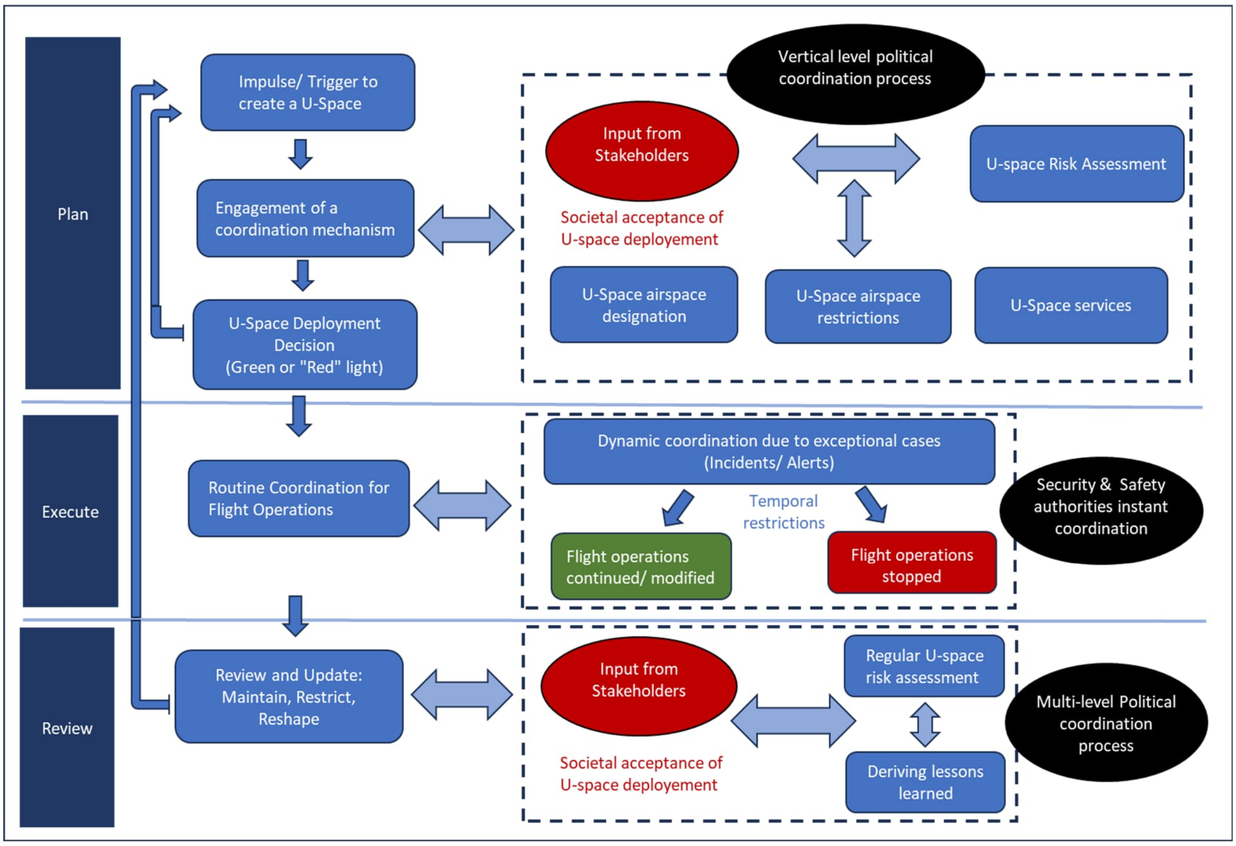

Figure 4.2: Overview of the main tasks that require coordination among stakeholders across the different levels of governance, and of the activities for the planning, execution and review phase of the U-space deployment (EASA 2022)

Competent authorities should nominate an entity as the 'U-space coordinator' responsible for setting up the coordination mechanism. The U-space coordinator should take the initiative to coordinate with other public and administrative authorities and entities (including private ones). These are ministries, environmental defence organizations, municipalities, associations, civil society organizations, airspace users, drone operators, etc. It is worth mentioning that citizens should also be involved in this setup. Public consultation is considered a necessary step in determining and evaluating the level of societal acceptance of the planned U-space airspace.

The U-space coordinator should be established at various governance levels, including national, regional, and local levels. Therefore, it is envisaged that national, regional, and local authorities will assume responsibility for coordinating and aligning relevant policies, approaches, and practices. This might lead to larger urban and metropolitan areas; there will also be a U-space coordinator within the local authorities, coordinating with the regional and/ or national authorities. In that respect it is crucial that local actors start educating themselves about this topic, forming opinions, visions, policy plans and strategies.

The aim of the coordination mechanism is that the designated and deployed U-space airspace fits the regional and local well-being needs, sustainable urban mobility policies, and local traffic infrastructure. Specifically, in relation to the airspace constraints and the operational flights, cities and/ or other relevant urban authorities and their service will have to be consulted, or in the case of incidents will have a direct say in the continuation or temporal restrictions on flight operations.

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The following figure shows how the EASA regulation foresees a possible coordination scheme within the operational execution phase of U-space service provision.

