Study on the societal acceptance of Urban Air Mobility in Europe

May 19, 2021

Further information and the full survey insights are available at easa.europa.eu/UAM

 This study has measured the attitude of the EU society towards UAM early 2021, well in advance of future deployment in EU cities foreseen around 2024-2025. The results have been generated with best effort at this point in time, however public perception may change over time once citizens are exposed to actual UAM operations.

Executive Summary

New technologies such as the enhancement of battery technologies and electric propulsion as well as major investments made into start-ups are enabling the development of new vertical take-off and landing Urban Air Mobility (UAM) aircraft. Thus, Urban Air Mobility – defined as an air transportation system for passengers and cargo in and around urban environments – may be deployed in Europe within three to five years, offering the potential for greener and faster mobility solutions.

As several projects and demonstrations are under way, it is time for the European Union, and for national and local authorities to prepare the framework that will enable this new mode of transport and give Europe the chance of establishing itself as one of the first movers in this field at a global level.

Citizens' and future UAM users' confidence and acceptance will be critical to success. As part of the preparation of an adequate regulatory framework, the European Union Aviation Safety Agency (EASA) therefore conducted this comprehensive study on the societal acceptance of UAM operations across the European Union. The study was carried out together with the consulting firm McKinsey & Company between November 2020 and April 2021. Full details of the report can be found on the EASA website.

Based on thorough research, literature review, local market analysis, surveys and interviews, the study examined the attitudes, expectations and concerns of EU citizens with respect to UAM and revealed interesting insights, some unexpected. The survey results were very homogeneous among all those surveyed across the EU and in all socio-economic categories. They can be clustered into 10 key take-aways:

1. EU citizens initially and spontaneously express a positive attitude toward and interest in UAM; it is seen as a new and attractive means of mobility and a majority is ready to try it out;
2. The notion of general/public interest is a determining factor for acceptance: use cases for the benefit of the community, such as medical or emergency transport or those connecting remote areas, are better supported than use cases satisfying individual/private needs;
3. The main benefits expected from UAM are faster, cleaner and extended connectivity;
4. However, when encouraged to reflect upon the concrete consequences of potential UAM operations in their city, EU citizens want to limit their own exposure to risks, in particular when related to safety, noise, security and environmental impact;
5. Safety concerns come first, but the study also shows that citizens seem to trust the current aviation safety levels and would be reassured if these levels were applied for UAM;
6. Noise is the second main concern expressed; the study indicates that the level of annoyance varies with the familiarity of the sound, with familiar city sounds at the same decibel levels being better accepted; it also confirms that the distance, duration and repetition of the sound impacts its acceptance;
7. UAM is seen as a good option to improve the local environmental footprint, through reduced urban traffic congestion and better local air quality; but at the same time citizens express major concerns about UAM's impact on wildlife;
8. The results also demonstrate a limited trust in the security and cyber security of UAM, requiring threat-prevention measures;
9. The integration of UAM into the existing air and ground infrastructure must respect residents' quality of life and the cultural heritage of old European cities;
10. Finally, local residents and authorities feel directly affected by the deployment of UAM and want to engage and play an active role in its implementation.

The study results show that EU citizens are calling for active and pre-emptive measures from competent authorities.

In addition to mitigating risks related to safety, security, noise and environmental impact, these measures are expected to ensure that UAM will be a common benefit to all of society by offering affordable, integrated and complementary mobility. By providing transparent and timely information and guidance, the authorities at all levels – local, national and European – have the chance to consolidate public acceptance of UAM.

By 2024-25, UAM may be a lived reality in Europe. The EU has only a few years, and a unique opportunity, to prepare for the smooth transition of European cities, and also of the European aviation system, towards the mobility of the future.

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Definitions

ANSP: air navigation service provider
BVLOS: beyond visual line of sight
EASA: European Union Aviation Safety Agency
EIS: entry into service
OEM: Original Equipment manufacturer
Transforming vehicle: a vehicle that can drive on the road and fly, e.g. a flying car
NASA: National Aeronautics and Space Administration
UAM: urban air mobility
VTOL: vertical takeoff and landing
Conjoint analysis: trade-off survey method to evaluate relevance and extend of decision factors
eVTOL: electric vertical takeoff and landing
UAS: Unmanned Aircraft System, i.e. an unmanned aircraft, i.e. without a pilot on board, and the equipment to control it remotely
Manned / unmanned aircraft: an aircraft with a pilot/ without a pilot on board
Autonomous aircraft: an aircraft flying without the assistance of a dedicated pilot

Introduction

Background and context of the study

Congested streets and pollution are already a reality in several European cities, as indicated by the TomTom Traffic Index 2020 and the Air quality in Europe 2020 report by the European Environment Agency. With the population of cities in the European Union set to grow to more than 340 million citizens by 2030, there is a risk of increased pollution and congestion. In this context, local authorities are looking at smarter, greener, more integrated and sustainable mobility solutions.

Urban Air Mobility (UAM) has the potential to respond to these needs. Air transport of goods and people is no longer science fiction and will become a reality in European Union cities soon. Adding a new dimension to urban transportation will allow air transport of goods and people and may also help to make a leap towards smarter and more sustainable cities. Urban Air Mobility is expected to bring environmental benefits as well as advantages for citizens and businesses – notably for commercial or emergency/medical purposes.

A key enabler for the development of Urban Air Mobility solutions was the significant reduction in lithium-ion battery cell costs to 110€/kWh in 2020 from 1000€/kWh in 2010, as well as the increase of cell energy density to approximately 300 Wh/kg from approximately 150 Wh/kg in the same timeframe.[1] The experiences gained with the development of electric vehicles in the automotive industry have also influenced the development of UAM globally and in Europe. The European industry has played a leading role in the development of UAM since the first flight of a manned eVTOL proof-of-concept by Volocopter in 2011. There are also several other European companies developing UAM aircraft at the moment, for example Airbus, Ascendance, Lilium, Pipistrel, Quantum Systems, and Tecnalia.

Objective of the study

This breakthrough in urban mobility needs to be accompanied and supported by relevant measures, in particular an adequate regulatory environment, which would reflect the needs and aspirations of European society and provide a stable and clear framework for the industry. The first step consists in measuring EU citizens' willingness to accept this new mode of transport and collating their possible concerns and expectations, for instance related to safety, security, privacy and environmental impact.

The European Union Aviation Safety Agency (EASA) launched a comprehensive study on the societal acceptance of UAM across Europe in November 2020. The study included research work, literature review, as well as a survey with around 4000 residents of six European cities. These survey cities – *Barcelona, Budapest, Hamburg, Milan, Paris and the cross-border region Öresund* – were identified as potential target markets for the future deployment of Urban Air Mobility. The quantitative survey was complemented by more than 40 qualitative interviews with focus groups of local, national and European stakeholders as well as by a noise perception study with a group of 20 European residents.

EASA ambition

The study on societal acceptance is only one aspect of EASA's work to support the deployment of UAM in the EU. EASA's ambition is to anticipate this new mode of transport and provide an enabling comprehensive regulatory environment, allowing the EU to establish itself as one of the first global movers in this field.

1 Bloomberg NEF

Work has started and initial actions have been taken. EASA has prepared a number of regulatory documents, the latest one being the first worldwide regulation on U-Space recently adopted by the European Commission. The SESAR JU defines U-space as follows: "U-space is a set of new services relying on a high level of digitalisation and automation of functions and specific procedures designed to support safe, efficient and secure access to airspace for large numbers of drones. As such, U-space is an enabling framework designed to facilitate any kind of routine mission, in all classes of airspace and all types of environment - even the most congested - while addressing an appropriate interface with manned aviation and air traffic control." The full overview of these documents is provided in Appendix 1.

The results of the study will be considered by EASA in the preparatory work for a future regulatory proposal for the so called high risk operations of the specific category of drones and for operations of the certified category of drones and manned VTOLs in urban environments. They will also serve to raise awareness about UAM across the EU as a means of fostering public adoption.

Scope of the study

The terms 'Advanced Air Mobility (AAM)' and 'Urban Air Mobility (UAM)' are both in common use. As can be seen in Figure 1, AAM covers passenger and cargo transport as well as other aerial missions in urban, regional, and interregional geographies. UAM can be understood as a subset of AAM, which covers transportation systems that move people or cargo by air in and around urban environments.[2] In the absence, as yet, of agreed standard definitions, the term "Urban Air Mobility" is used in the context of this study, as it explicitly refers to the specific context of the operations, i.e. in cities and densely populated environments, and is therefore more easily understood by the general public.

