

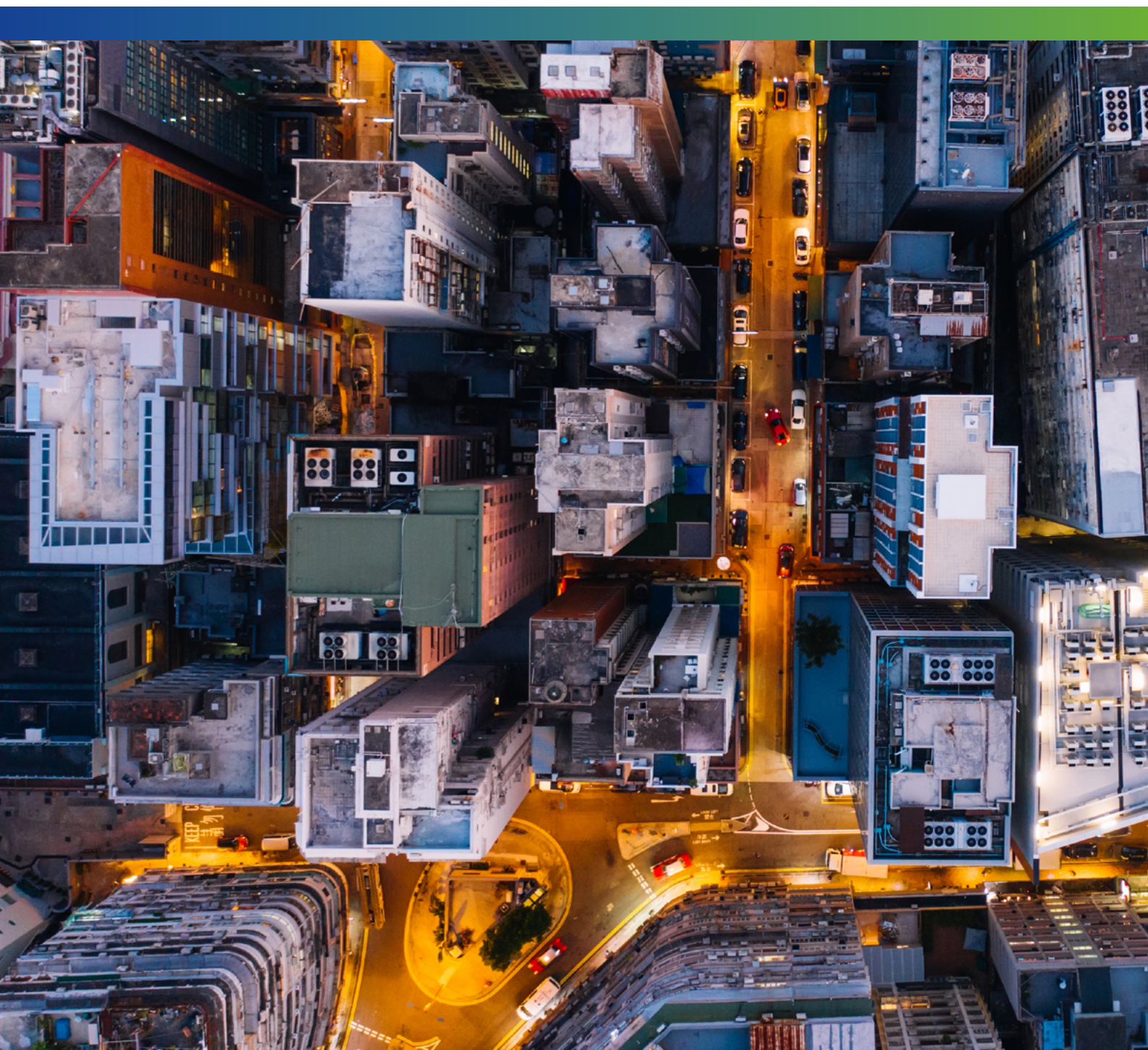
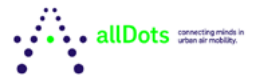


Urban Mobility Next 8

Expectations and success factors for Urban Air Mobility in Europe

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List of Abbreviations

AAM	Advanced Air Mobility
AGL	Above Ground Level
ATC	Air Traffic Control
ATM	Air Traffic Management
DAA	Detect And Avoid
eVTOL	Electric Vertical Take-Off and Landing
FAA	Federal Aviation Administration
GPS	Global Positioning System
OEM	Original Equipment Manufacturer
SESAR	Single European Sky ATM Research
SIG	Special Interest Group
SUMP	Sustainable Urban Mobility Planning
UAM	Urban Air Mobility
UAM-SIG	Special Interest Group on Urban Air Mobility
UIC2	Urban-Air-Mobility Initiative Cities Community
VFR	Visual Flight Conditions
VTOL	Vertical Take-Off and Landing

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Executive Summary

UAM in the European landscape

- The European UAM market size is predicted to be **4.2 billion EUR by 2030**, representing a **31% global share [4]**.
- Europe can build on a long history in civil aviation, being home to Airbus, Pipistrel and several leading universities such as Delft University of Technology, Technical University of Munich and ENAC (French National School of Civil Aviation) providing a solid industry base for UAM.
- UAM is expected to become a **reality in Europe within 3-5 years**. Several European manufacturers have applied for certification, and some pilot projects are already in progress. The European Commission and EASA's role are essential role in enabling this breakthrough.

UAM expected and current applications

- The majority of experts surveyed for this study expects that **UAM applications will play a very important (71%) or important (18%) role in improving medical transport and support in medical emergency services**.
- One main possible use case for UAM could be **regional airport shuttle links – as agreed by 47% of experts** – for instance between Andorra and Barcelona, or between Monaco and Nice airport. Whilst private use vehicles or taxi drones are considered **less important and more of a niche**, reflecting an expert's comment that "UAM can be an appropriate mobility solution for some rich people but not for the city as a whole."
- **63% of questionnaire respondents** think that UAM will play an important role in transporting packages in industrial spaces. By contrast, only a **minority of experts see a significant role in UAM applications in e-commerce and food deliveries**.
- **47% of experts** consider UAM applications in the field of **media and public information provision at events** as important.
- **47% of respondents** agree that **UAM will greatly improve urban mobility and transport**. This is in line with the **57% of experts** who agree that **UAM's value and opportunities outweigh the overall risks**.

Safety and regulatory framework

- When moving forward with UAM, **it is essential to consult citizens and important for them to feel safe**, where subjective safety matters as much as objective one.
- UAM operations should have **at least the same safety levels as today's aviation industry**.
- This is reflected by the fact that **67%** of questionnaire respondents wish for a **highly regulated air traffic for UAM with central guidance for entire routes**.
- **Experts are split when it comes to the most suitable regulatory level for UAM**, between a centralised (state-led) and localised (city-led) approach.

Outlook

- Traffic noise is a prevalent nuisance in the urban environment. EASA 's study on social acceptance of AAM in Europe, concluded that noise is the second main concern after safety. Analysing UAM's **noise emissions** warrant further study, to ensure a uniform high level of environmental protection, and to address the noise-related concerns expressed by European citizens.
- Continuous dialogue between stakeholders should address the required effort in terms of **investment, land use allocation**, adapted or new **regulations** that would be required depending on the scale of UAM operations.
- Mapping **living labs** is important to take stock of the progress made in implementing UAM, and **to identify citizens' needs** that can be efficiently addressed by UAM solutions.

1. Introduction

Urban Air Mobility (UAM) has gained traction in the public debate along with the multiplication of announcements of new UAM products and solutions. The topic quickly proved relevant for most public and private actors of the urban mobility ecosystem, who work toward assessing the potential of UAM, its development needs, and the most suitable regulatory framework for its deployment. **At EIT Urban Mobility our ambition is to foster the discussion on UAM in Europe and contribute to a better understanding of the solutions it offers across businesses, cities, research institutions and universities.**

In 2021, EIT Urban Mobility initiated the Special Interest Groups (SIGs), to shape the future mobility landscape by fostering public-private collaboration, addressing key urban mobility trends. **The goal of EIT Urban Mobility's Special Interest Group on Urban Air Mobility (UAM-SIG) is to support all UAM actors in the complex process of mobility transition we are facing, to create an ecosystem and to facilitate its development, in which all views and experiences are included.**

As far as UAM definitions are concerned, the term Advanced Air Mobility (AAM) is also sometimes used. AAM defines a future concept of mobility and of transportation of people and goods. It incorporates use cases of urban, suburban, and rural applications using innovative new aerial vehicles, such as unmanned aerial vehicles (UAVs) or electric vertical take-off and landing vehicles (eVTOLs). **The term AAM is often used interchangeably with Urban Air Mobility (UAM) but UAM mainly focuses on urban use cases and applications.**

The institutionalized European partnership between private and public sector SESAR 3 Joint Undertaking, in **their vision of the Digital European Sky**, highlight the need for:

“the aviation infrastructure (air traffic management) [to] be modernised at a more rapid pace and bring environmental benefits in the shorter term. Advancing innovations applied today in the digital economy will result in radical transformation of Europe's aviation infrastructure, making air transport smarter, more sustainable, connected and accessible to all.”

The Digital European Sky is relevant for UAM as it “leverages the latest digital technologies (“SESAR Solutions”) to increase the levels of automation, cyber-secure data sharing and connectivity in air traffic management, as well as to enable the virtualisation of its infrastructure and air traffic service provision in all types of airspace, including for very low and high-altitude operations.” [1]

In June 2022, EIT Urban Mobility organised a workshop on UAM, offering 23 city partners and UAM-SIG members the opportunity to exchange views on the topic, to identify best practices and

relevant use cases that can address challenges faced by European cities, and to give feedback and recommendations for the study. In addition, EIT Urban Mobility conducted an expert survey followed by targeted interviews. **Overall, 49 experts contributed to the questionnaire. Additional interviews were conducted with selected experts to share precise insights about their expectations for UAM in the European context.** The questionnaire and interviews covered the fields of opportunities and applications, implementation and perceptions, regulation and governance, as well as value created and vision.