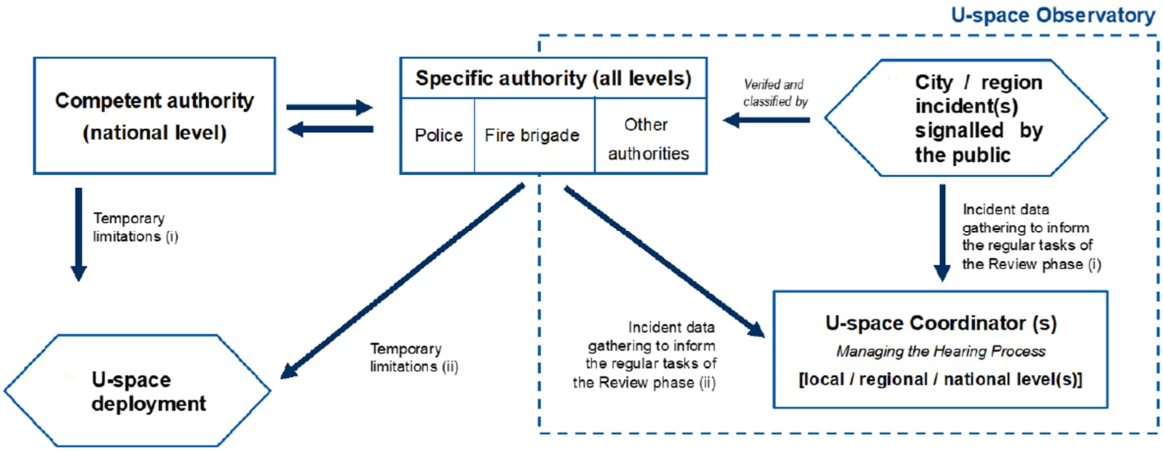

Figure 4.3: Example of how the coordination mechanism could be implemented. The diagram provides an overview of high-level steps, the stakeholders, and their relationship during the execution phase (EASA, 2022).

Emergency response authorities at all levels, including the police, fire brigade, and civil protection agencies, will have the authority to request temporary restrictions based on the governance and legal framework of the respective Member State. Temporary limitations within the U-space may be imposed by the competent authority for safety and security reasons, such as during emergencies or natural disasters, leading to restrictions like airspace closures or limits on the number of UAS in a specific area. Also, within the phase of review and evaluation, cooperation is expected with the regional and local authorities together with other stakeholders representing societal, environmental, economic and other areas. The review will make use of U-space KPIs' monitoring and feedback from stakeholders. These U-space KPIs could also include sustainable urban mobility indicators. This might lead to considering adding or removing optional services, e.g. by either further restricting or expanding them to new UAM routes (including e-VTOL). With the imminent set up of U-space and U-space airspace, it might be clear that for the non-aviation authorities, it becomes a need to understand aviation and UAS and eVTOL-based services and combine this knowledge with the needs from a city point of view.

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Chapter 5 Urban planning and UAM

U-space airspace will be set up in the urban airspace mostly. UAM will, at a certain point in time, be introduced in more urbanized areas, and makes use of ground infrastructure for landing and/or take-off of non-ground level infrastructures such as rooftops of buildings. At that stage, the need for an integration between regional and urban land planning emerges.

UAM services carry the potential of influencing the mobility of a city or region in many different ways, for example, whether it is goods or passenger transportation and might initiate a deep transformational process. For example, UAM services could offer an advantage for medium-to-longer commute distances, reducing those trips' commute time. In the case of logistics, drones might be used for EMS services. Initially, this is expected to be in the frame of emergency and medical services; at a later stage, this might also be integrated into public transport services and or last-mile logistic deliveries (AiRMOUR, 2022).

That will trigger the need to come from an initial integration of U-space airspace with related local functionalities (e.g., assuring safety, security and emergency services) and ensure the alignment with more general social, sustainable mobility and environmental policies into a more complete urban planning approach. Firstly, that might encompass the integration of UAM, along with its support infrastructure on the ground, into the transportation system. There will then need to be a wider reflection of the integration of UAM into the evolving urban infrastructure, land-use planning, mobility planning and the possible contribution of UAM to overall city livability objectives.

In order to achieve the integration of UAM into the urban environment is to be achieved, infrastructure, regulations, and other challenges will need to be met. Initially it is expected that UAM will predominantly rely on existing infrastructure such as heliports, but over time, it will require a network of vertiports and these must be complementary and fully integrated with existing land uses and mobility planning. (Drévillon, 2023).

5.1 UAM and urban planning policies

The impact of UAM on existing land use is poised to be transformative. Consideration for establishing approaches for regulating land use around UAM infrastructure, drone ports and drone pads can help the city promote a safe, healthy, liveable, and sustainable transportation network of the future through policy and regulation. Until now, aviation and city planning regulations have not been seen as linked. The role of a region or a city related to aviation has been limited to questions of land use and building permits.