In this report, "urban" is defined according to the functional urban area concept used by Eurostat: "A functional urban area consists of a city and its commuting zone. Functional urban areas therefore consist of a densely inhabited city and a less densely populated commuting zone whose labour market is highly integrated with the city (OECD, 2012)".

2 https://www.easa.europa.eu/sites/default/files/dfu/easa_drones_section.pdf

Figure 1: AAM covers a wider scope than UAM

Included scope in AAM and UAM definitions

(✓) No explicit mention ✓ Explicit mention

		Use cases			Geographic reach		
		Passenger	Cargo	Operations	Urban	Regional	Interregional
AAM	**FAA**	✓	✓	✓	✓	(✓)	✓
	NASA	✓	✓		✓	✓	
	NASA	✓	✓	✓	✓	✓	
	Deakin Uni.	✓	✓		✓	✓	
UAM	**NASA**	✓	✓		✓		
	SESAR JU	✓			✓		
	FAA	✓	✓		✓	✓	
	Deakin Uni.	✓			✓		
	Jonkoping Uni.	✓	✓		✓		
	MITRE Corp	(✓)	(✓)		(✓)	(✓)	(✓)
	UC Berkley	✓	✓		✓		
	TU Munich	✓			✓		

Furthermore, the scope of the study was intentionally limited to:

- The transportation systems that move people or cargo by air in and around urban environments for commercial or emergency service operations. Other use cases, such as infrastructure assessment, surveillance, 5G emissions or state operations (e.g. military, police surveillance) were excluded. The transportation of goods or people is indeed adding an additional risk that may require specific attention;
- Drones and manned VTOL aircraft with electric propulsion systems were the focus for this study. Other vehicles such as traditional helicopters or transforming vehicles (e.g. flying cars or motorcycles) were excluded as the focus should remain on new types of vehicles intended for use in urban airspace;
- A 10 year timeframe, i.e. until 2030: for this reason, the study focused on manned VTOL (i.e. with a pilot on board) for the transport of people, as it appears unlikely that unmanned transport of people in urban environments may take place within that timeframe;
- The European Union, although global developments were taken into account for information purposes.

This report was created based on the best knowledge of the involved parties at the time of writing. However, due to the fast pace of this emerging industry the stated content might be subject to change in the future.

1. Research and literature review

This first chapter contains information on the literature reviewed and the research done to set up the study on societal acceptance in general. This preparatory work ensured that the starting point was the most up-to-date state of science, research and market development.

1.1 Literature review

To lay the foundations for the study on societal acceptance of Urban Air Mobility (UAM) as well as to collect initial data and information to build the quantitative and qualitative survey, a thorough literature review from two different perspectives was carried out:

1) The UAM market and UAM-related societal acceptance factors
2) Insights about relevant societal acceptance factors from adjacent technologies, such as autonomous driving, smart home and other emerging technologies.

The review focused on the UAM market and related societal acceptance factors, as core objectives of this study. Literature reviewed included recent publications, i.e. not older than three years, in English and other European languages, from academia or other publicly-accessible sources.

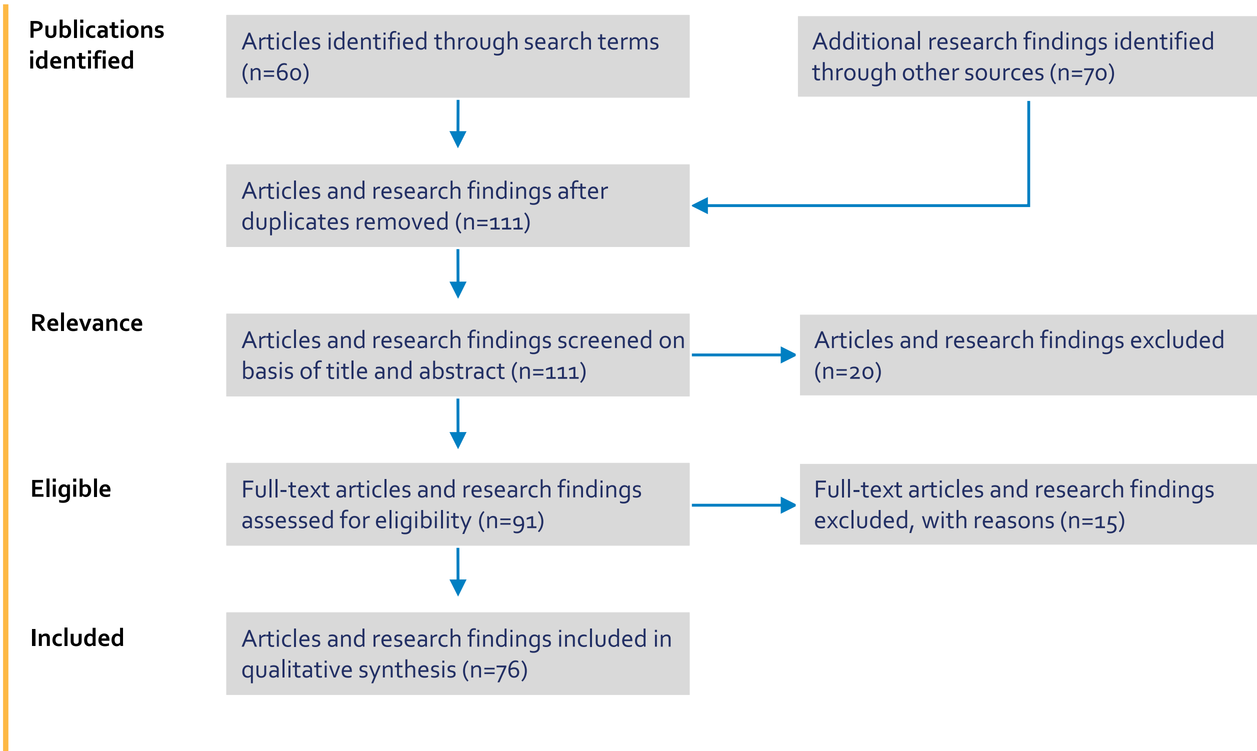
Methodology

The methodology used to filter publications was the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. This framework is a systematic process for filtering publications for duplicates, relevance, and eligibility.

Figure 2 shows that this process was applied to all UAM 130 publications identified through search terms (n=60) as well as publications identified through other sources (n=70). As a first step, 19 duplicates were removed from further consideration. The next step involved a check for relevance: here 20 publications were excluded, as they were either published before 2017, did not cover the UAM space at least partially, or did not mention UAM use cases or societal acceptance factors. In the last step only publicly available publications, which are available free of charge, passed the eligibility filter; the others (n=15) were excluded. This left a total of 76 publications for consideration during the detailed UAM literature review (see Bibliography).

16 publications were identified for the review on societal acceptance factors for adjacent technologies, such as autonomous driving and smart home. There were no duplicates, but three publications did not pass the relevance test as they were either published before 2017 or did not cover societal acceptance factors. Another three publications did not pass the eligibility test as they were not publicly available. This left a total of ten publications for the comparison of societal acceptance factors for smart homes and autonomous driving with UAM.