This paper looks at the UAM context in Europe and aims to answer the following research questions:

- How has the market for UAM developed in recent years? What are the trends and forecasts for UAM uptake in European cities? Where is the EU doing well and where can it improve?
- What are the latest technical evolutions in the UAM sector? What timeline and developments can be expected until full-scale deployment?
- What do cities, citizens, and experts expect from UAM?
- How safe are drone operations today, and how can safety be further improved for UAM in the future?
- What are the biggest challenges cities and municipalities are facing with regards to a successful implementation of UAM on city level?

2. Evolution of UAM

2.1. How did aviation transform from traditional proven principles to new, urban focussed aircraft designs?

Urban-centred air mobility (transportation of people and goods) is not a new concept. Between the 1970s until the 1990s, major cities like New York, London and others had on-demand services for helicopter taxis. These services slowly came to a hold in the early 2000s due to accidents, air and noise pollution and the ever-rising cost factor of traditional fuel based aerial transport.

Urban-centred air mobility (transportation of people and goods) is not a new concept.

By the mid-2000s, however, this mode of transportation saw a revival through a redesign as start-ups and traditional aircraft designers were adapting proven technology concepts of small drones into new aircraft designs for passengers and, later, cargo. These technologies include but are not limited to at least a distributed electric propulsion system (the use of multiple rotors or fans), an interchangeable or fixed battery system, optimized aeronautical and navigation systems and lightweight frame construction design.

In 2010, Kitty Hawk Corporation, funded by Google Co-founder Larry Page, began development of the Kitty Hawk Flyer. A year later, in 2011, Marcus Leng, Founder of Opener, piloted the first manned flight of a fixed-wing all electric Vertical Take-Off and Landing (VTOL) aircraft. On October 21, 2011, the co-founder and primary designer of Volocopter, Thomas Senkel, flew the first manned flight of an electric multicopter, the Volocopter VC1 prototype. In 2012, Joby Aviation and NASA partnered to prototype an experimental eVTOL.

During the 2010s, the era of concept exploration was in full swing. **The shift to the 2020s marked the manifestation of three promising eVTOL aircraft concepts, each associated with their own advantages and disadvantages: Multirotor/wingless designs, Lift and Cruise designs, and Tilt Wing / Tilt Rotor designs.**




Multirotor (wingless) 	Lift & Cruise 	Tilt Wing/ Rotor 
<ul style="list-style-type: none"> ✔ Low efforts to flight control ✔ Inherent redundancy ✔ Low system complexity 	<ul style="list-style-type: none"> ✔ Medium energy efficiency ✔ Medium efforts to flight control ✔ Gliding possible 	<ul style="list-style-type: none"> ✔ Good energy efficiency ✔ Effective use of propulsion, no extra weight for carrying temporarily unused engines ✔ Gliding possible
<ul style="list-style-type: none"> ✘ Limited energy efficiency in cruise flight ✘ Limited flight speeds ✘ Limited/ no Gliding capabilities 	<ul style="list-style-type: none"> ✘ Ineffective use of propulsion, extra weight for carrying temporarily unused engines ✘ Increased drag in horizontal flight due to rotors (if not retractable) 	<ul style="list-style-type: none"> ✘ More complex design ✘ High efforts to flight control
>40 concepts	>20 concepts	>50 concepts
E.g. Airbus, Volocopter	E.g. Kittyhawk, Aurora	E.g. Lilium, A ³ by Airbus, Joby

Figure 1: eVOTL Configurations and Limitations [4]

2.2. How has the market for UAM developed in Europe in recent years?

Europe has in recent years emerged as a market leader in the development of UAM, having **announced** several pilot projects and being host of many original parts hardware manufacturers, second only to North America. The European UAM market size is predicted to be 4.2 billion EUR by 2030, presenting a 31% global share [4]. Europe is more urbanized than other global regions and on average the EU network of cities is denser than anywhere else with over 340 million European citizens projected to live in cities by 2030. Europe consists of mostly mid-sized rather than large cities with an average density of 3,000 residents per sq.km.. This makes EU cities twice as dense as US cities, but less dense than African or Asian cities. Europe is driven by a need to find greener solutions for mobility and transport and UAM offers some potential solutions. Industry insiders consider the advent of commercial UAM services a near certainty, albeit challenges to its implementation remain to be solved.

For parcel delivery, the most prominent concepts include B2B, and B2C delivery services for small items. **Many companies currently focus on urgent deliveries for high-value health care applications such as organs and defibrillators, however there are clear intentions to explore the B2C market for consumer products to complement conventional small parcel delivery modes.** A case study by Roland Berger for the use case of parcel delivery in Berlin determined that up to 1,200 drones could fly at the same time, delivering 3.6% of parcel deliveries under 2kg. This would partially shift transportation modes to the air relieving pressure on ground infrastructure [2].

Vertical mobility, the transport of people, remains technically the more challenging segment of the industry, as aircrafts are larger, and more is at stake if people are on board the aircraft. This comes with greater sensitivities to social acceptance of the technology, which is still seen as the greatest threat to the sector.

The industry is still on track to delivering the first commercial passenger mobility flights by around 2025. Joby Aviation, a world leader for air taxis predicts that its first commercial flying taxi operations will be available by 2024, in line with industry predictions that limited commercial services will be available sometime before 2025 – in some places for some people as a luxury service [5].

For the UAM to be successful the vision cannot stop at providing luxury services, however. There are several scenarios for the vertical mobility market, one more optimistic being that it will continue to develop into a relevant niche market that is accessible broadly to the population. In the failed scenario, the market will remain limited to only few users—in this scenario it would be “limited to an electric version of a helicopter for the rich” and “therefore a market that is economically and socially irrelevant” [6]. **Growth is likely going to be incremental rather than explosive,**

as services are expanding to a broader user base making UAM more accessible.

According to Porsche Consulting, 20-25 billion USD before 2035 in financing will be needed to make vertical mobility relevant [6]. There will likely be no positive return on investment before 2030, where a cumulative revenue of 60-65 billion USD is expected. Most of the necessary financing for hardware development is already funded with the remaining investment needs likely to follow in coming years.

Growth is likely going to be incremental rather than explosive, as services are expanding to a broader user base making UAM more accessible.

Strengths

- Large international share of hardware providers
- A leader in the development of UAM relevant regulations
- Strong ecosystem of research, private sector and policy institutions.
- Long history in aviation provides experience and know-how
- Leading authorities and thought leaders for the UAM industry tend to be HQ'ed in Europe.

Weaknesses

- Step-by-step regulatory process could lead to slower approval of innovative designs compared to China.
- Urban dwellers are hesitant to pay a premium for fast parcel deliveries.
- Dedicated noise certification standards that take into account the specific characteristics of UAM are still in development by EASA
- Infrastructure projects are notoriously slow in general and complex planning procedures

Opportunities

- Cities' openness to host pilot projects and test UAM concepts
- EU citizens generally show a positive attitude and interest in UAM
- Competitive UAM "industry" made in Europe
- Beside urban areas, Europe has several coastal, island use cases to connect and integrate rural and isolated areas to urban regions (e.g., Greece, Norway, Italy)

Threats

- Perception that the industry is social washing, by promoting medical use cases.
- Other jurisdictions are more willing to experiment and streamline political processes for experimentation.
- Perceptions and social acceptance by cities may pose greater challenge than in other regions

Table 1: European implementation of UAM compared to other global regions SWOT.

2.3. Today's market, operational & technical status quo of UAM in Europe

The UAM ecosystem has gained some maturity but is still considered as an Early-Stage Market by the end of 2022 [7]. Europe can build on a long history in civil aviation, being home to Airbus, Pipistrel and several leading universities such as Delft University of Technology, Technical University of Munich and ENAC (French National School of Civil Aviation) providing a solid industry base for UAM. The sector of eVTOL manufacturers and original equipment manufacturers (OEMs) has developed massively in recent years. **Currently, more than 200 eVTOL designs and concepts are being developed and tested.** In addition to established traditional aviation companies, start-ups are emerging as important OEM players in the UAM market such as European companies, Volocopter, Wingcopter, Lilium or Ascendance Flight Technologies.

In the coming years, these novel aerial vehicle systems will go through the certification phases, some of which are already advanced, on their way to approval. Europe is leading the way in establishing demo and pilot regions and projects, for example in Frankfurt, Paris, Cologne and Düsseldorf, Linz, Hamburg, Helsinki, Ingolstadt or Islands off the coast of Malta. Those trials and demo sites will increase during the next years on Europe's roadmap to certify and implement passenger, cargo and emergency UAM use cases by 2025.

3. UAM current scenario

The full potential of UAM rests on several elements within the ecosystem that need to be in place concurrently. The concept of UAM thus involves more than the new kind of urban focussed airframes and technologies but UAM depends on an ecosystem comprised of manufacturers and their suppliers, ground infrastructure such as vertiports and parcel stations but also infrastructure designers, air traffic management system providers and multi-modal flight booking and pooling software companies like Uber Elevate. These need to be backed with policy development, research and regulatory development.

The European Commission and EASA have developed frameworks to advance UAM as one block, which has given the EU advantage. The EU has invested into several research programs, among the most prominent being the joint undertaking SESAR, which is implementing research towards Europe's vision for a unified digital sky. The UAM Consortium within SESAR comprises a broad stakeholder base that is currently undertaking demonstrations on U-Space, as well as demo activities in multiple European countries. The EU is globally first to establish a comprehensive

regulatory framework for U-Space in anticipation of increasing air traffic due to the presence of UAS (unmanned aerial systems) alongside conventional aircraft. With regards to certification of new aircraft designs, the United States is leading in the work to develop a certification framework for eVTOLs. The EU’s Smart Cities Marketplace has developed extensive guidance through a practitioner’s briefing on how cities and regions can implement UAM in mobility planning and urban development in relation to Sustainable Urban Mobility Planning (SUMP) to support cities on their path to implementing UAM [8].