Currently, there are no specific zoning designations for UAM. (Brent Chamberlain, November, 2021) The existing infrastructure that manages air mobility has been oriented toward larger aircraft and for servicing macro-scale industrial and commercial needs. Therefore, the land-use planning for UAM should coordinate with zoning laws and be developed in a complementary manner to balance acceptable uses without restricting innovation. Land uses for UAM will need to address and differentiate between public, recreational, commercial, residential and transportation uses through suitability analysis.

There are a few factors that must be considered when developing potential elements for UAM framework land use policy/planning, including the following.

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Table 5.1 Consideration for the integration UAM into land use planning

Elements for UAM land use planning	Description
Zoning considerations	Understand current or new zoning considerations and existing guidelines for different zones
Safety regulations	Minimize the risks associated with potential aircraft accidents by providing for the safety of people and property on the ground
Noise considerations	Minimize the number of people exposed to frequent or high levels of UAS and eVTOL aircraft noise capable of disrupting noise-sensitive activities. Compare noise effects and influence on land uses and local communities.
Environmental considerations	City authorities and UAM operators should carefully consider the environmental impacts of UAM and eVTOL aircraft and their operations and facilitate mitigation of potentially damaging impacts on the surrounding natural environment through regulations.
Community impact	City/regional authorities should work with urban planners & local communities to ensure that UAM infrastructure(vertiport) locations do not negatively impact.
Multimodal connectivity	New transit modes should connect with existing forms of transportation and mobility hubs for secure integrated operations
First & last mile connectivity	Prioritize locations for equitable access and integration with the city's existing density and transportation network
Height restrictions	An altitude range in the vicinity of a UAM zone/vertiport should be required to protect public safety and health, and it is the local government's responsibility to ensure the airspace surrounding designated UAS and eVTOL aircraft routes & vertiports is clear of vertical encroachment via zoning and height permits.

In the first stage, to accompany in a responsible manner from a planning perspective the introduction of UAS traffic within the urban area, it is considered of interest to provide guidelines from a local perspective on the integration of UAS into the airspace. Practically this could be preparing and making available open 3D data on to avoid and preferred areas, possibly accompanied with details in terms of applicability times (e.g., day and night times flight preferences). This approach would not only facilitate a smooth set up of U-space airspace, yet also bring the local authorities as a more relevant partner in the setup of U-space airspace and introduction of UAS services.

In addition, during the planning of operations phase the local authorities should provide access to both static and dynamic ground risk data, covering events such as outdoor gatherings and marathons. This information would enable UAS operators to make informed decisions regarding flight paths, ensuring the safety of both the drones and the public. Firstly this will avoid unnecessary complexity, yet also allow for the needs and perquisites of all stakeholders to be taken into account.

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Facilitating the provision of data to the relevant stakeholders is another critical aspect and could, for example, be fostered through open urban mobility data spaces. Ensuring the ease of data exchange contributes to keeping information up to date, reflecting the dynamic nature of airspace conditions.

5.2 UAM and sustainable mobility policies

In time, a more elaborated introduction of UAM into Sustainable Urban Mobility Planning (SUMP) might become useful. A Sustainable Urban Mobility Plan (SUMP) is a strategic and holistic framework designed to address the multifaceted challenges associated to mobility within the urban area and its wider catchment area. is a comprehensive approach aimed at addressing the intricate challenges of urban transport with a focus on environment and the actual mobility needs of citizens. Urban logistics might be part of the SUMP are a separately dealt with in a Sustainable Urban Logistic Plan (SULP).

The Practitioner Briefing on SUMP-UAM describes the planning, modelling and implementation of UAM services into the SUMP emphasizing the importance of integrating UAM into sustainable urban mobility planning process. There are eight principles that will have to be considered when developing a SUMP.

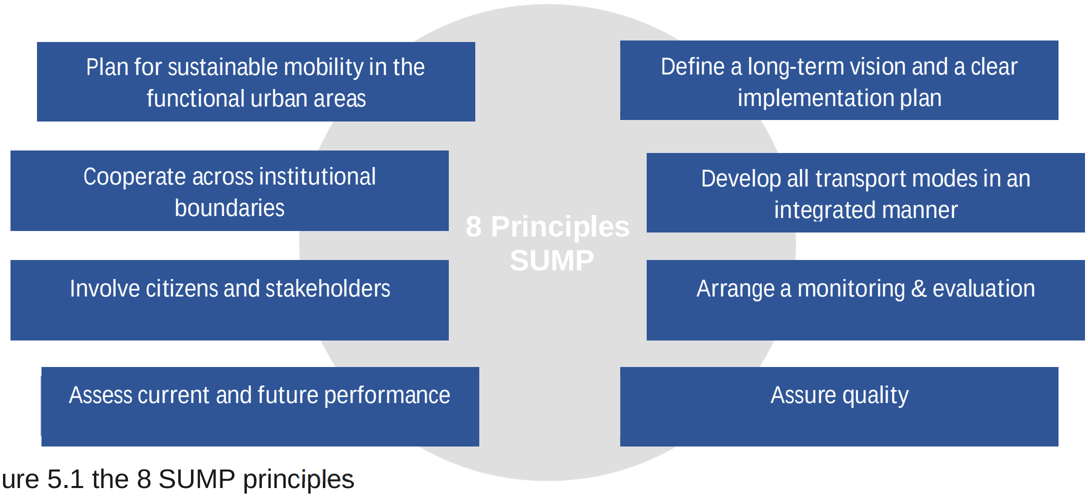

Figure 5.1 the 8 SUMP principles

In general, SUMPS highlighted the importance of citizen- and stakeholder involvement at virtually every planning and implementation stage of urban mobility. This aligns with the EASA's involvement of citizens and the general public during the planning, execution and review phase of the establishment of U-space airspace and UAM services provisions.