Figure 2: Application of PRISMA framework for UAM literature review

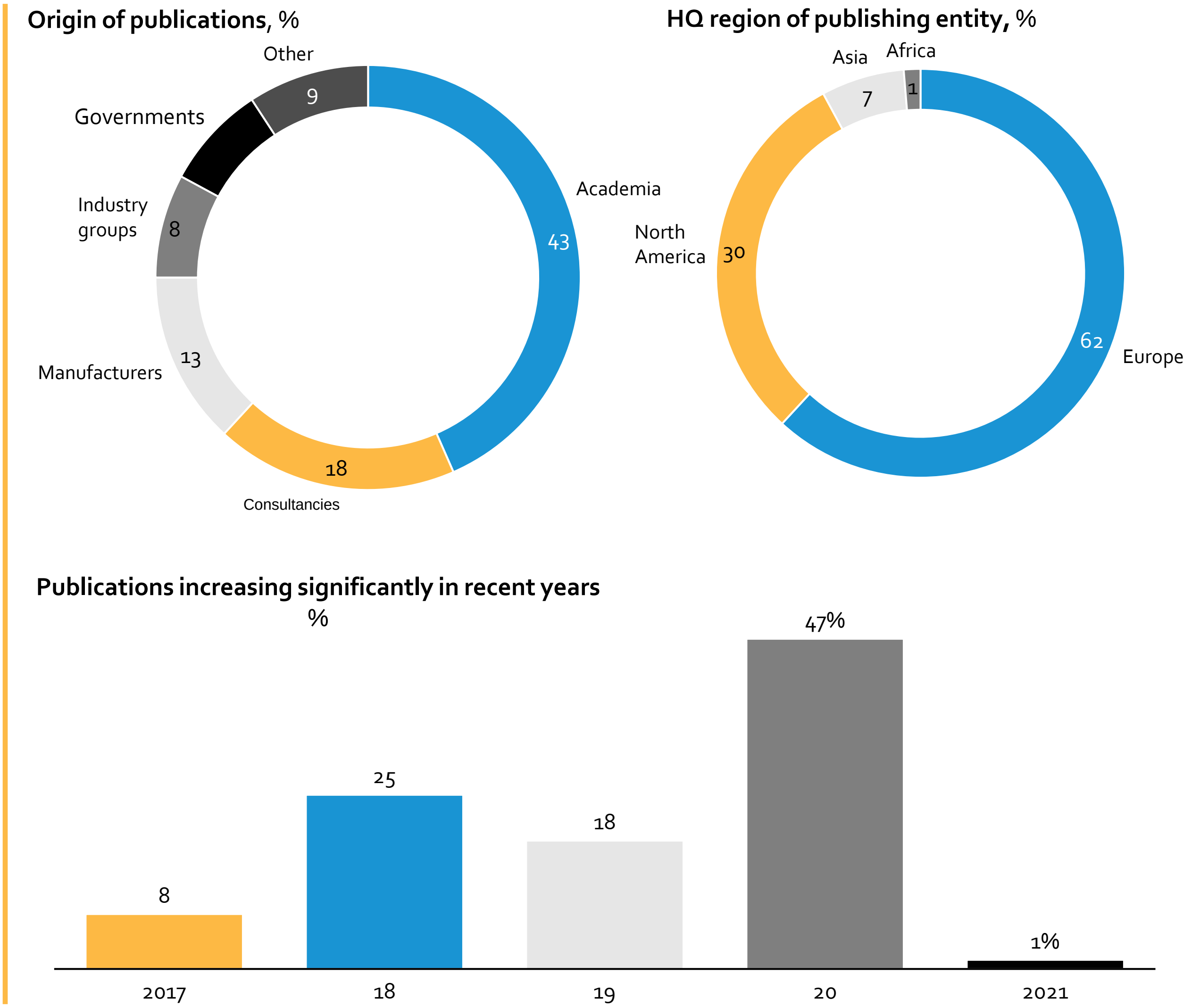


Source: Adapted from The PRISMA Group (2009)

Summary of insights

As shown in Figure 3, a considerable increase in the frequency of UAM-related publications can be observed between the years of 2017 and 2020.

Figure 3: Origin and timing of publications



It can also be seen in Figure 3 that:

- More than a third of the publications included are from academia, with contributions from leading entities such as TU Munich, Fraunhofer, Massachusetts Institute of Technology (MIT) and the National Aeronautics and Space Administration (NASA). Consultancies and manufacturers within UAM are the other main contributors of recent publications.
- More than half of the included publications originate from entities with their headquarters in Europe, indicating that leading authorities in the emerging UAM industry tend to be based in Europe. The region with the second highest number of publications was North America. However, the relatively small number of publications from Asia and Africa could be related to the focus on publications in English and other European languages.

In order to gain an understanding of the UAM market, literature contributions were evaluated in terms of:

- use cases,
- challenges,
- societal acceptance factors,
- stakeholders,
- timelines,
- target markets.

Interest in UAM increased in recent years

Initially, 130 publications were identified and still 76 of them – published since 2017 – were analysed and considered in the study. More than half of them originate from entities with their headquarters in Europe. The frequency of publications increased recently, showing a growing interest in the topic.

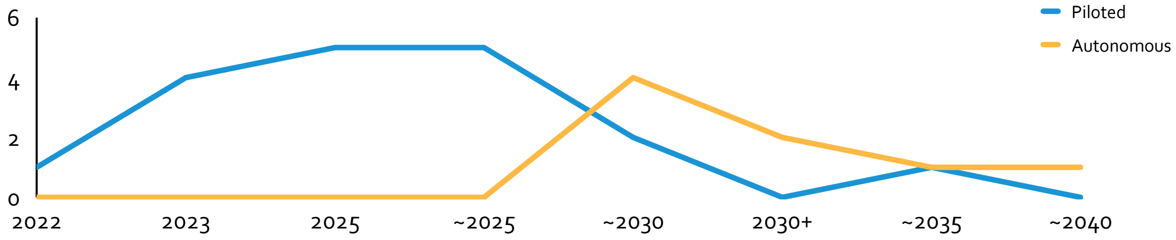
The key results of this evaluation are summarised in Figure 4 and more detailed in the following Figures. The use cases most frequently mentioned in publications are air taxis, drone delivery and rescue drones. The main challenges raised are infrastructure and safety. Noise and safety were listed as the major societal acceptance barriers. Entry into service (EIS) timelines differ significantly between piloted and autonomous vehicles, with most certification or EIS for piloted operations being planned for around 2025. Unmanned or autonomous operations are expected to start entering the market not before 2030, according to statements made by the OEMs in the reviewed literature.

Figure 4: Key insights from the literature review

Most often named ...

...use cases	...challenges[2]	...societal acceptance barriers[3]
Taxi Air Taxi	**11%** Infrastructure	**18%** Noise
Drone delivery	**9%** Safety	**17%** Safety
Rescue drone[1]		

Number of mentions with regard to expected start of entering the market



1. Transporting a first responder to the location of an accident
2. Share of the 173 mentions regarding challenges (multiple per publication possible)
3. Share of the 188 mentions regarding societal acceptance (multiple per publication possible)

Source: Literature review

1.1.1 UAM use cases found in literature

Cases that were found during the literature review can be grouped into five functionally distinct groups.

1) Passenger transport
   The most frequently mentioned passenger transport use case is the air taxi. Here, passengers will initially use UAM aircraft to travel from one vertiport to another. Eventually it may be possible to hire an air taxi in a street or park close to the starting point and land in a street or park next to the destination. Quickly flying an emergency doctor to the site of an accident is the application mentioned second most frequently.
2) Delivery
   The most often described use cases are package and food delivery by drones into private gardens or properties, and package delivery by drones into a central delivery hub. A number of publications also describe the usage of drones for time-critical medical applications, such as the delivery of organs or stored blood.
3) Civil surveillance and other operations
   The autonomous inspection and/or maintenance of bridges and other infrastructure is expected to be the major operations use case. Other operations use cases include precision agriculture and the preliminary visual assessment of incident sites, such as assessing the extent of fires and accidents.
4) Sovereign functions
   The top-ranking application of UAM aircraft in this group is police surveillance.
5) Signal emitting
   Emitting signals for multimedia applications or internet access was only mentioned in two publications.