Technical challenges still exist, as, for example, the certifiable solution that will enable automation and finally fully autonomous operations is yet to be developed and at the current state of knowledge, small drones cannot safely fly in environments with wind flow speeds greater than 5 m/s (NASA)-- this is an impediment for urban areas where tall buildings cause local wind tunnel effects. [9]. European cities are also denser than US cities which translates to greater potential of communal impact for better or for worse. **Much still needs to be learned in terms of what UAM means for urban planning, zoning, air rights, public transportation, real estate development public acceptance and access inequalities [3].**



Figure 2: UAM Cargo Vehicle Implementation Roadmap [4].

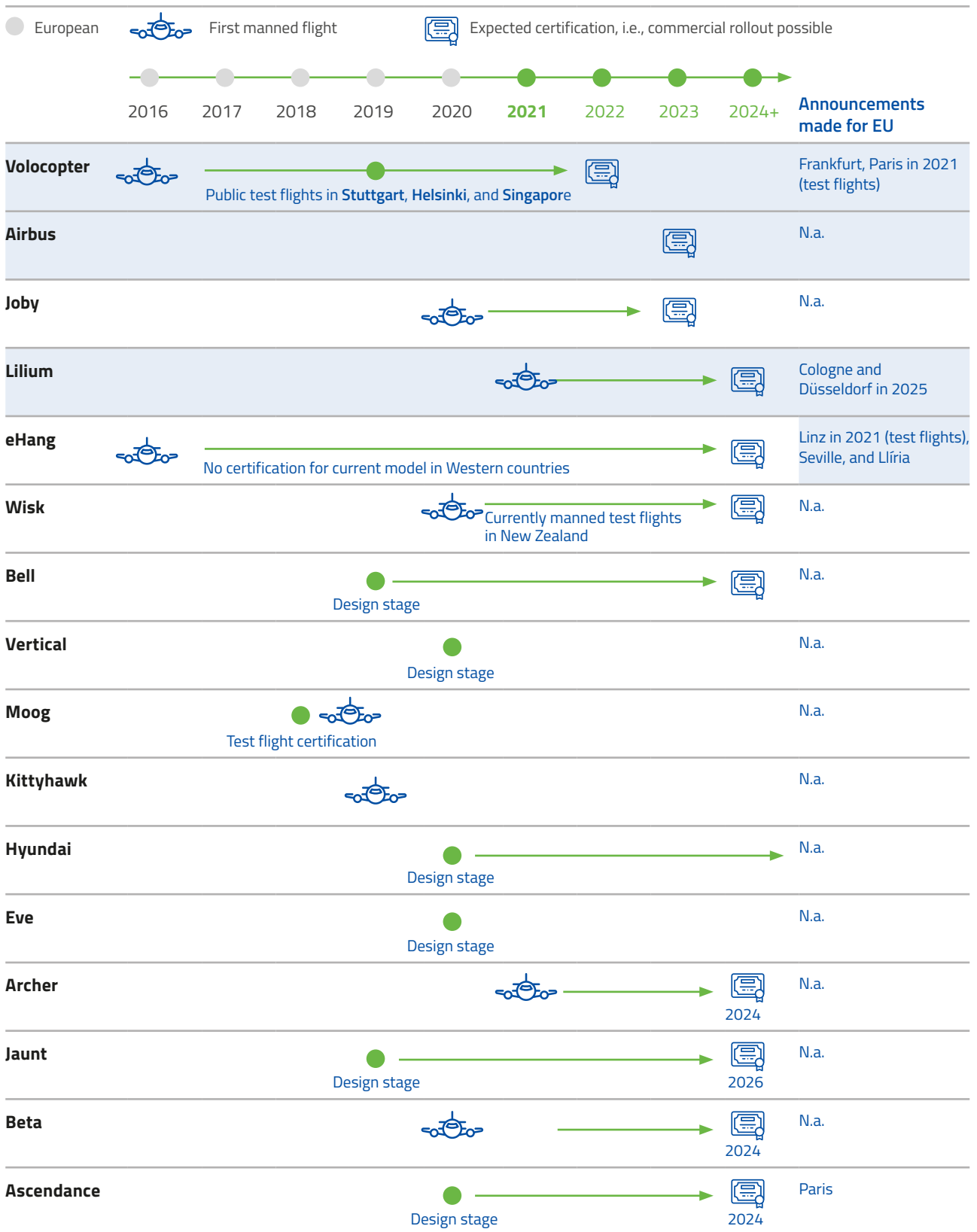


Figure 3: UAM Passenger Vehicle Implementation Roadmap [4].

Today, several European municipalities are already hosting small-scale cargo vehicle operations. These include food deliveries in Helsinki, medical logistics in Zurich and Lugano and emergency defibrillator transports in Gothenburg. Many operations for parcel delivery however are still limited to low-risk settings, or even over water to strategically manage the risk posed by overflying people, such as pilot flights conducted near Rome to transport medical supplies.

In the realm of passenger transport, the first commercial services are mapped to take off in 2024 and 2025 however these will involve fully trained pilots before transitioning in a stepwise manner to remote piloting and eventual autonomy. Policy makers, technologists and regulators are thus still in phase of progressively building up their expertise with UAM prior to moving fully into autonomous operations in complex urban environments. The SESAR ATM master plan considers the possibility to reach the implementation of full SESAR vision in 2040 (option 1). The broader vision that EASA supports for UAM includes a level playing field in the EU, that delivers social value to citizens, where people can access taxi drone services that will be 1,500 times less likely to be involved in an accident compared to road transport on a passenger km basis, where organs can be delivered between city hospitals 73% faster and transit times between airports and cities are reduced by factors of 2-4 [4].

4. Expected UAM use cases

Almost half the experts surveyed think UAM will greatly support improved urban mobility and transport, with a large majority anticipating a positive contribution especially in supporting with medical emergencies. Overall, UAM applications are expected to generate new and innovative business approaches, attracting talent and highly skilled labour to cities where they are deployed.

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4.1. Methodology

This section defines the methodology employed to gather data from UAM experts. The stakeholder workshop and questionnaire are described herein. Details about the organisations participating in the survey can be found in the annexes. The findings of the data collected are presented and discussed in the sections to follow.

Stakeholder workshop

The recent evolution of UAM and current scenario projections call for a closer assessment of city use cases. In June 2022, EIT Urban Mobility organised a workshop with 23 practitioners from the private and public sectors exploring the most relevant use cases in European cities, looking at their ongoing projects and expectations.

Expert survey

A survey was set up to collect practitioner insights on the development and implementation of UAM. As this study focuses on the UAM landscape in Europe, survey respondents were asked to provide answers in relation to the European context, based on their experience and knowledge of the UAM market in Europe.

The questionnaire was produced in English and was translated into four different languages (German, Spanish, Italian, and French). Microsoft Forms was used to administer the survey, consisting of 6 content-related sections and 26 questions. The outputs of the survey were analysed using Excel software.

4.2. Participants and respondents' profile

This section presents an evaluation of the participants and respondents' profiles.

The first section of the survey included questions related to demographics, location of residence, experience and background, and prior knowledge of UAM. **A total of 49 respondents from 12 European countries participated in the questionnaire.** 10 % of participants are from research & academia, 16% are from the public sector (public administration/government/ ministry), and 47% are from the private sector (UAM industry and services). The results show that the majority of respondents (71%) are knowledgeable about UAM, and that very few (6%) are not knowledgeable on the topic.

As far as city representatives are concerned, it is important to note that every city has a different attitude when it comes to adopting UAM. Some cities are pioneers in implementing pilot use cases whereas some are not aware of the new technology. The attitude of cities towards the new form of mobility is developing from their own as well as other's cities experience in UAM projects or from other new mobility trends like e-scooter.

Most of the cities classify themselves under the three categories for implementing UAM depending on their level of maturity:

- **Front runner cities:** These cities are the ones which have a positive and excitement mindset towards implementing UAM. These are the kind of cities which are most likely to have a wealthy background to afford research and implement latest technology trends.
- **Follower cities:** These cities have an overall positive mindset but are observant towards the new technology and with what the front runners are doing before implementing any steps.
- **Observers/Non-adopters:** These cities generally have an attitude of indifference, lack of awareness, or scepticism towards implementing UAM.

Beyond this categorisation, it is essential to take the heterogeneous attitudes within cities' administrations into account. Economic departments are in general rather more eager as this is an upcoming opportunity for new revenues, driver for the local economy and new job employment aspects. On the other hand, this topic is a worrisome situation for the planning and traffic department as they see challenges about the regulations and the infrastructure requirements of this form of transportation which need more staff and budget to manage it properly considering the industry and public interest.

At this stage it is difficult to gauge UAM acceptance because the technology is not fully mature yet, and there is no experience with UAM operations at scale. Even if individual effects can be positive, the aggregate effects of UAM can be negative (e.g., one air taxi over a neighbourhood compared to hundreds of them).

4.3. Citizens and cities experience with UAM

To improve cities' safety assessment, there is a need for more experiences and evidence through pilot use cases. This will help cities find systems that are trustworthy and reliable to organise the traffic over their urban spaces.

The important aspect when considering UAM operations and regulation is that vehicles fly "low" level (manned flights between 500 and 2500 feet Above Ground Level (AGL)) over people. However, drones e.g., cargo delivery will fly lowest level under 500 feet AGL. **Whether the journey is interurban, urban, or metropolitan is not the crucial question. In this regard the UAM debate differs from most of the mobility discussion.**

Pilot projects should give people the chance to assess the value of UAM. UAM operations need to demonstrate that they are bringing something tangible to people. For instance, drone services could have two tiers: emergency services as a priority, and VIP services only when there is no emergency.

Demonstrations are crucial, as the many ongoing projects currently funded by SESAR illustrate. Examples of pilots include:

- Pharmacy product delivery
- Mapping invasive species
- Tracking of oil spills and (wild) fires
- 3D mapping for digital twins
- Traffic flow mapping

In addition to pilots and demonstrations, living labs to engage with citizens are key to develop meaningful UAM systems that answer real needs. Part of citizen engagement in UAM consists in inviting citizens to project demonstrations in order to ask them their impressions. Bringing citizens into pilots lead to better knowledge and acceptance.