The introduction of UAM calls for a holistic planning approach that encompasses not only the integration of UAM, along with its support infrastructure on the ground into the transportation system but also the urban infrastructure and overall city planning. Three alternative techniques were suggested to help cities and regions contribute to the planning of UAM implementation and to help stakeholders make better decisions.

1.Top-down approach: This approach involves centralized planning and regulations by government authorities or aviation agencies. It focuses on comprehensive policies, regulations and infrastructure for safe and efficient UAM and UAS and eVTOL aircraft-based operations across the region. This planning process is overseen by government organizations, aviation authorities, and transportation departments, which also determine the airspace regulations,

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safety requirements, and infrastructure needs for drone operations in urban areas. Finally, it will ensure consistency, safety, and alignment with national aviation regulations in UAM operation, as well as the ability to coordinate with air traffic control.

2. Bottom-up approach: This approach involves community and stakeholder engagement and private players shaping UAM and drone solutions according to their local needs. It encourages local communities, service providers and the drone industry to participate actively in decision-making. By using this technique, cities can address specific local mobility issues, encourage drone application innovation, and get support from the general public. The community-directed drone delivery trials for urgent medical supplies led by local authorities are best illustrated by the AiRMOUR demonstrations.

3. Greenfield approach:. The greenfield strategy emphasizes the creation of sustainable drone and UAM solutions from scratch, necessitating the integration of new UAM structures into both current mobility systems and regional/urban planning. This approach specifies a comprehensive mobility planning approach like the SUMP process, which fits purposefully in such an initial situation by providing structure to the planning process and by integrating elements of both the top-down approach and the bottom-up approach.

By following these three approaches, a city and region can systematically plan, regulate, and integrate UAM into its transportation ecosystem while considering various factors such as ensuring safety, efficiency, community engagement, and sustainability depending on their specific needs.

UAM will function alongside existing air, ground and water transport modes. The scope for UAM to gain market share will depend on the quality of service it offers relative to competitors in terms of cost, access time, service frequency, speed, reliability, safety, comfort and compatibility with social equity ideals. UAM may also complement existing services by providing part of the multimodal transport trip (James Raymond). The way UAM will function will depend on the available technology, regulatory framework, organization and capacity of the U-space airspace and infrastructure, yet also how the different UAM concepts might be integrated into the present mobility and business concepts.

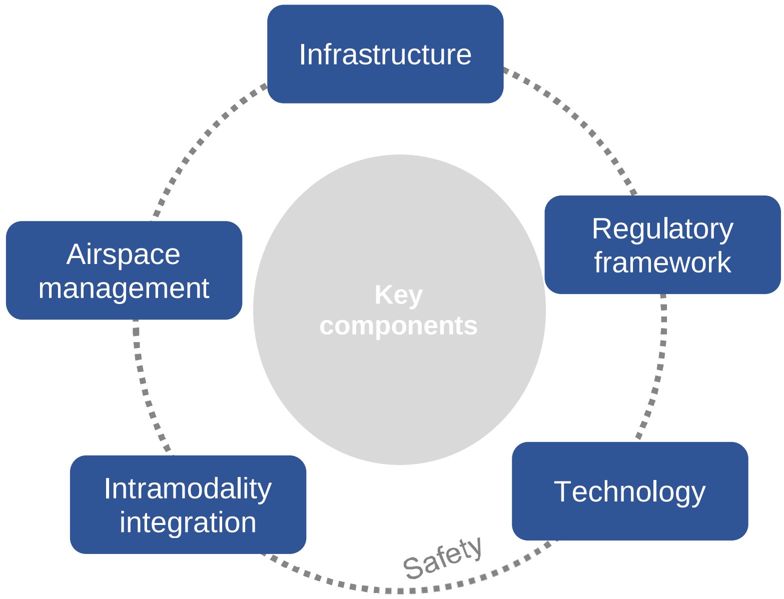

Figure 5.2 Five elements that determine the integration of UAM in present and future mobility concepts.

More specifically the necessary technology is advancing rapidly together with the regulatory framework needed to manage common airspace. Integrating drone operations with existing

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transport systems is a multifaced endeavour that requires careful planning and consideration of various aspects, such as infrastructure development (vertiports and loading stations), that is (operationally, physically and electronically) safe and efficient and also deployment of the UAS and eVTOL aircraft operation with a multimodal hub.