1.1.2 Expected challenges identified in literature

Infrastructure named as leading challenge in existing literature

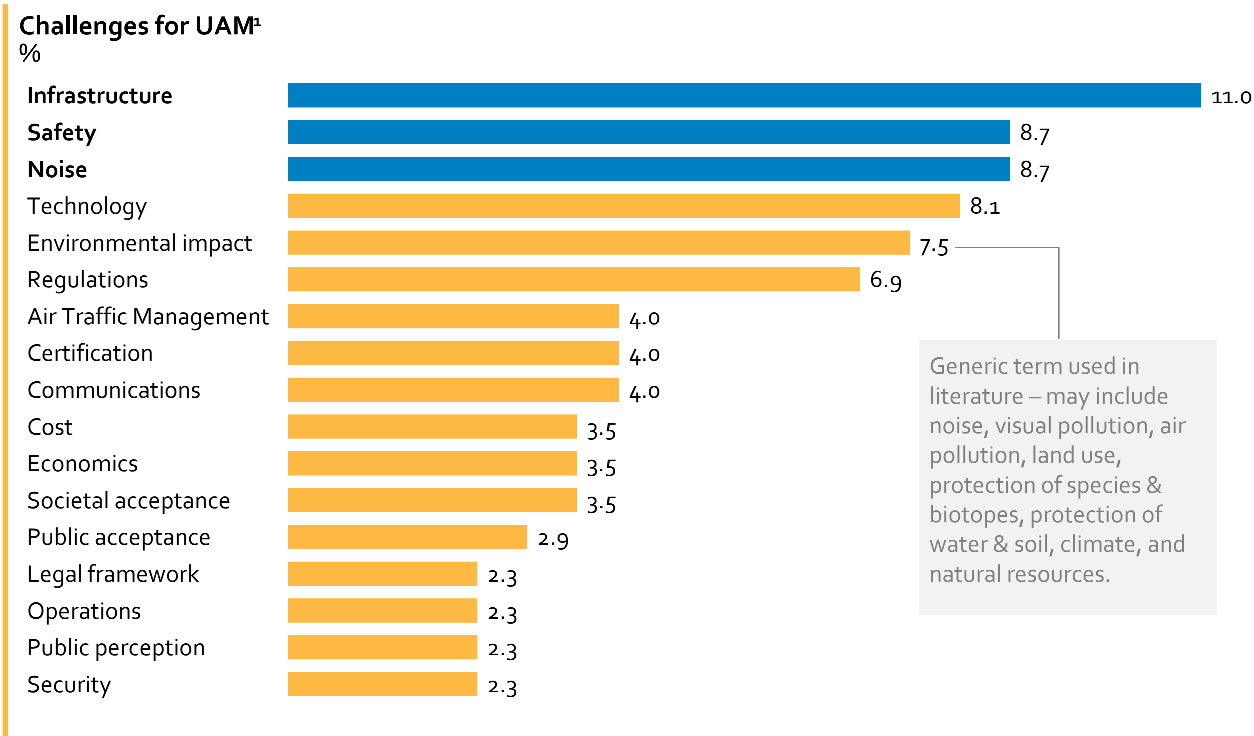
Based on literature, biggest challen-ges for UAM are expected to be related to infrastructure, safety and noise. Namely:

- Finding suitable locations / buildings for Vertiports
- Aiming for safety level similar/equal to commercial aircraft
- Achieving low noise level for better social acceptance

Figure 5 provides details on the expected challenges for UAM. 50 of the 76 reviewed publications mentioned challenges, where the leading challenges are related to infrastructure, safety and noise. In this categorisation, while technology covers a large variety of technological solutions, it mostly refers to battery electric propulsion systems and their current limitations in terms of energy density and overall weight. Environmental impact is a term used generically in the reviewed literature and can include a plethora of topics such as noise, visual pollution, air pollution, land use, protection of species and biotopes, climate, natural resources, water and soil.

Societal acceptance, the focus of this study, is not listed among the overall top five challenges for UAM, but is an important dimension for EASA as its role is to serve the general public in its actions.

Figure 5: Challenges for UAM



1. Share of the 173 mentions regarding challenges (multiple per publication possible);

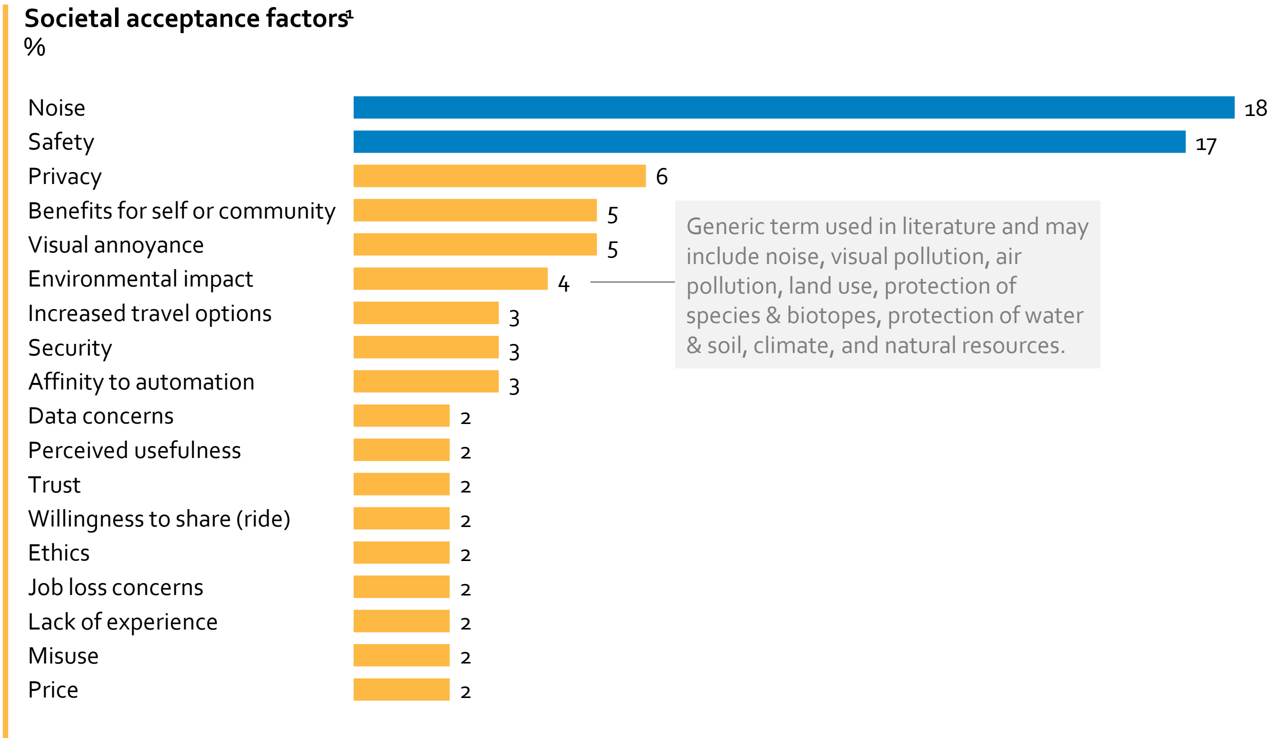
1.1.3 Societal acceptance factors identified in literature

Main societal acceptance factors are comparable to those of other smart technologies

If comparing acceptance barriers for Urban Air Mobility with those of other smart technologies, it is noticeable that they are similar. Safety is the leading acceptance factor for autonomous driving – which is in line with the findings for UAM. Probably because both solutions carry goods and passengers. Privacy on the other hand is also a top concern in the smart home space.

Although most publications do not mention societal acceptance as a main challenge, 61 of the 76 reviewed publications mention social acceptance factors. Figure 6 summarises the main insights from literature. Noise and safety are the leading factors mentioned by a large margin. Combined, they constitute 35 percent of all 188 mentions of an acceptance factor within the publications reviewed. Most of the time, safety refers to the safety of an occupant of an air taxi, but it does also include people on the ground. Environmental impact has the same wide definition in literature as for UAM challenges. Increased travel options refer to the provision of an additional mode of transport for a certain route. This metric has diminishing returns as it provides the highest benefit if there is no other option to travel an intended route without UAM, but only contributes a small benefit if there are, for example, four other modes of transport available.

Figure 6: Societal acceptance factors



1. Share of the 188 mentions regarding societal acceptance (multiple per publication possible)

Comparison with societal acceptance factors for smart home and autonomous driving

As explained at the beginning of this section, literature for adjacent technologies, such as smart home and autonomous driving, was also reviewed for societal acceptance factors. The literature reviewed is indicated in the Bibliography and the findings are displayed in Figure 7.

Safety was a leading acceptance factor for autonomous driving. This is in line with the findings for UAM and could be explained by both topics being mobility solutions carrying goods or passengers. Noise, on the other hand, does not appear as a major topic for autonomous driving, as a level of noise comparable to current passenger cars seems to be acceptable.

Privacy is also a top-ranking concern in the smart home space, which potentially explains the lower usage rate for this technology in Western Europe compared to the United States.

In the reviewed surveys for the acceptance of autonomous driving, the survey participant's openness to and interest in new technologies has a stronger influence than their sociodemographic background, such as age, gender, or employment status. With both autonomous vehicles and smart homes, participants with a positive attitude towards the technology were more likely to use it.