4.4. Visions for UAM deployment

The basic questions that need answering when discussing UAM deployment are:

- For what?
- For whom?
- For what benefits?

Linked to these questions, cities and citizens are reflecting upon the following:

- What can UAM do, that other modes of transport cannot do?
- How do we evaluate and foster complementarity between the different modes to maximise sustainability gains?
- How to ensure UAM is affordable and inclusive?
- How to manage air traffic over cities?
- How to manage safety risks?

General expectations

High safety standards for systems and solutions themselves are expected by cities. UAM can increase the safety of people's and of goods' mobility, but it is also important for citizens to feel safe (subjective safety matters as much as objective one).

Safety of the UAM equipment is a priority, and cyber security is another dimension of the safety debate (hard- and software safety are as important as each other): an important barrier to

consider is the question of liability of the city for whatever may happen to citizens with an UAM crash (e.g., will elected politicians will bear responsibility for such events?)

To ensure proper safety and regulatory standards in line with cities’ expectations, UAM should be considered in the sustainable city mobility plans and projects – as recommended in the UAM practitioner briefing developed by the Urban Air Mobility Initiative Cities Community of the EU’s Smart Cities Community (UIC2) Marketplace [8]. Part 5 provides more insights on safety.

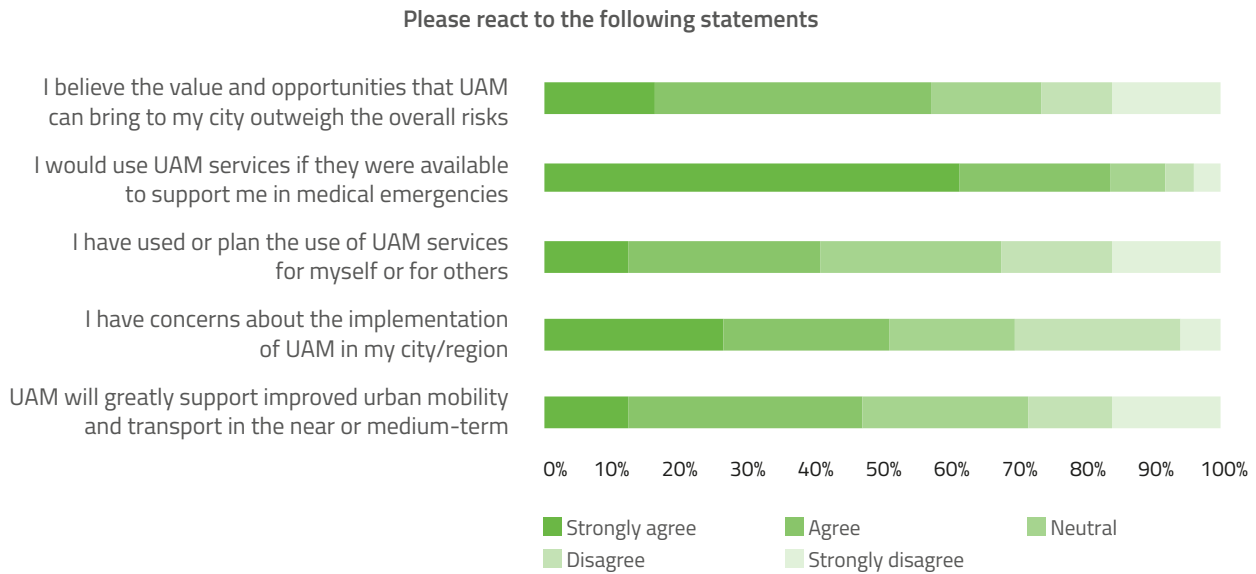


Figure 4: Value Created & Vision.

However, there are some regulatory impediments to the implementation framework: some cities are not responsible for the regulation over their territory because of state or federal law.

Figure 4 shows experts’ attitudes toward future UAM developments. **83.6% of respondents agree that they would use UAM services if they were available to support them in medical emergencies**, confirming the relevance of UAM applications for medical and emergency related services.

Interestingly, expectations for the near to medium terms are quite high with **47% of respondents who agree that UAM will greatly support improved urban mobility and transport**. This is in line with the **57% who agree that UAM’s value and opportunities outweigh the overall risks**. **31% of respondent do not have concerns about UAM implementation in their cities**, while 51% do.

Community acceptance of UAM technology is a key pre-requisite to its implementation. City officials consider UAM as long-term horizon, not an immediate priority because of the numerous safety and sustainability concerns over maturity of the solution. There is also a question of space use in a context of city densification: mobility flow densification and higher density of inhabitants per square meter is a trade-off.

UAM use cases must solve existing urban mobility problems without creating more nuisance. On the contrary, UAM should create economic development cases for cities (see figure 7) and help improve mobility objectives to move people and goods in safer conditions, with a more sustainable CO2 footprint, and in a more efficient way.

The contribution to more sustainable cities is a core key condition to support further UAM operations. At its core, UAM should contribute to social sustainability, inclusiveness, and equity.

4.5. Variety and relevance of UAM use cases

Information about the perceived importance of UAM applications (in terms of services they can offer) were collected both during the workshop and in the survey. Applications can be divided between data acquisition, logistics, movement of people, entertainment and luxury, as well as new business development.

Logistics

Four main categories were identified in the logistics sector: e-commerce deliveries, food deliveries, medical transports, and transport of packages in industrial spaces.

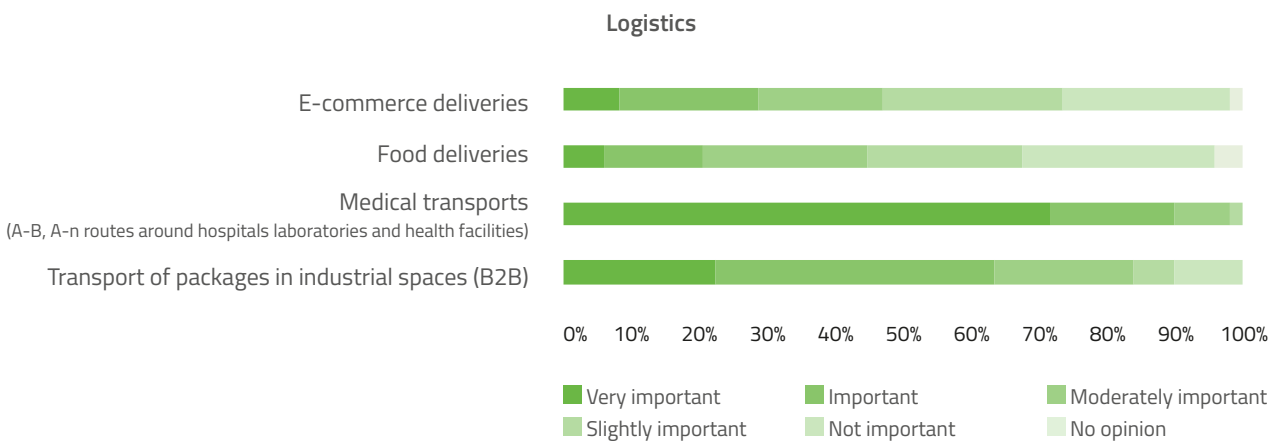


Figure 5: In the field of logistics, medical transport is expected to benefit the most from UAM applications.

Figure 5 clearly shows that a vast majority of respondent expects that **UAM applications will play a very important (71%) or important (18%) role in improving medical transport.**

63% think that in the logistics field, UAM will play an important or a very important role in the transport of packages in industrial spaces.

By contrast, only a **minority of experts see a significant role for UAM applications in e-commerce and food deliveries**, with only 29% and 20% considering them important, respectively.

Movement of People

For now, the right use case for UAM still needs to emerge. While it can lead to a disruption in how people move, it is not clear yet whether it will mostly affect urban, metropolitan, or inter-urban areas. Figure 6 provides insights on the most important expected UAM applications for passenger mobility services.

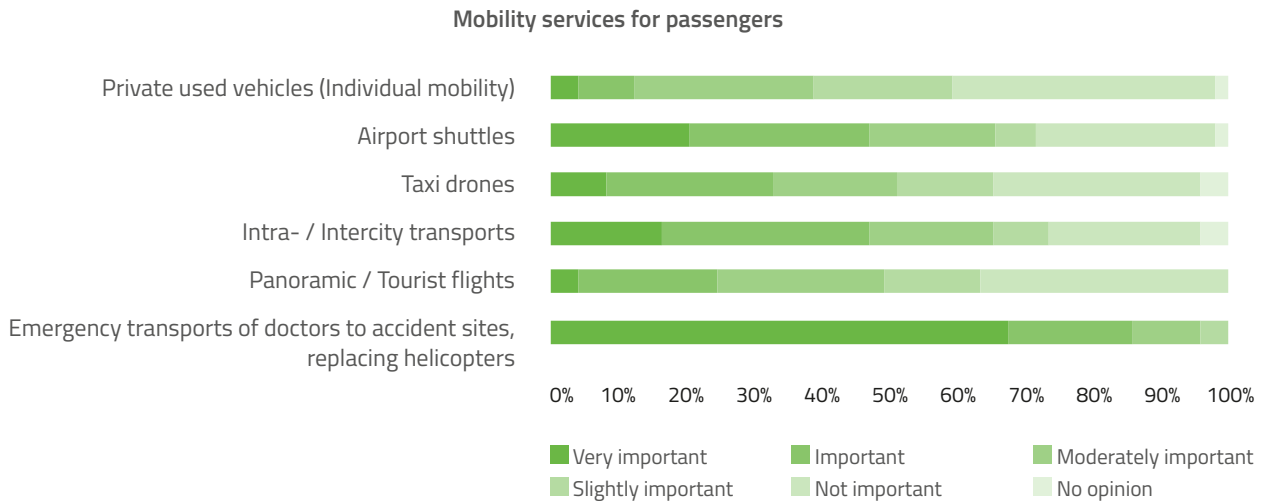


Figure 6: Emergency transport of doctors to accident sites is by far the most important expected UAM application for passenger mobility.