The substitution effects between traffic flows on the ground and in the urban airspace, as well as the infrastructure that needs to be integrated into the urban landscape, will undoubtedly have an impact on the ground-based transportation system yet is considered for the coming years small. If drone cargo deliveries grow rapidly there may be challenges related to the integration of ground infrastructure if landing areas are placed in public areas. By taking the spatial requirements of the ground infrastructure into account in city planning and zoning, future needs may be anticipated.

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Chapter 6 Infrastructure requirements for UAM

Ground infrastructure such as take-off and landing, ditch sites, communication and navigation infrastructure are part of the UAM service concepts (Straubinger, 2018). Cities will need infrastructure on the ground, smaller drone pads, drone ports and larger vertiports. The initial idea for near future UAM operations is to make use of existing infrastructure (such as existing heliports and airports). They will require modification or enhancements to accommodate early entry UAM concepts and eVTOL passenger flights.

A vertiport is the ground infrastructure where UAS or eVTOL aircraft take off and land and payload, cargo, or passengers are managed, boarded and onboarded. Unlike most airports, vertiports may be built in populated urban environments. Even if they are presently operated under different regulations existing heliports could operate as vertiport providers if they comply with regulations and have the required systems in place (such as electric charging capability). Alternatively, vertiports could be designed to support eVTOL aircraft that use different energy sources like hydrogen. Size, layouts, and designs will be determined by the vehicle specification, as well as the loading and unloading needs. The manufacturer of the particular UAM system mostly drives the operational and technical requirements of vertiport development. These landing sites for eVTOL will need special permission within the present EASA regulation. However, it will be the responsibility of the operators, manufacturers, local governments, and other stakeholders to plan, develop, and enable vertiport infrastructure. Before considering the construction of a vertiport, developers and operators will need to fulfil the requirements of an integrated UAM Concept of Operations (ConOps) and be compliant with regulations across the planning, designing, and operational phases. They will have to ensure that they meet all the requirements for safe and scalable operations.

Meanwhile, UAS industry players are conceiving UAM ground infrastructure for cargo drone transportation that fits residential or office buildings, parking areas, rooftops of high-rise buildings, highway plazas, and/ or shopping malls. The selection of take-off and landing sites for any non-human carrying aircraft is not restricted by aviation law and does now not need a specific permit. These privately owned landing sites are unlikely to be open for competing air operators. From a city perspective these drone take-off and landing sites might only be subject to environmental permits.

For any UAS and eVTOL aircraft operations, public acceptance, the need for reduction of noise and visual impact might limit the number of suitable ground sites. Initial considerations of a city that wants to take the lead on the UAM topic might be that if they identify UAM use cases of public interest (e.g. emergency and medical transportation) the city could provide the UAM ground infrastructure to the private sector (City of Helsinki, 2023). Therewith it could be that the city authorities provide and operate the UAM ground infrastructure as to ensure equal access to all and an open market for all UAM service providers, or only takes care of the necessary regulation and permissions, while tendering for its services.

If, at a certain point, UAM will be part of a multimodal service concept, the respective UAM infrastructure could be integrated into mobility hubs with other modes of mobility. At that stage integration in SUMP will make sense. It is clear that at that point expect cities will be engaged in the planning of at least the high-traffic landing sites to ensure, that they remain socially acceptable to citizens in addition to being well integrated with overall urban mobility plans.

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To identify the infrastructure opportunities for vertiports and assess the impact of spatial constraints, the following steps could be considered at the city level:

- Collect data layers that the city considers relevant for landing site planning and use existing UAM GIS tools as a help in the selection process.
- Explore the availability and spatial distribution of current urban infrastructure that can be potentially used as UAM landing sites or vertiports.
- Conduct scenario analyses on how various spatial constraints affect the infrastructure opportunities of UAM.
- Investigates how different scenarios affect the accessibility of vertiports for different

Beyond the safety and environmental impacts, to realize the projected economic benefits of UAM, state and local governments will need to actively plan for UAM infrastructure to accommodate future demand, support private investment, and ensure certain viability of the UAM investments. The decisions on the location, design and organizational frameworks of the vertiports will need to allow room for growth based on both government and industry forecasts. As such state and local governments will need to incorporate vertiports into broader transportation and planning efforts.

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Chapter 7 Environmental policies and UAM

The previous chapters showed that environmental permission is leverage for local authorities to steer the desired introduction path of UAS within the urban environment. One of the most important present UAM concerns is the environmental impact of UAM operation, specifically around take-off and landing infrastructure. It has proven to be difficult to objectively measure the sound, as it is very dependent on the type of drone, weather conditions, flight path and cooperation of the operator/manufacturer. Also, in addition to the difficulty of measuring drone sound levels as such, the frequency of such sounds has a large impact on the perceived noise These noise, visual and CO2 impacts can limit the permission and operation of UAM services.

UAS and eVTOL aircraft noise may be classified as environmental noise, characterized by high frequencies and high tonality, especially for small aircraft; the frequency decreases with increasing rotor size. A general definition of visual pollution is the negative impact an individual may experience by viewing a visual pollutant and its movement. A visual impact may be defined as any object or artificial structure that degrades visual quality or distracts the individual, i.e. a subjective experience for each observer. A difference between noise impact and visual impact lies in the fact that while noise impact has both physiological (physically measurable causes and effects) and psychological (subjective) elements, the visual impact is purely psychological.