Figure 7: Societal acceptance barriers for smart homes and autonomous driving

Privacy

Smart Home penetration rate in West Europe 15% lower in comparison to the **USA.** Major **adoption barriers** in the EU are **privacy, interoperability, possibility to control devices in local languages**[1]**.**

2 EU countries (Germany and Belgium) have an option on Google maps for citizens to **pixelate the houses.** The option was introduced because of the **high population privacy concerns** in these countries[2]

Safety

Safety was mentioned **by 4 from 6 publications** as a **leading acceptance factor** for **autonomous vehicles.** According to literature, people have great concerns about AV safety because the technology is not mature enough and the public does not have enough knowledge about it[3].

Source: 1 Strategy Analytics - 2019 Smart Home Forecast,
2 Googlemaps analysis,
3 Literature research for autonomous driving+

Noise

No major concerns about noise **of cars or busses** in the EU were identified. The **level of noise comparable** to an average **passenger car** seems to be **acceptable by the population**[3]**.**

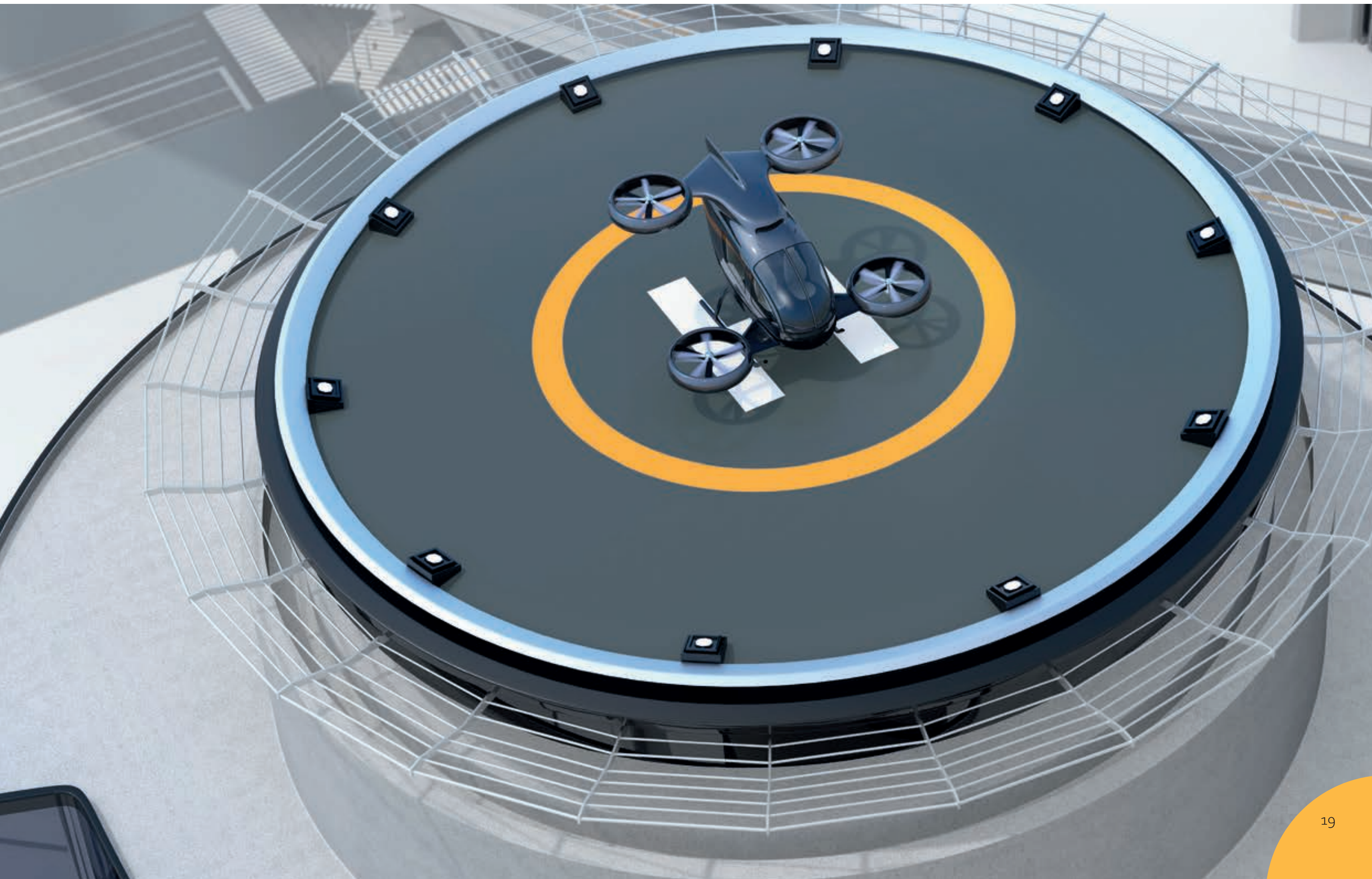
Additional insights[3]

Self-reported **acceptance of driverless vehicles** is more strongly determined by **domain-specific attitudes** than by **sociodemographic characteristics.**

People in Europe and Asia have **substantial differences in attitudes toward AVs. Safety** is one of the **most concerned factors of AVs** by respondents.

Risk perception is identified as a **major inhibitor** to the use **intention of smart homes.**

The use of **smart home technology** is influenced by **positive attitude (perceived newness, societal influence, innovativeness)** towards it.



1.2. Industry status and projection

This section of the report provides an overview of the industry status, including UAM aircraft types, use case applications for these UAM aircraft and the UAM stakeholder environment.

Overview

As of 2021, the UAM market is still in an early stage, while showing increasing momentum. Many start-ups and companies are emerging across the entire value chain. In particular, the eVTOL manufacturing and Original Equipment Manufacturer (OEM) sector is rapidly evolving. More than 200 eVTOL designs and concepts are currently being investigated and developed with many prominent ones like Volocopter, Joby, Lilium, Airbus, or Kitty Hawk. Some of these air vehicle systems are already in advanced certification stages. Europe is leading with many OEMs such as Volocopter, Airbus, Lilium, Ascendance, and Pipistrel in advanced certification stages and a significant number of pilot regions and projects, for example in Frankfurt, Paris, Cologne and Dusseldorf, Linz, Helsinki, and Ingolstadt (see Figure 8 and Figure 9).

Figure 8: Passenger vehicle certification announcements (non-exhaustive)