UAM applications are expected to play a very important (67%) or important (18%) role for emergency transport of doctors to accident sites, as a replacement for helicopters. This appears coherent with the anticipated importance the technology will play in supporting medical logistics services.

As far as non-urgency related mobility is concerned, **47% of experts consider airport shuttles an important or very important application**. A special use case for UAM here could be **regional links** – more than half of the respondents see an important (31%) or very important (16%) role for UAM applications there – for instance between Andorra and Barcelona, or between Monaco and Nice airport.

Private use vehicles or taxi drones are considered less important, reflecting an expert comment that “UAM can be an appropriate mobility solution for some rich people but not for the city as a whole.” Compared to ground-based transportation, UAM might reduce travel times. Rothfeld et al. conducted simulations for three scenarios: Munich Metropolitan Region, Île-de-France, and San Francisco Bay Area, to calculate congested trip travel times for each trip’s original mode (i.e., car or public transport) and UAM, and to determine potential UAM trip shares under various UAM parameters such as the cruise flight speed, process time, and number of stations. Under base-case conditions, the share of motorized trips for which UAM would shorten the travel

times falls between 3% and 13% in each of the three scenarios. In comparison to private-vehicle usage, UAM's (base case) travel times are expected to be competitive beyond the range of a 50-minute car trip and are less than half as much influenced by traffic congestion [10]. While UAM is not ideal for mass transport, the underlying technologies could be suitable in areas that, for instance, cause large detours for ground-based transportation.

New Business Development

Economic development is an important factor to consider when discussing UAM uptake. One of the key challenges linked to UAM deployment will be to reconcile its role in supporting local innovation ecosystems while at the same time not worsening space problems in cities. In addition, the question of the cost savings the technology can bring will also determine its contribution to economic development. New business development around UAM can also act as a job magnet for highly skilled new inhabitants of the cities.

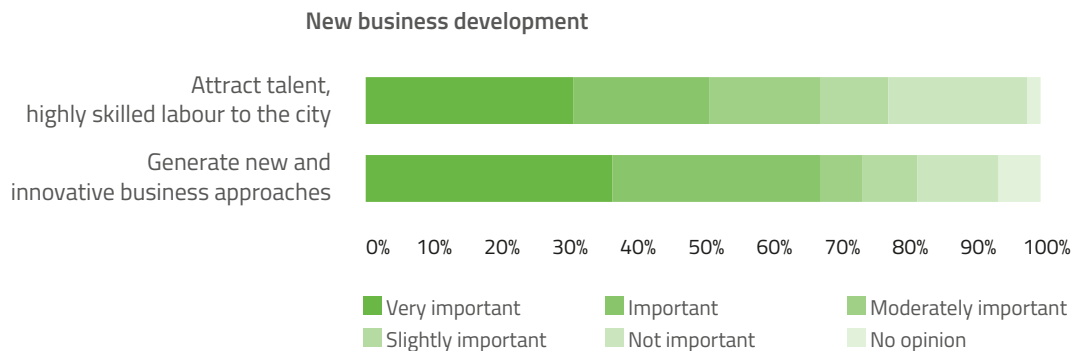


Figure 7: New UAM applications will play an important role in generating new and innovative business approaches.

Figure 7 shows that in terms of new business development, **the contribution of UAM application is deemed substantial to generate new and innovative business approaches**, with 37% of experts considering it very important, and 31% important.

In line with this, **UAM role in attracting talent and highly skilled labour is assessed as very important (31%) and important (20%)**. Interestingly the expectation on the sector on new business development contrasts with the attitude to the evaluated use especially regarding the mobility service for passengers. Such a business development and attraction of a region for driving new businesses could not be borne only by medical services and e-commerce delivery per drones.

Entertainment and Luxury

The assessed importance of UAM applications in the field of entertainment and luxury varies **between media and public information provision at events (very important to 27% of experts, and important to 20% of them)** and light shows and choreography. Only 18% of respondents considers this latter category important or very important.

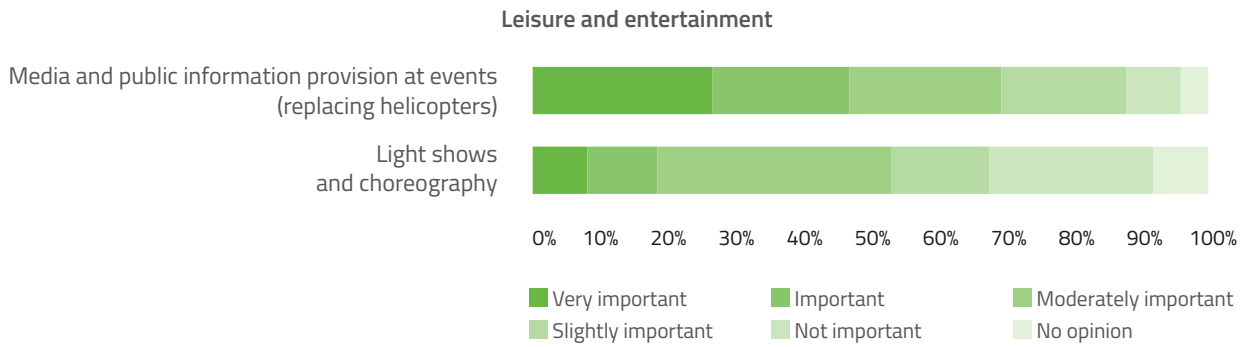


Figure 8: The most important UAM’s leisure and entertainment services are the provision of media and public information at events.

Data Acquisition

UAM applications are considered useful to support with activities related to data acquisition, such as 3D mapping of construction sites, infrastructure inspection and maintenance (esp. buildings and roads), port operations, and traffic planning and management (e.g., in locations where a temporary data collection is preferred over permanent cameras). For example, the Open Science Initiative of pNEUMA¹ enables better traffic congestion monitoring and more efficient transport planning strategies. Through the distribution of this dataset, researchers, anywhere in the world, can produce and build on existing transport models, and can conduct research from an open benchmark dataset, and produce and build on existing transport models. Further applications relate to crowd control in confined areas (including harbour regions and big events), search and rescue, or support to emergency services (fire department, police).

¹ www.open-traffic.epfl.ch

5. Safety aspects of UAM implementation

5.1 How safe should UAM concepts be?

Cities and its citizens' confidence in UAM is a key prerequisite for the uptake of these solutions. This confidence will come if citizens feel safe with the operations, either while using these services themselves or having these aircrafts fly overhead.

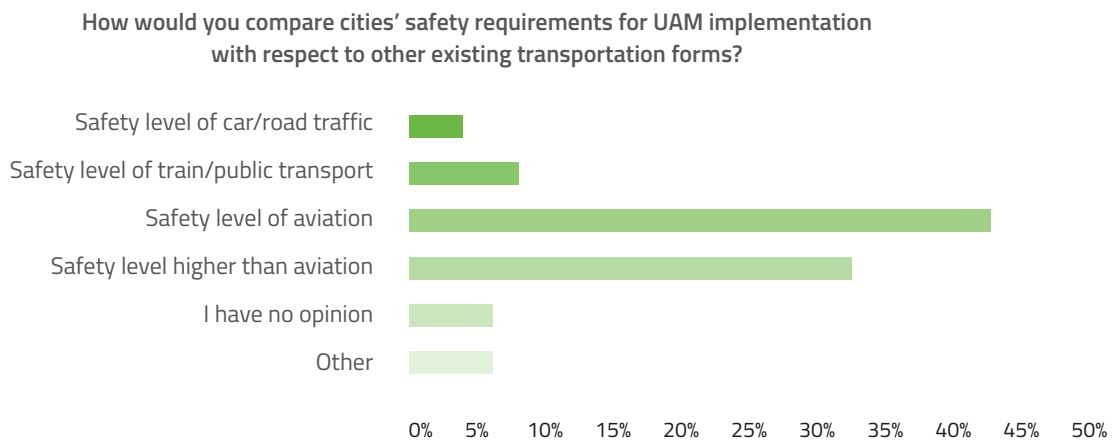


Figure 9: UAM safety level should at least match today's requirements for aviation.

Figure 9 illustrates expectations of questionnaire respondents vis-à-vis safety levels of AAM operations. **43% of respondents confirm that they expect UAM to have the safety levels equal to the existing level of aviation safety for commercial aviation. A third of the respondents have stated that they would expect this level to be even higher than aviation today.**

Today's national airspace systems are particularly safe for commercial air operations. According to EASA, their regulation has led to the lowest rate of fatal accidents per one million worldwide. This rate has remained well below 0.5 fatal accident per million departures since 2006 [11]. The emergence of new and innovative aircrafts for UAM and their anticipated novel operations are a disruptor to the means of regulating air traffic today. The regulatory bodies of aviation are currently working on adapting their approaches to ensure that this new system will also provide highest operating safety level. **According to EASA, UAM is therefore assumed to be subjected to the same safety standards as traditional commercial aviation.**

Accomplishing the current safety standards has taken the aviation industry decades, but UAM is expected to exceed or at least meet these standards in a much shorter amount of time: companies designing and building UAM systems are required to implement the necessary safety precautions and redundancies to ensure that air vehicles can operate safely even under highly unusual circumstances. An unsafe system could have widespread implications for public acceptance [2]. As a result, various regulatory considerations to ensure safety have been mandated.

Certification considerations

The certification authorities are developing new regulations for certifying the design of the new form of UAM aircrafts. Type certification is required for any aircrafts carrying passengers or cargo. In case of vertical take-off and landing aircrafts called VTOLs, EASA has developed a complete set of dedicated technical specifications that address the unique characteristics of these vehicles and prescribes standards to certify their airworthiness. This will ensure that VTOLs comply with the necessary safety requirements [13].

Operational Considerations

It is also important to follow operational safety, after design safety, when the aircrafts are flying over the city denser airspaces. The design concerns relating to the safety of the aircraft would be considered along the aircraft certification process, but the operating considerations and access to the airspace are addressed through the operational approval process. This mainly relates to the air traffic management system of the AAM ecosystem. EASA's Air traffic management masterplan shows the roadmap of projects to finally achieve a status where a certifiable ATM (eco-) system is defined including high level of automation: **“it should be possible to reach the implementation of the full SESAR vision by 2040...”**[14].