At the international and national level, in collaboration with the responsible agencies and the industry, standards and environmental reporting for UAM noise should be further addressed and aligned with the urban noise policies in place. That would allow local authorities and city planning departments to better consider the possible environmental noise impacts of UAM aircraft types upfront. With many new vehicle types and flight patterns coming on the market manufacturers and standards organizations will have to collaborate to minimize any noise or visual impacts generated by UAM aircrafts.

AiRMOUR findings (AiRMOUR, 2023) show that, although the perception of impacts increases with the number of UAM flights and decreases with the distance of the observer, the relationship is not linear. The results indicate that it may be a good idea to pre-plan UAS and eVTOL aircraft flight paths and corridors, which have a minimal impact on society, affecting as few people as possible with noise and visual impacts.

As it is situational, local methods must be used to reduce noise impacts. Recommendations include the idea of grouping drones closer together, which can lessen the visual impact overall. On the other hand a cluster of drones more easily causes emitted noise that exceeds the threshold for “pollution” compared to individual drones. In that respect, measurement and management of visual and noise impact will have to be dealt with in an integrated manner. Assessing noise exposure and expectations of residents nearby vertiports and along corridors is crucial.

In terms of policies and planning, the introduction of UAM will necessitate integration into the municipal noise and visual abatement plans. Related noise action plans must be designed to manage noise issues and effects, including noise reduction measure if necessary. As such, it is still necessary to further define measurement methods/procedures to support noise regulations and assessment of community noise and visuals impacts, and coordinate with UAM vehicle manufacturers on the development of low noise approach and take-off procedures for drone operations.

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Integrating the local authorities and community groups in the design process of the local UAM services is essential. An active approach in decreasing the noise and visual exposure linked to the UAS and eVTOL aircraft for the residents, and potentially mixing it with noise arises from the different land use, industrial areas, as well as traffic routes can be considered as a good approach. If done correctly this can help to increase the public's acceptance of UAM in metropolitan settings

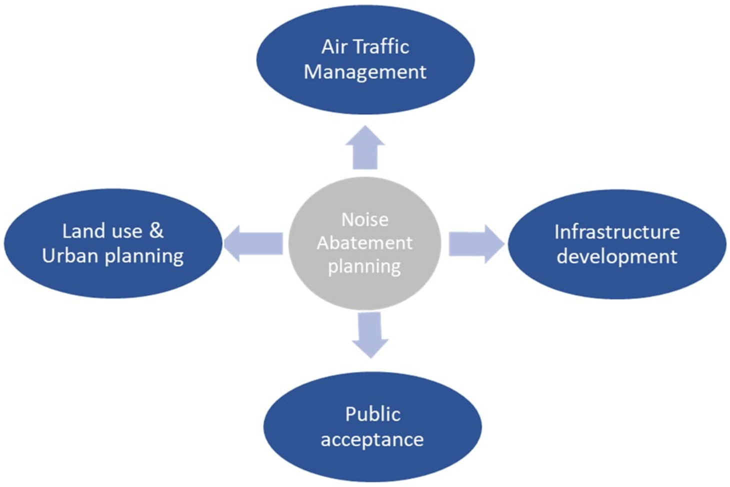

Figure 7.1 Urban policy domains to be considered by noise and visual impact abatement planning

When engaging with the local citizens and communities, careful treatment of possible environmental impacts and mitigation actions are needed. UAM noise policies need to be constructed with a view to preventing and reducing environmental impacts. In this respect local authorities could consider defining measures (e.g., sound insulation), preventive measures (e.g., creation of noise overlay zones), and operational measures (e.g., flight-routing, hours of operation) for noise abatement. Likewise, the showcasing of how to integrate UAM infrastructure with existing transportation infrastructure such as rail and road, and opportunities to place noisy infrastructure components where they will blend in with the pre-existing noise background are considered of use. Last but not least, the claim of any net zero-emission UAM service provision should be correctly proven.

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Chapter 8 UAM stakeholder integration and public acceptance

Several stakeholders will have to be engaged to achieve the responsible integration of UAM into communities to meet our daily transportation needs and serve the public good. Historically, city planners, politicians and business leaders did not consider the needs of the aviation community outside of local airports, but UAM changed everything. Cities need to be much more involved to serve their role as planners, managers and regulators of the public right of way for public good.

Considering the identified needs, aspirations, and concerns of UAM stakeholders is one part of the city's ongoing community engagement efforts. Implementing the UAM framework will require coordination and cooperation between regulators and agencies at every level, from national to local, to define and resolve any conflicts that may arise within the essential roles and responsibilities of the UAM operations.

Local authorities are presently not a core stakeholder group in UAM deployment. They represent a large and very heterogeneous group of departments with interests that may be conflicting and should be balanced between short-term goals and long-term objectives. They are well represented among AiRMOUR partner and replicator cities and will likely either define or participate in local communication plans to engage other stakeholders.