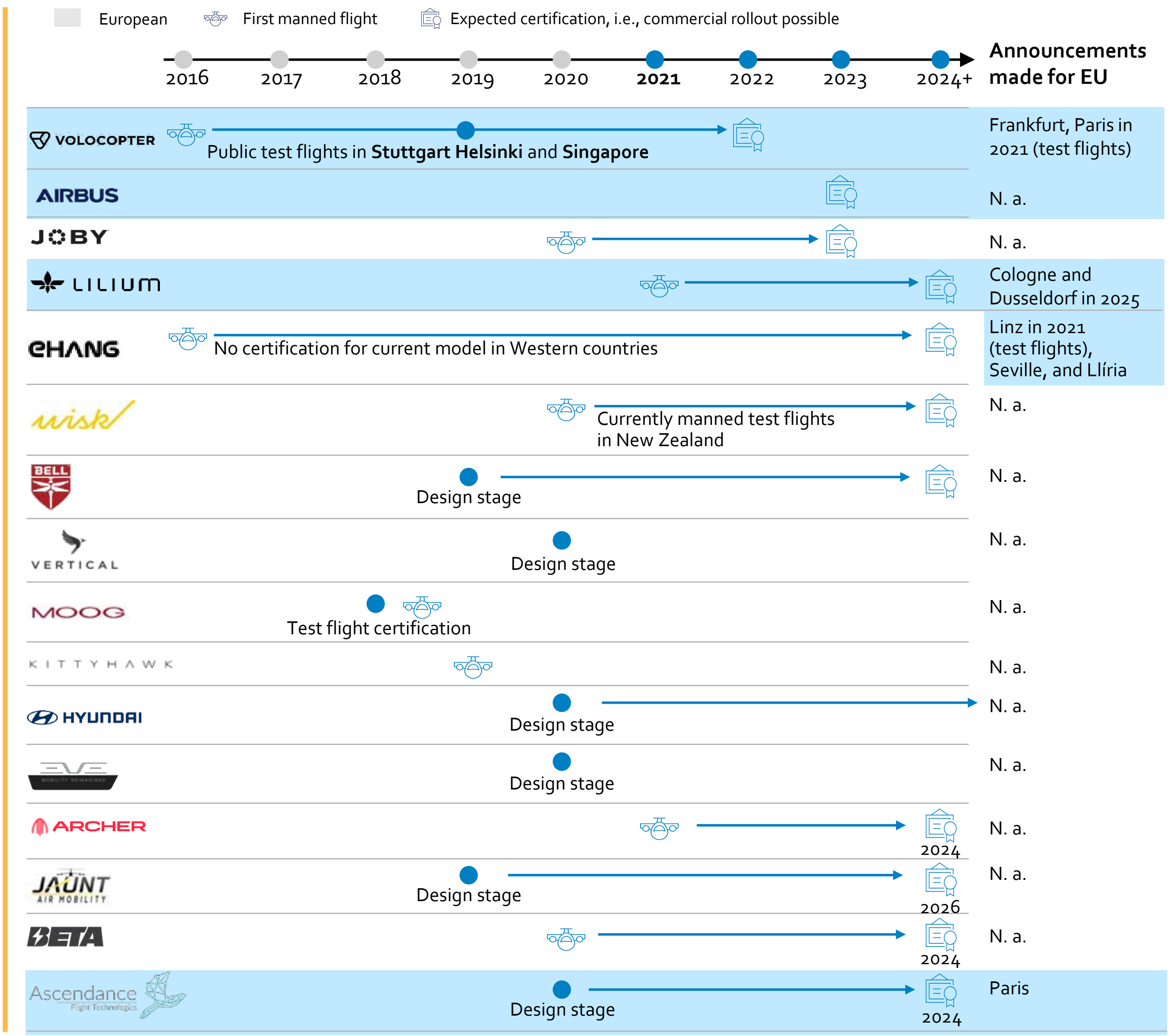
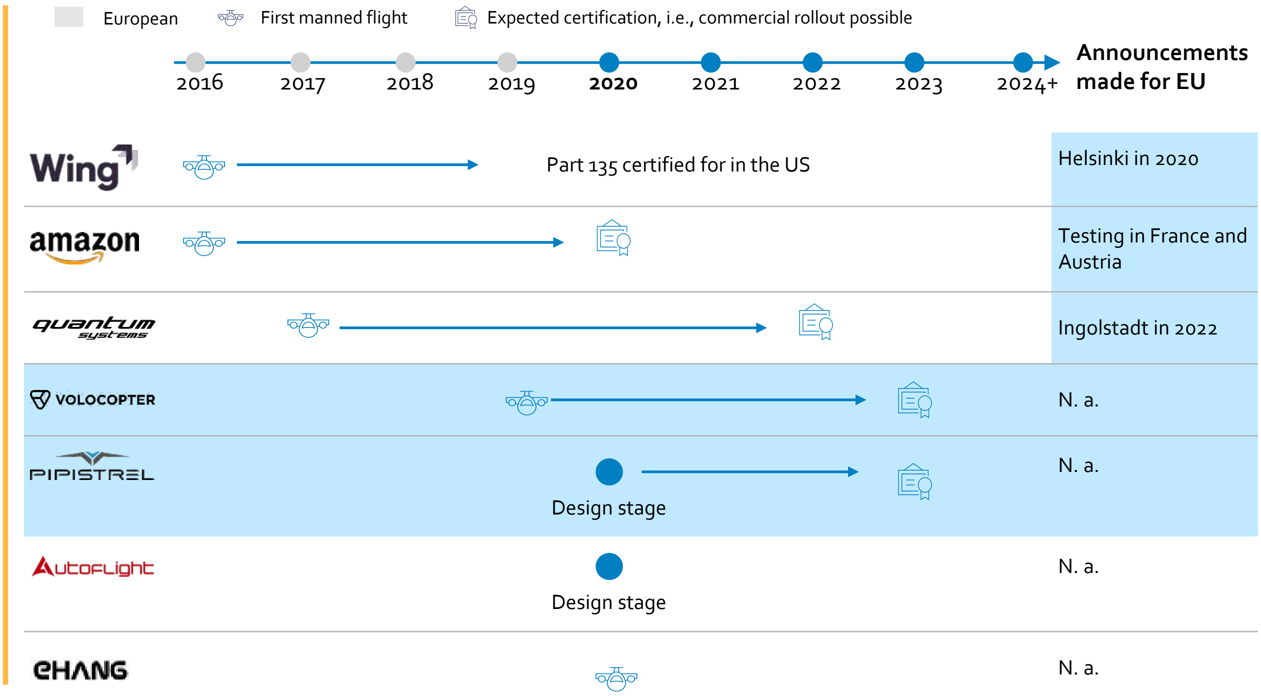


Figure 9: Cargo vehicle announcements: (non-exhaustive)



UAM vehicle types

In general, UAM aircraft layouts for vertical take-off and landing (VTOL) can be categorised into three archetypes:

i. Vectored thrust
The same propulsion units first provide lift during the hover and then swivel to create thrust in the cruise phase. During the cruise phase, lift is generated by the wings. This layout is better suited to longer-distance flights, as the system is more efficient but more complex than the other concepts. An example can be seen on the left side of Figure 10.

ii. Lift + cruise
This layout has separate propulsion units for the hover and cruise phases. Wings create the necessary lift during the cruise phase. Lift + cruise is suited to shorter distance flights than vectored thrust, but to longer distances than wingless. It is potentially easier to certify than vectored thrust because the propulsion systems are separate. An example can be seen in the middle of Figure 10.

iii. Wingless (multicopter)
Here the propulsion units are fixed in position and create lift all the time. This is the option that offers the shortest flight distances and is overall the simplest concept, as it is avoiding any unnecessary movable parts (e.g. thrust vectoring). An example can be seen on the right side of Figure 10.

1.2.1 Aircraft and Use Cases

In the following subchapters, the aircraft types and certification timelines of the main use case categories of this study (passenger transport, cargo transport, and emergency) are discussed. Detailed statements related to autonomy levels,

Figure 10: UAM vehicle types

	Vectored Thrust **Thrusters** used for lift and cruise	**Lift + Cruise** Independent thrusters used for cruise as for lift	**Wingless (Multicopter)** Thrusters only for lift, cruise via rotor pitch
			
Example	**Hyundai SA1 eVTOL**	**Wisk (Kitty Hawk) Cora**	**Volocopter 2X**
Benefits	Optimized for both hover and cruise Lift provided by wings for cruise for highest efficiency Highest cruising speeds	Redundancy benefits of multicopter without collective or cyclic actuation Wing configuration allows for more speed in cruise	High redundancy and simple controls Significantly quieter than helicopters Lower maintenance and lightweight

range, energy consumption and required ground infrastructure are not presented in the following as these are kept confidential by the relevant actors.

Passenger transport aircraft

The commercial transport of people by UAM aircraft is covered by this segment. This can be, for example, a flight between a city centre and an airport, flights within a metropolitan area, or flights within a city for sightseeing.

For the passenger transport use cases, vectored thrust (i) appears to be a preferred solution, with 7 out of 16 of the concepts reviewed opting for this solution (e.g. Bell, Hyundai and Joby). This is followed by lift + cruise (5 out of 16, e.g. EVE, BETA and Wisk), and finally wingless (4 out of 16, e.g. Airbus, Volocopter and EHang). Planned passenger numbers range from one to five.

Passenger, cargo and emergency use cases and potential vehicles

For passenger transport use cases, (i) vectored thrust appears to be the preferred solution for OEMs. Most of them plan to start operations with a pilot on board. First certifications for passenger transport use cases are estimated for 2022. To ensure infrastructure needed, vehicle manufacturers, cities and infrastructure companies are cooperating. Most of this is happening in Europe right now.

For cargo transport use cases, (ii) lift + cruise is the preferred archetype for OEMs, followed by wingless. Most concepts plan to fly autonomously from the beginning and have a payload between 0.7 to 200 kg. First operational certifications are already achieved.

For emergency use cases, (iii) wingless vehicles are preferred, all planned to be remote controlled. They can cover transport of medical emergency personnel to an accident site, patients to a hospital but also e.g. direct firefighting.