Personnel Considerations

Along with the above-mentioned considerations, the personnel operating the aircrafts are also vital to ensure the safety of both vehicles and operations, pointing out to the need for safety procedures as in commercial aviation today [15]. Meanwhile, new qualification systems are in development considering the specific type of operations and vehicles (eVTOL) with upcoming new features including simplified vehicle operations (SVO) [14].

5.2. What are possible UAM-related hazards?

The term “hazard” can be defined as a condition, event, object, or circumstance that could lead to or contribute to an unplanned or undesired event or state [6]. The unplanned or undesired event/state may be the result of a single hazard but more often is the result of a series or combination of hazards.

Since UAM is based on a new technology, early identification of potential hazards is important for a system so that corrective actions can be taken to minimize risks. **To avoid probable hazards, UAM stakeholders should take preventive actions, for instance with intelligent design decisions for the city infrastructures.**

UAM area	Examples of potential hazards
Operations of aircraft and traffic management	Upset attitude of the vehicle, UAM route conflicts with existing air traffic, Loss of safety-critical functions on ground station
Technology of aircraft	Failures with the powertrain, Failure or spoofing of GPS/Receiver, Problems with the autonomous systems leading to accidents/crashes
External environment	Weather, collision with birds, tall buildings, power lines
Human related	Inadequate pilot training for maintaining safety margins, Loss of pilot situational awareness and errors made by pilots, passenger interference in the systems, emergency/ sickness situations of the passengers
Cybersecurity	Hijacking of the air vehicles
Ground infrastructure	Lack of vertiport availability (occupied, damaged, closed to traffic), Inadequate ground crew training for maintaining safety margins

Table 2: Examples of potential hazards for cities during UAM operations (Source: [17]).

5.3. How can traffic over city airspaces be safely orchestrated?

Currently all airspaces above urban areas are a national remit according to EASA. Traditional air traffic control service providers are public institutions, which follow mandatory regulations.

Factors limiting airspace capacity today are air traffic controllers’ workload, the cognitive capabilities of pilots, and the ability to ensure vehicle trajectories to very close tolerances. **To make UAM at scale possible, a paradigm shift for air traffic management including new flight**

rules is needed. [18] The EU's SESAR program on U-Space definitions is intended to open the field for innovations also in the field of urban air traffic management systems. In fact, to foster innovation, the first regulations kept the possibility for urban air traffic control to be developed and operated also by non-governmental bodies in the classified airspaces. The deployment of UAM will make this classification of airspaces much more relevant to cities.

From a city point of view, the question is whether air spaces above cities should become an extension of their public space? If the answer is yes, this would have important regulatory implications as cities would have the competence to regulate UAM operations within their boundaries.

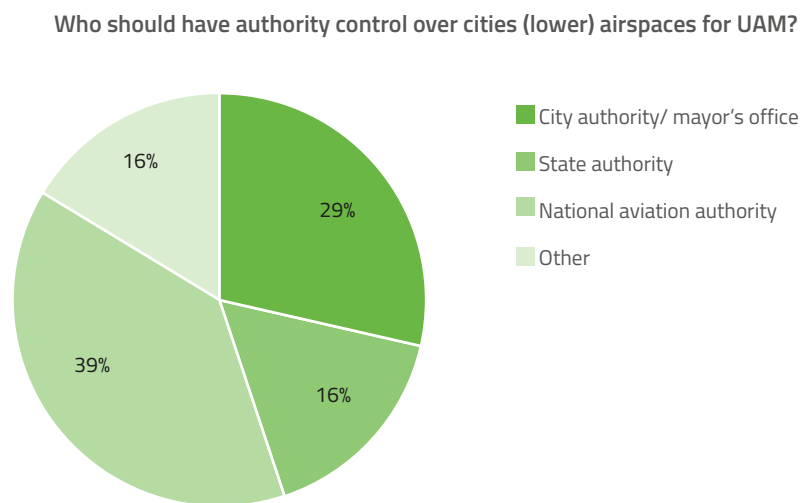


Figure 10: Experts are divided as to the best regulation level for UAM over cities' lower airspaces.

Figure 10 illustrates the expectations of experts about whom they think should have control over the cities' lower airspaces. **39% of respondents, which form the majority, believe that the lower airspaces should be regulated by the National Aviation Authority. Almost a third of questionnaire respondents (29%) think that the city authority should have a department taking care of regulating the air traffic above them.** 16% of experts believe in another form of centralised regulation.

Both the survey and workshop discussions indicate that there is no clear consensus on this important question and shows the need for further investigation. When it comes to ground infrastructure e.g., vertiports the city planning departments are already in charged and hence some experts from the workshop also consider the inclusion of air traffic management in the city authority.

On one hand, cities have a better understanding of their assets and long terms plans of infrastructure while on the other hand the aviation authorities have the competence of airspace

management and knowledge of air traffic control regulations. Since the majority of the cities from the workshop strongly believe that UAM is an urban mobility mode, a new integrated and interoperable approach may be needed, if UAM is to serve urbanites and prove its expected benefits. Some cities cannot do much about the regulation over their territory because of state or federal law. Taking an example from the city of Strasbourg, the transborder aspects turn out especially important and UAM in this region would need a new transborder framework of regulation - collaboration between private and public sector is important to craft this new framework [12].

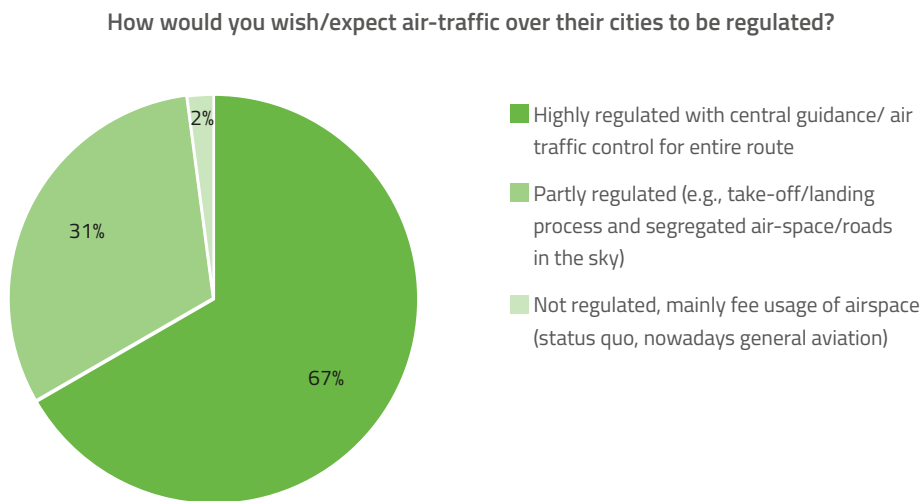


Figure 11: 2/3rd of respondents expects highly regulated air traffic control with central guidance.

67% of respondents expect that UAM air traffic must be centrally regulated, while 31% of the respondents think that regulation of take-off and landing or segregation of airspaces in the air-space during the flight will be relevant and is a necessary area to be regulated. However, today's lower airspaces including most urban airspaces, are uncontrolled and flights are operating under Visual Flight Rules (VFR) conditions, meaning pilots are in full control. In the operational ATM environment manned and unmanned aircraft are expected to co-exist safely, which also includes the UAS in the airspace below 500ft. The operators for such UAS and pilots will be supported by U-Space services, for example for flight registration, planning and strategic deconfliction.

How would you expect the regulation of air traffic to be organized?

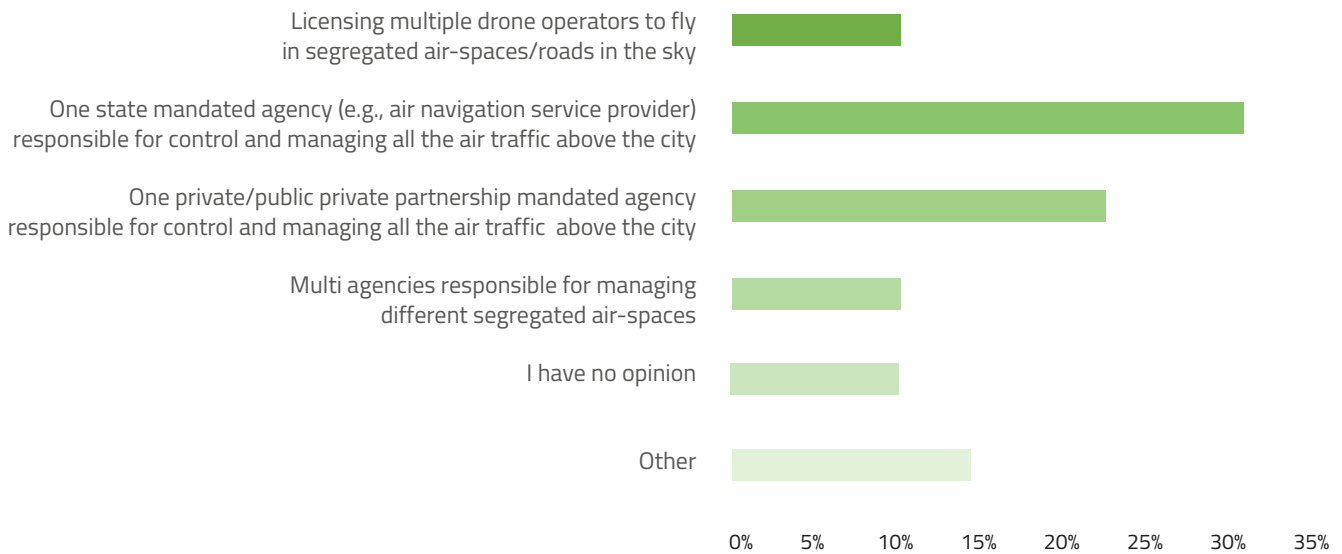


Figure 12: Experts anticipate only one entity in charge of regulating air traffic.