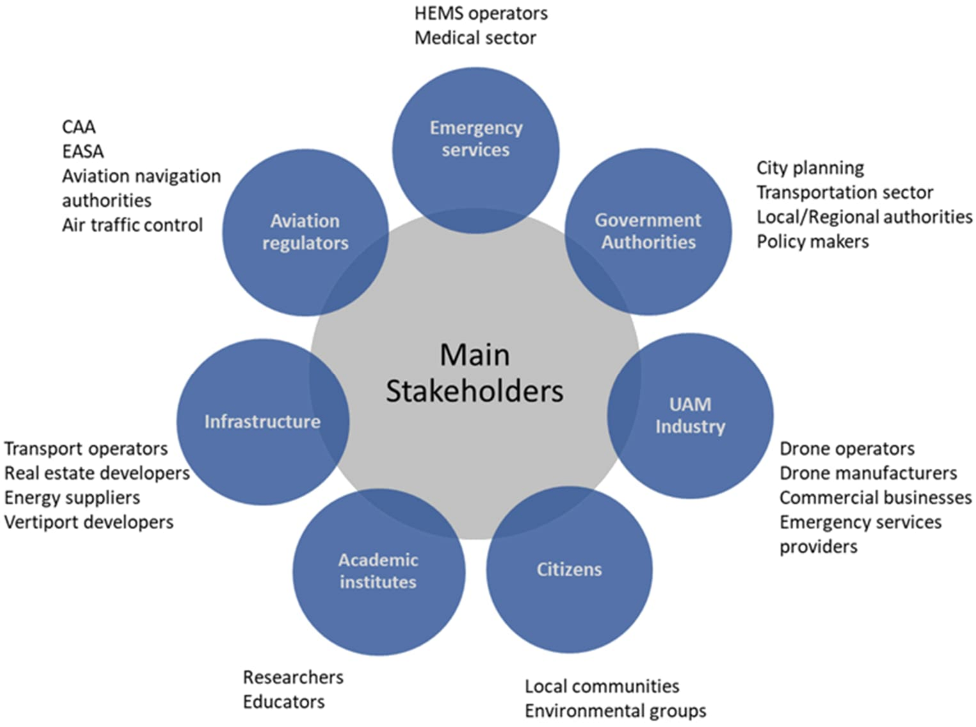

Figure 8.1 Main local UAM stakeholders

UAS and eVTOL operators may become natural allies to cities to help answer questions from citizens and to bridge the knowledge gap about aviation in urban environments. Companies developing or operating UAM aircraft are key stakeholders in the integration process. These

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companies will need to work with government agencies to bring forward the use cases and locations of interest, obtain necessary certifications and approvals, and ensure that their aircraft and operations meet safety and regulatory requirements.

Another primary stakeholder group are citizens. As UAM begin to operate in urban areas, communities and the general public will be affected by these new technologies, capabilities, and services. Community involvement is the process of engaging in dialogue and collaboration with communities affected by UAM actions. To ensure that communities are aware of the advantages and effects of UAM activities, as well as to address any potential concerns they may have, public engagement and education involving all stakeholders will be required. Additionally, academic institutes & research centres help in conducting research and development to advance UAM technologies and safety measures and increase awareness among the local communities. They can support industry players and regulators in developing and testing systems and technologies.

Whenever new transportation is introduced, communities must plan for the integration of those operations either within existing infrastructure or through the development of new facilities. Infrastructure developers provide necessary digital infrastructure and physical infrastructure such as charging stations, design vertiports, and other infrastructure required for UAM operations also play a crucial role in integration. Providers of private infrastructure that do not require EASA approval will, in particular, need to engage with relevant communities, minimize environmental and other impacts on communities, and foster community support.

The CAA mission is to oversee all aviation safety aspects of UAM integration, including operating rules, aircraft certification, and pilot certification. The agency provides a leadership role in identifying and integrating the responsibilities of all the key actors and stakeholders. is responsible for implementing the new UAM-related regulations, which have been set by EASA, for implementing nationally aviation regulations and for managing the airspace, including flight restrictions. Their primary responsibility includes protecting aviation safety, and they work to make sure that the industry (including original equipment manufacturers (OEMs), local and regional governments, and operators of aircraft and vertiports can handle UAM operations and make appropriate plans.

Emergency services, such as HEMS operators, and healthcare providers have vital roles and responsibilities in UAM, as studied in AiRMOUR. Emergency services may enhance city capabilities by adopting UAM as a complement to existing emergency-response fleets and personnel. Their involvement is crucial for rapid response, transporting patients quickly to healthcare facilities and delivery of medical supplies, disaster management and ensuring public safety. Based on AiRMOUR work, it seems clear that the adoption of UAM will, in the short term, require additional resources, with net economic benefits only being realized once UAM services have matured.

To sum up, the integration of UAM will require city and regional authorities to take an active role in shaping some aspects of UAM policy development. These key stakeholders from the UAM ecosystem must collaborate in order to strategically and effectively incorporate UAM activities into the larger planning framework for smart cities. City authorities could develop a platform for an Advocacy Advisory Committee (AAC), which will provide a high-level community lens in the development of a new UAM policy and record the needs of the local communities in which UAM will be implemented. The following table provides an overview of the possible stakeholders that could be part of such an AAC.