Most OEMs plan to start operations with vehicles with a pilot on board (e.g. Volocopter, Lilium and Bell). Very few plan to start operations with fully remote controlled or autonomous vehicles (e.g. EHang and Wisk). All concepts are powered by a battery electric propulsion system, except for those from Moog and Ascendance Flight Technologies, which utilise a hybrid electric propulsion system.

The earliest estimated certification year for the companies reviewed within the passenger transport use case is 2022 (for Volocopter), followed in 2023 by Airbus and Joby. The bulk of players (e.g. Lilium, EHang, Wisk etc.) announced they would expect certification in 2024 or later. The most ambitious timelines were four years from the start of the design phase to planned certification for Vertical Aerospace and Ascendance Flight Technologies. Both companies are currently in the design phase. The European OEMs Lilium and Volocopter were among the first to start development of passenger transport aircraft.

UAM ground infrastructure

Dedicated infrastructure is required for the initial operation of UAM passenger transport. 'Vertiports' will probably appear in different sizes and numbers in different cities, depending on expected traffic volumes. The largest vertiports will be the fewest in number in a city, and the smallest ones will be the most numerous. Figure 11 indicates potential numbers for different city archetypes in mature UAM network state. The number of landing pads is different for the three vertiport types, with vertipads only having one or two, while a vertihub can have around ten landing pads. The number of landing pads per vertiport multiplied by the respective number of vertiports in a city results in the total landing pad number.

Figure 11: Urban Air Mobility infrastructure may come in scalable size types

Large cities Large, dense, high-income urban city, e.g., Paris, Berlin, Madrid, Hamburg, Vienna, Barcelona				**Medium cities** Medium, less dense, medium income, urban/suburban city, Sevilla, Lisbon, Dusseldorf, Riga, Athens
Outposts, areas of interest or private use	**3-5**	**Vertipads** 	**3-5**	Major suburban commuting stations, private use for high net worth individuals, or in wealthy suburbs
Near concentrations of high origin and destination points	**5-10**	**Vertibases** 	**3-7**	Major corporate headquarters, major retail districts, and major commuting stations
Major airports, city centres, and major commute corridors	**2-3**	**Vertihubs** 	**1-2**	Main airport, downtown, and major work district
	40-60	**Total landing pads**	**20-45**	

What are vertiports?

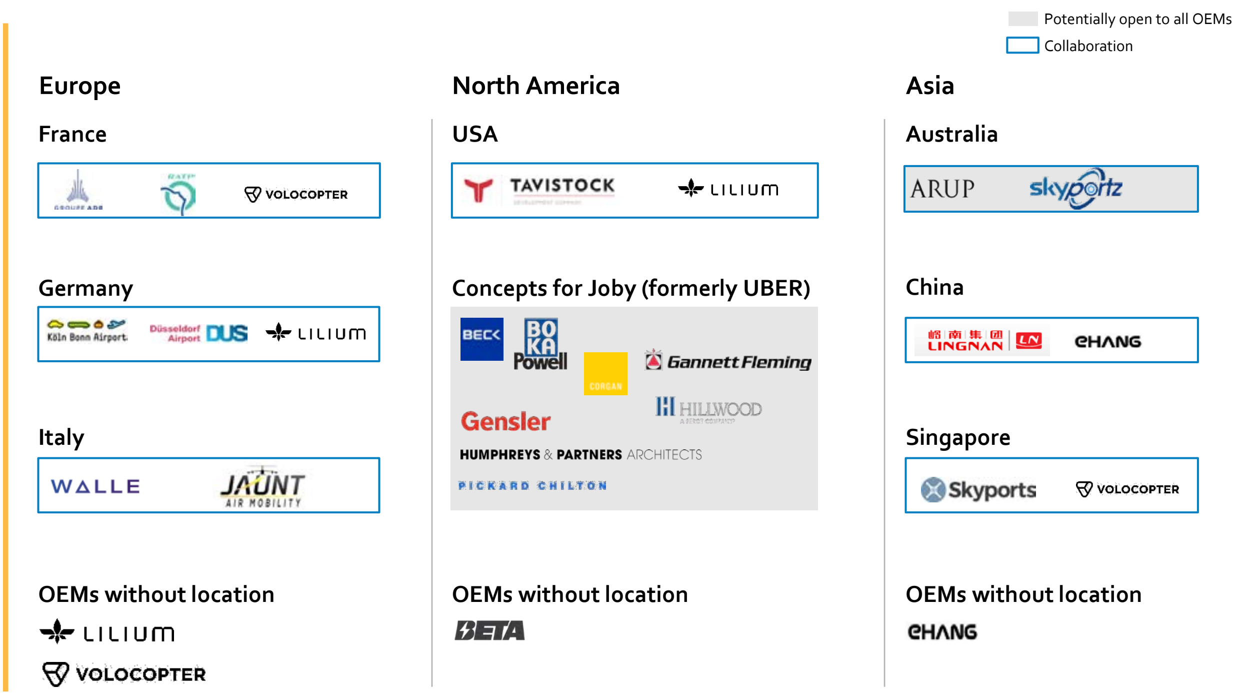
Vertiports are needed to enable take-off and landing of air taxis. They are expected to appear in different sizes. Depending on the traffic of a city, number of vertiports will vary.
At the moment, the development of vertiports seems to be mostly through collaborations between experienced infrastructure players and UAM vehicle manufactures.

Two important factors for locating vertiports will be the ease of access to them, as well as the electricity infrastructure connection. As the energy for the operations of most UAM aircraft will be electricity stored in batteries, the recharging of the batteries will probably happen at the vertiports and therefore a suitable connection to the electricity grid will probably be required.

At the moment, the development of vertiports seems to be mostly through collaborations between experienced infrastructure players and UAM aircraft manufacturers, although manufacturers, have also demonstrated development of some of their own concepts. Some infrastructure players have also demonstrated concepts they are developing on their own that would be compatible with various UAM aircraft manufacturers. But at the moment the interoperability of these concepts is difficult to assess.

Europe seems to be a leading market for passenger transport, as demonstrated by the announcements of collaborations between UAM aircraft manufacturers, cities, and infrastructure companies by the various regions, as can be seen in Figure 12.

Figure 12: Vertiport announcements



Cargo transport aircraft

This segment covers the transport of goods by UAM aircraft for commercial or industrial applications. This can include, for example, last-mile delivery, delivery to a hub, or rural delivery of supplies. The transport of emergency and medical goods, such as organs and blood, is excluded from this category as it is covered by the emergency use case.

The delivery could be lowered via a winch on the UAM vehicle into the garden of the receiving person or organisation, or the vehicle could land on the roof of a multistorey building and the delivery could be picked up from there. Another option is the delivery to a fixed station in the vicinity of the receiving person, similar to the self-service parcel terminals already used today.

The lift+cruise aircraft is the preferred archetype in this category (with four out of eight OEMs using this concept), followed by wingless (three out of eight) and vectored thrust (one out of eight). The stated payload of the concepts ranges from 0.7 to 200.0 kg. Only two concepts will initially be remote controlled (EHang and Volodrone); the others are already planned to be autonomous during initial operation. Six of the concepts use battery electric propulsion, while two will use hybrid propulsion, which includes two or more sources of propulsion in one design (Pipistrel and AutoFlight).

Of the companies reviewed within the cargo use case, Wing and Amazon have already achieved operational certification according to Part 135. From an aircraft point of view, Quantum-Systems is aiming for certification in 2022, while Volodrone and Pipistrel are aiming for 2023. The other players did not state a definite target for aircraft certification and are mostly in the prototype stage.

From a European OEM point of view, quantum systems had already started development of a cargo vehicle with 0.7 kg payload in 2017, while Volocopter and Pipistrel announced plans for vehicles with a larger payload (200 and 460 kg respectively) in 2019 and 2020.

Emergency aircraft

Aircraft for emergency-related use cases are summarised in this segment. These can cover applications such as the transport of medical emergency personnel to an accident site, the transport of patients to a hospital, the evaluation of emergency areas, direct firefighting, or the delivery of medical and emergency supplies.

The emergency UAM aircraft development does not seem to be a focus for European OEMs so far. Only Volocopter collaborates with ADAC Luftrettung, a German non-profit air medical provider, on the use of Volocopter's passenger UAM for flying emergency doctors to accident sites. However, any passenger transport UAM could in principle be used for transport of a doctor, while for a patient transport a dedicated cabin modification would be needed. Thus, aeromedical services are more dependent on the operations regulations.