Figure 12 shows that the majority (54%) of the respondent hold the view that only one organisation should be mandated to regulate air traffic over cities. While a third of the experts think one state mandated agency should regulate such traffic, 23% of the respondents believe that one public or private entity in partnership with the state authority should be responsible for regulating the lower airspace traffic. 10% of the respondents think that there could be multiple agencies that will manage different parts of the airspaces. Comparably same number i.e., 10% of the respondents have an opinion that the lower airspace can be regulated by licensing multiple drone operators to fly in segregated airspaces.

Considering UAM scalability expectations, managing a significant number of vehicles in dense and complex airspaces, a unified method of commanding these air vehicles will be required to achieve a safety level of aviation or even higher. Since it is difficult for safety to be tested or audited into a system, system safety approaches should focus on building safety into systems from the inception stage, instead of adding it on to a completed design [15].

Based on the research done by EASA, Research institutions and forerunner OEMs, it is expected that demand for UAM services will become highly visible in the timeframe 2026-2028, with hundreds to thousands of daily eVTOL movements over major metropolitan areas considering minimum 25 flights/vehicle a day [19].

Current ATC systems do not support high-density, low-altitude operations that a UAM environment would require for the following primary reasons [8]:

- Lack of scalability to meet the predicted rapidly increasing demand
- Voice communication methods are not suited for UAM traffic density

- Current surveillance and navigation infrastructures are not suited for the emerging types of air traffic and need significant enhancement
- Predicted UAM traffic volumes and density in high-demand scenarios will exceed pilots' see-and-avoid capacity, and it needs to be complemented by a certified electronic sense and-avoid system.

Currently various services propose UAS management in the lower airspace and there is an assumption that these systems will further mature and be integrated to form a sufficient and complete set of services with corresponding reliability levels that will fulfil the requirements for passenger-carrying flights. **However, it is important to understand that these systems built with lower design assurance levels for managing non-passenger-carrying smaller vehicles cannot be “upgraded” to reach the safety level required for regulatory certification of manned aviation [14].** With an assumption that the airspace above cities will not be “up for grabs” but will be heavily segregated into flyable and non-flyable zones, this will further increase traffic density and the requirement for control. It should be noted that the operational requirements of manned and unmanned drones differ substantially. Hence, it is needed to approach the design task systematically to achieve the required level of safety.

In order to safely orchestrate a significant number of vehicles in dense city airspace, a unified method of coordinating UAM vehicles should be adopted [10]. A central guidance based on shared infrastructure with a “master-system” can integrate diverse services into a coherent whole in order to achieve overall system reliability. Such an air traffic management system for UAM would be a central part of a city's future mobility ecosystem and will be accessible to all stakeholders.

Moreover, layered safety mechanisms are required to ensure a uniform behaviour of air vehicles across a system in the event of failures of specific system components, in order to restrict failure propagation. Systems that conform to this type of requirement are frequently called “safety critical” (systems). For today's commercial aviation, the regulators have set the highest safety levels, with the target that catastrophic failures should be “extremely unrealistic”, which is defined as 10^{-9} probability per flight hour or one in 1 billion flight hours. UAM operations carrying heavy cargo and passengers also lie in the same category. However, as the number of flights is expected to massively increase up to 4.5m flights daily, with 180,000 vehicles operating in 2050 with a higher ground risk, some regulators experts already claim a higher safety level needed [2].

Another dimension to further increase the safety of UAM operations is automation, as one of the main reasons for accidents in aviation are human errors. **Automation of flight operations would be key to the emerging UAM industry if it scales to a point where the size of air vehicle fleets surpasses the size of current airline fleets.** In such a scenario, there would not be enough pilots available to fly all these air vehicles, nor air traffic controllers to guide them safely. Significant fulfilment parameters such as safety, time-to-travel, flexibility, and environmental impact can be improved by flight automation.

6. Infrastructure requirements that ensure safety

Good Infrastructure is one of the major requirements for AAM to take birth in cities. Infrastructure is needed for the safe take-off and landing of the air vehicles as well as for managing the air traffic above cities. AAM needs a combination of physical and digital infrastructure which is described in the next sections.

6.1. What infrastructure elements are needed?

Any form of mobility needs relevant ground infrastructure. For the operation of AAM, 'Vertiports' are the form of ground infrastructure that will appear in different sizes and numbers in different cities, depending on expected traffic volumes. **The location of vertiports in and around the cities is very important and must be considered in planning aspects.** Possible locations include existing local airports and helipads while new locations could be on top of buildings, on purpose-built platforms on top of railways, or large streets or vertipads floating on waterbodies [12].

Additionally, since the air vehicles will make some noise, although less than traditional helicopters, citizens' attitude toward locations need to be carefully considered. EASA's study on social acceptance of AAM in Europe concluded that noise is the second main concern after safety. The study also confirmed that AAM noise is perceived to be more annoying than other city sounds. To ensure a uniform high level of environmental protection, and to address the noise-related concerns expressed by EU citizens, EASA is developing dedicated noise certification standards that consider the specific characteristics of these products.

A prerequisite for the location of the vertiports will be that they should be accepted by citizens, and well-integrated in the existing mobility infrastructure. This is especially important for European cities.

A prerequisite for the location of the vertiports will be that they should be accepted by citizens, and well-integrated in the existing mobility infrastructure.

The services offered through such UAM

infrastructure also requires consideration on security of the operations. Besides environmental and noise impacts, important factors for locating the vertiports will include the ease of accessing the vertiport and the electricity grid connection for charging.

As discussed in chapter 5, for safe operations in the urban air space and across the vertiports, proper air traffic control and communications infrastructure is another critical infrastructural

requirement. Depending on the actual uptake of UAM in cities, the setting of such air traffic management infrastructure could be:

Highly automated: No human operators for every air vehicle (leading to increased safety and capacity, lower cost), the best case is minimal human interference and only a supervisory role.

Allow for regional competition: No single service provider for an entire country, but connected and interoperable service providers, in best case supported by an interoperable technical solution for all actors.

Integrate small work drones and passenger-carrying drones in the same low-altitude airspace. This point is not fully addressed by regulatory authorities yet.

Examples of the air traffic management infrastructure are the Common altitude reference system for manned and unmanned air vehicles, certified Detect-and-avoid (DAA) systems, positioning systems (GPS) and data communication (vehicle-to-ground/vehicle-to-vehicle). It is important to mention that the data link service provider is not an aviation approved organization under the future regulation on the 'certified' category of UAM aircraft operations. Nevertheless, the data link, having safety critical functions will need to be considered under safety oversight for management of the UAM aircraft operations. To facilitate this, voluntary industry standards might be used as Acceptable Means of Compliance, and 4G/5G cellular networks including hardware (antennas) would need to be installed or rebuilt. Finally, ground stations for Air Traffic Control centres have must be built up according to the position at each vertiport like nowadays ATC towers at airports.

Use-case: Skyroads

Skyroads focusses on the concept of deterministic planning of flight routes. This approach is viable to making urban air transport an ultimately safe proposition: deterministic route planning with dissimilar and redundant safety layers. This approach considers a criterion that is the main element that will satisfy the requirements for public safety.

Certification for an urban air traffic management system is mandatory, as the same rules and safety requirements as for current air traffic control systems will apply. In order to achieve overall safety levels, air vehicles will have to be equipped with the ability to perform harmonized escape or recovery manoeuvres in the event of primary system failures or outages. Such a secondary system essentially replaces the highly intelligent but volume-limited tactical deconfliction, following the "rules of the air".

For the air traffic management infrastructure, Skyroads solution integrates an airborne and a ground segment (dedicated integrated software/hardware inside the AV and on the ground). It automates the communication between the two segments, provides safe, collision-free

(deconflicted) routings as well as back-up on-board intelligence for contingency/escape manoeuvres and thus allows for continuous use of airspace and capacity optimization.

Skyroads believes that the value of its product and solution can be at the earliest demonstrated through adoption by vehicle manufacturers. It will benefit the air vehicles to choose the Skyroads software/hardware solution, if the evolution of Skyroads system capabilities suit their requirements and those of their customers.

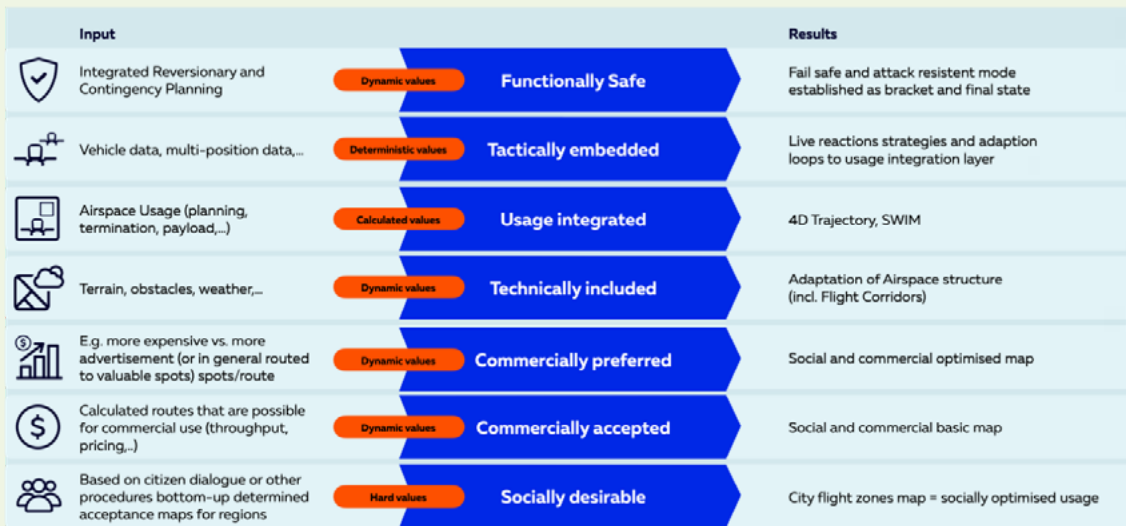


Figure 13: Illustration: Skyroads flight guarding data logic and processes.