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Table 8.1 UAM component and relevant stakeholders

UAM elements	Description	Identified Stakeholder
Research and development	• Academic: workforce development and technology adoption • Industry: commercialization and regulatory	Research institutes Universities
Infrastructure	• Take-off/landing infrastructure • Energy resources • Severe weather management and urban wind	Airport authority City authority Land use planner Real estate developers Transport department
Manufacturing	• Aircraft original equipment manufacturer (OEM) • Design, manufacture and system readiness of UAS/ eVTOL aircraft • Iintegrated Communications and geospatial navigation systems (CNS) part of U-space	Drone manufacturer Automotive industry Technology providers
Operations	Air traffic management and concept of operations (ConOps): • Route planning and airspace congestion • Compatibility with infrastructure and aircraft systems • Service provider: aircraft and non-aircraft • Maintenance and repair, pilot training	UAS/ eVTOL operators Airport authority Ministry of Transport ANSPs USSPs CISPs
Public acceptance	• Urban safety and risk management • Noise & Visual impact • Privacy • Social equity • Communication plan	Citizens Disabled community Rural communities Medical sector Environmental planners
Supporting technology	• Develop technologies and platforms to be applied to vehicles & supporting system • Define standards to support AI applications • Airspace monitoring equipment	Industry player Technology providers telecommunications
Regulations/Policy	• Addressing each dimension of public acceptance • Applied to infrastructure, manufacturing and operations • Market and non-market (certification, standards and approvals) • Policies on research and development	European Commission Civil aviation authority Ministry of transport Municipalities/local authorities EASA
Finance/Investment	• Define business models • Public or Private: venture capital, bonds, equities • Public–private partnership (PPP)	National/state governments Private players Airport authority
Market demand	• By use cases and industry of end-user	Logistics Local pharmaceutical

This should be done in parallel to convening relevant stakeholder groups of national and local regulators and agencies.

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Chapter 9 Concluding

The integration of UAM within the context of urban policies is only starting. Addressing critical aspects such as regulations, organizational frameworks, environmental challenges, and public engagement strategies from an urban perspective are sketched yet not yet operationalized. This will need to be done in order to provide a real opportunity for the EU UAM vision and targets to be met. The AiRMOUR validation activities showed that specific actions aimed at urban planners, policymakers, and local stakeholders underpin the need for a multifaceted approach and mapping of the real potential impact of UAM on local mobility and related governance.

The research recognizes the transformative potential of UAM in addressing specific mobility and emergency and medical services. No expectation is presently shown that UAM will also address major transportation and logistics delivery challenges in the short term. More demonstrations and reflection on potential business cases of public interest are encouraged to keep the reflections ongoing, yet also to empower local authorities to make informed decisions on the topic of UAM. The European (EASA) regulations and the EU Drone Strategy 2.0, set the stage for responsible UAM development. This approach emphasizes safety, security, sustainability, privacy, and affordability, aligning with the broader goals of urban policies.

The critical need for evolving urban policies and regulations emerges in Chapter 3, reflecting on various policy domains impacted by UAM, including urban airspace regulations, traffic management, zoning, land use planning, and infrastructure regulations. Recommendations from the EU Drone Strategy, advocating for community involvement and integration into Sustainable Urban Mobility Plans (SUMPs), provide a strategic foundation for navigating the complex regulatory landscape.

The U-space framework, governed by EU regulation, establishes standardized digital services, underlining collaboration between national, regional, and local authorities. An evolving “traffic management” landscape with U-space, BVLOS UAS and eVTOL operations emphasize the importance of enhanced cooperation between aviation and non-aviation entities. Citizen engagement is highlighted, ensuring societal acceptance aligns with regional and local well-being and sustainable urban mobility policies.

More operationally, the UAM's integration into urban planning policies requires a comprehensive approach that considers zoning, safety regulations, noise, environmental concerns, community impact, multimodal connectivity, and height restrictions. Vertiports are recognized in this respect as critical components of a visual integration. The environmental impact, including noise and visual pollution, underscores the need for noise abatement planning and community engagement. The emphasis on a responsible and participatory approach, encouraging open data exchange, public consultation, and adherence to Sustainable Urban Mobility Planning (SUMP) principles at a later stage, is pivotal for successful UAM integration.

In conclusion, this deliverable tried to provide a holistic understanding of UAM's integration into urban environments. Striking a balance between innovation and societal well-being requires ongoing dialogue, strategic planning, and a commitment to addressing challenges. As UAM becomes integral to urban ecosystems, proactive measures, public awareness, and stakeholder collaboration will be key to shaping a sustainable and inclusive UAM future. More detail information can also be found in the different AiRMOUR Masterclass presentations and online course organised in cooperation with the Eurocontrol learning centre[3].

[3] https://airmour-learningcentre.talentlms.com/catalog (last check 22/12/2023)

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