6.2. How can cities and stakeholders already plan the physical and digital infrastructure necessary for UAM uptake?

It becomes increasingly clear with the infrastructure requirements that UAM is not only an element of aviation and mobility technology advancement but predominantly a significant part of mobility planning and urban development. UAM may feature prominently in the formation of urban innovation and sustainable transition strategies, but **it is essential that the cities having the ambition to deploy UAM take an active role in integrating it to their existing mobility systems.**

A core question that the cities and regions face is: How should UAM be integrated in the higher-level urban mobility planning? Or in more practical terms, which role should UAM assume in current and future urban transportation systems? Should transport departments take over the responsibility or should dedicated interdisciplinary internal or external organisation be set up?

No matter how the organizational setup is and will be designed, a new mode of mobility and its planning is a region/city specific exercise and should not only consider its private economic benefits

but also the benefits of its citizens. Most of the respondents (67%) in this study's survey have also argued that public benefit and thus social desirability needs to be achieved to succeed in the implementation of UAM. Hence, the introduction of UAM calls for a holistic planning approach that

Most of the respondents (67%) in this study's survey have also argued that public benefit and thus social desirability needs to be achieved to succeed in the implementation of UAM.

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 liveability. This is necessary to ensure the purposeful emergence of a responsible and sustainable UAM ecosystem.

Before starting or in parallel to pilot implementation projects, the digital simulation of the entire mobility scenario considering the stakeholder eco-system would support decision-makers to answer their questions based on city mobility strategy premises as well as technological solution approaches using different infrastructural architectures. Such a simulation project would include the planning of urban and inter-urban aerial transportation in a city or a region, getting information and analysing all travel processes in detail, to find the best solutions for present and future mobility challenges with different vehicle concepts and intermodal embedding for an optimal implementation strategy. Based on joint data interpretation, tool-based simulations can provide a validation and comparative analysis of different scenarios or even comparison with the situation in other cities.

Conclusion and recommendations

The development of UAM over the past years has stressed the variety of concepts and use cases that characterize the industry.

Attitudes and expectations toward UAM, mainly reflected in the expert workshop and questionnaire, indicate that the **technology's benefits are expected to outweigh the risks and support mobility and transport (57% of the respondents)**. A large majority of respondents anticipate a positive contribution of UAM, especially in supporting with medical emergencies.

UAM applications are also expected to generate new and innovative business approaches (e.g., from airport shuttles to infrastructure maintenance and various goods deliveries), attracting talents and highly skilled labour to cities where they are deployed. **The feedback gathered for this study shows that a critical aspect of any UAM solution deployment is the capacity to ensure that very high safety standards are met, and that citizens are thoroughly consulted.** Only then can UAM deployment succeed by bringing solutions to existing mobility challenges.

In fact, the public debate on UAM has been increasingly focused on safety and the required regulatory framework to accompany the development of AAM.

Survey results have shown that the **discussion on the right level of regulation for AAM is still undecided among experts, between a more centralised and localised approach.**

This study comprehends the following recommendations from cities towards the AAM implementation:

- UAM operations should have at least the same safety levels of today's aviation industry.
- A single responsible entity should be responsible for the traffic management of UAM operations – which can be either state mandated or in a public private partnership form.

Following recommendation will support cities looking to implement UAM in the best possible conditions:

- The role and responsibility of cities over their airspace should be clearly defined.
- A central guidance based on shared infrastructure with a “master-system” that integrates diverse services into a coherent whole can help to efficiently achieve overall system reliability.
- For cities eager to implement UAM, a dedicated air traffic management system should be a central part of a city's mobility ecosystem that will be accessible to all stakeholders.

To address their concerns and expectations for a safe and sustainable implementation of UAM, cities can co-create the rule- and policymaking process and use the full potential of commendation and consideration with EASA and other authorities. In general, **for safe operations in the urban air space and across the vertiports, air traffic control and communications are a critical infrastructural requirement** that needs a high degree of automation for increased safety and efficiency of UAM operations.

Future research directions

Further projects and research should clarify the **implications for all stakeholders of both centralised and a decentralised UAM regulatory options.**

Continuous dialogue between stakeholders and cities should address the required effort in terms of investment, land use allocation, adapted or new regulations that would be required depending on the scale of UAM operations. Similarly, living labs are important tools to engage with citizens and foster co-creation of UAM-based solutions that fit the needs of cities and their inhabitants.

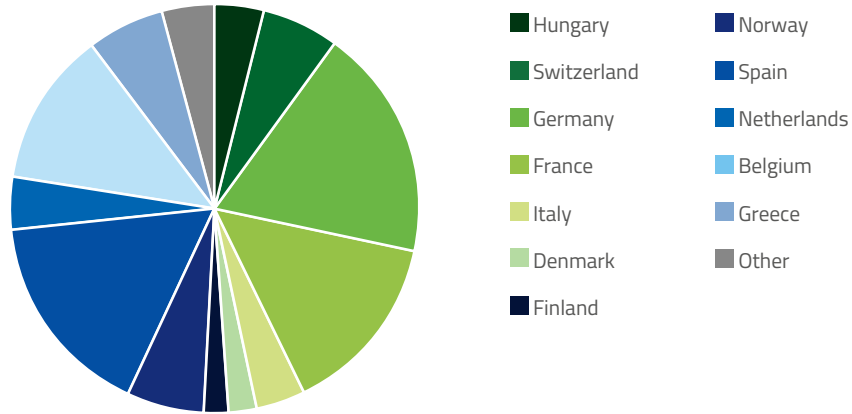
There is still no consensus around the acceptable noise pollution resulting from UAM operations in cities. Further investigations on this topic will provide valuable information for the adequate planning of the necessary infrastructure.

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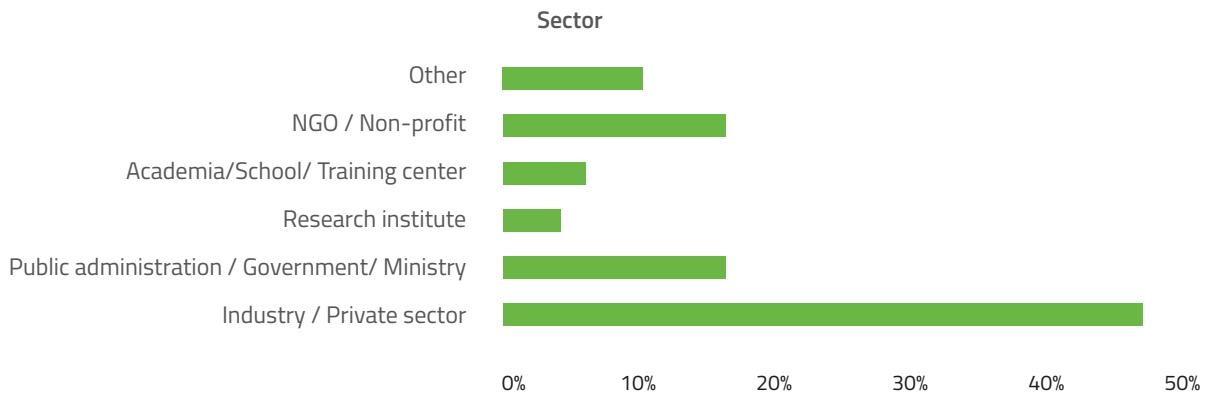
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Annexes

A. Respondents by countries



B. Respondents by sectors



C. Survey questions

All survey questions relating to content are displayed below:

According to your experience, please rank in order of perceived importance the following services that UAM can offer in the context of urban planning and development. *Scale 0 Not important, 1 Slightly important, 2 Moderately important, 3 Important, 4 Very important, No opinion*

List of applications:

- Logistics
- Mobility of persons
- Entertainment and Leisure
- New Business Development

Would you like to share any further thoughts on other UAM applications?

- How should UAM be a part of the city mobility?
- Integrated into the public mobility system of a city
- It should/could be a standalone system with one private operator
- It could be a standalone system of several private operators
- It could be Individual/private mode of mobility/traffic

How would you evaluate cities' safety requirements for UAM implementation (safety = number of accidents per operations hours)?

- Safety level of car/ road traffic
- Safety level of train/public transport
- Safety level of aviation
- Safety level higher than aviation

How would you evaluate the following factors with respect to fostering community acceptance towards UAM? *Scale 0 no effect, 1 low, 2 moderately, 3 high, 4 very high effect, sliding scale, optional*

- Involvement of population in planning (of air traffic and ground infrastructure)
- Simulation projects and proof of concept
- Initial trials and pilot use cases
- Benefit to the public (mobility, medical/emergency, ...)
- Benefit to the economy, economic growth (work)

Would you like to share any further thoughts, or insights to facilitate community acceptance of UAM?

Who should have authority control over cities (lower) airspaces for UAM?

- City authority/ mayor's office
- State authority
- National aviation authority

How would you wish/expect air-traffic over their cities to be regulated?

- Highly regulated with central guidance/ air traffic control for entire route
- Partly regulated (e.g., take-off/landing process and segregated air-space/roads in the sky)
- Not regulated, mainly free usage of airspace (status quo, nowadays general aviation)

How would you expect the regulation of air traffic to be organized?

- Licensing multiple drone operators to fly in segregated air-spaces/roads in the sky
- One state mandated agency (e.g., air navigation service provider) responsible for control and managing all the air traffic above the city
- One private/PPP mandated agency responsible for control and managing all the air traffic above the city
- Multi agencies responsible for managing different segregated air-spaces

How would cities adapt to the regulatory environment/ ensure compliance with existing regulation for implementing UAM?

Please react to the following statements

Scale I agree, I disagree, I neither agree nor disagree

- UAM will improve urban mobility and transport in the near or medium-term
- I have concerns about the implementation of UAM in my city/region
- I have used or plan the use of UAM services for myself or for others
- I would use UAM services if they were available to support me in medical emergencies
- I believe the value and opportunities that UAM can bring to my city outweigh the overall risks

If relevant, please elaborate on any concerns you may have with regards to the implementation of UAM

Would you like to share any further thoughts and insights on UAM?



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