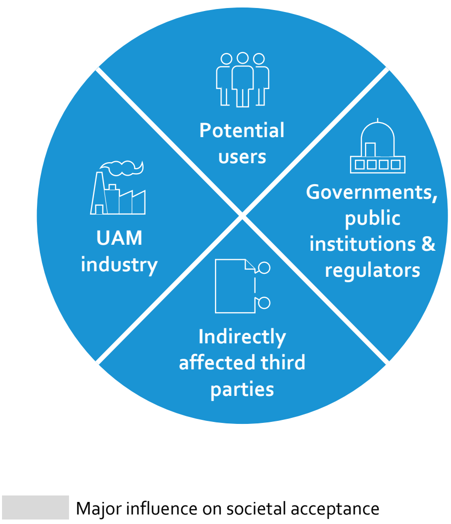
Other aircraft reviewed in this category are all wingless since non-urban applications such as those by Zipline are out of scope. Airobotics, DJI, IAI and Parrot plan to use vehicles for the visual assessment of emergency locations, while EHang plans to use them for extinguishing fires in high-rise buildings. All concepts reviewed were remote controlled and will have an electric propulsion system either powered by batteries or via a tether, for IAI.

No certification timelines were found for the five manufacturers reviewed (Airobotics, DJI, EHang, IAI and Parrot) in this segment.

1.2.2 UAM stakeholder environment

The emerging UAM industry and ecosystem is influenced by many stakeholders. The main UAM stakeholders can be categorised into four groups along the value chain, as can be seen in Figure 13.

Figure 13: UAM vehicle types



UAM industry
Manufacturers, UAM operators, maintenance services, airport operators, service providers, vertiports, communication providers, suppliers

Potential users
Urban residents, travellers, commuters, high wealth individuals, car users, emergency services, public transport users

Governments, public institutions & regulators
Supranational & national: EU institutions and bodies, EASA, air traffic control organizations, EU member state governments, state authorities, military & police

Local: Local authorities, municipalities, city officials, urban and city planners, public institutions and organizations

Indirectly affected third parties
Private individuals: Residents, communities, real-estate owners, citizens

Professionals: Pilots, academia, innovators

Associations: Local environmental protection associations, local traveller's' associations, unions, lobbies, associations, environmental groups

Extended industry: Airports, aerospace & automotive industry, energy providers, public transport providers, insurance providers, ticket brokers, businesses in other industries potentially interested in entering UAM space

Stakeholders at all level are important for societal acceptance of UAM

Urban Air Mobility needs to meet expectations of a wide variety of stakeholders. This involves reconciling different social acceptance perspectives.

The following section covers the different stakeholder groups in more detail and lists their motivation, expectations, and concerns.

The UAM industry stakeholder group includes all entities directly involved in the development, manufacturing, operation, and servicing of UAM aircraft and services. The main motivation for this group is generating a profit from their activities. They may also be motivated by advancing technologies, keeping or increasing their number of employees, or being a first mover.

While working on UAM topics, this group may hope for a stable regulatory framework, minimal levels of bureaucracy, support for building up a new industry, access to a qualified workforce, and beneficial taxation. Their main concerns could be the impact of regulation on the economics of UAM, excessive regulation, public opinion, nimbyism, and environmental issues.

For the **potential user stakeholder group,** time and cost savings, as well as comfort, are some of the main decision criteria for selecting a mode of transport. The expectations of the potential user group for UAM will probably be safety, reliability, predictability, affordability, ease of use, and convenience. Topics they may have concerns about are noise, safety, environmental impact, benefit for self and/or the community, automation, and accessibility.

From the **governments, public institutions, and regulators group** viewpoint, three different levels of political structures come into play: supranational, national, and local. The focus for this stakeholder group is the public good, safety of the public, an efficient mobility system, limitation of congestion and pollution, the creation of jobs, supporting and building up an industry in their respective jurisdictions, the environment, and public opinion.

The expectations regarding UAM are probably that it should generate a positive contribution to the community, contribute income tax that finances governmental tasks, and that the industry complies with regulations. The main concerns are likely around public opinion, loss of life, impact on voters, prestige for their respective jurisdictions, under- or over-regulation, and environmental issues.

Members of the **indirectly-affected third-parties group** may be impacted by an evolving UAM industry. They can be further divided into private individuals, professionals, associations, extended industry, and potential competitors. UAM will most likely be evaluated by this stakeholder group through the lens of the benefit for oneself and/or for society. Opportunities for growth and development are the probable expectations from this group and becoming irrelevant or losing job security may be some of their concerns.

1.3 UAM high level societal benefits and risks

The introduction of new technologies comes with benefits and risks for the users, but also for the general public. The following section reflects the high-level societal benefits and risks initially identified through the research and literature review. These elements were then used to build the survey questionnaires and were compared ultimately with the results of the survey (see Conclusion).

1.3.1 Benefits based on market models, literature and expert interviews

UAM will have societal benefits for the EU and Europe. These benefits come in a variety of dimensions, as shown in Figure 14.

The estimated market size of UAM in Europe, including R&D, vehicle manufacturing, operations and infrastructure construction, will be approximately EUR 4.2 billion in 2030[3], which represents almost one third of the global market and hints at the opportunity that this industry may offer for Europe. The estimated market size may create or sustain approximately 90,000 jobs in 2030, based on labour spending for constructing related infrastructure and operating the UAM. Manufacturing jobs are not included, as the whole supply chain setup is still uncertain. If we visualise what this market size would mean for the Paris metropolitan area in terms of UAM aircraft, the estimates range from approximately 3,000 to 3,500 UAM aircraft for passenger and cargo transport in 2030. In this estimate, UAM passenger aircraft represent the smallest part with numbers between 160 and 180, whereas the estimates for the UAM cargo aircraft and delivery drones range from 2,840 to 3,300.

Local emissions by UAM, in the city environment, could be almost zero if battery electric propulsion systems are used. Most of the reviewed UAM concepts already rely upon this propulsion type, with a minority working on hybrid electric propulsion systems.

3. Source: McKinsey Center for Future Mobility UAM Market Model

One of the major benefits of UAM for users will be time savings. For example, a city-to-airport transfer in Paris by air taxi could 2 to 4 times faster compared to a car journey on a Thursday evening during rush hour. Also, medical transportation of equipment or organs could be performed approximately 73 percent faster by drone than by ambulance, taking the example of a trip in Berlin on a Thursday evening, during rush hour.

If UAM passenger transport achieves the same level of safety as aviation did within the EU in 2018 (0.01 fatalities per billion passenger kilometers), it would then be approximately 1,500 times safer on a passenger-kilometer basis than road transportation. This number is based on data for road transport and commercial air transport in the EU. As a first step the fatalities per million passenger kilometers for both modes of transport were calculated and in a second step these respective numbers were put in proportion.

Figure 14: UAM benefits for the EU and Europe

~4.2 bn €

market size in Europe in 2030[1]

~31%

of global UAM market to be located in Europe in 2030[1]

~90 000

jobs created in the Europe in 2030[3]

100%

reduction of local emissions for electric propulsion[4]

1 500 times

less likely to be involved in a fatal accident compared to road transport on a passenger kilometre basis[2]

15-40 min

saved in average on travel time by UAM for a city to airport transfer[5]

~73%

faster delivery of organs between city hospitals possible[5]

1. Based on McKinsey VTOL market model
2. Assuming same safety level as commercial air transport in the EU
3. Based on direct, indirect and induced jobs created by CAPEX and OPEX spend of UAM industry in Europe in 2030
4. Compared to a helicopter with conventional kerosene propulsion
5. Compared to a car drive on a Thursday at 5pm

Source: VTOL team, Eurostat, Google Maps

1.3.2 Risks and acceptance based on literature and expert interviews

There are also a few risks associated with the implementation of UAM in Europe (see Figure 15). Amongst the top concerns in the literature or stated by experts are:

- **Noise:** is perceived as a prevalent risk of UAM. This includes the noise generated by the vehicles when they take-off and land, as well as while they are in flight.
- **Safety:** Ranks high among the risks of UAM mentioned in the reviewed literature, as an unsafe system could have widespread implications for public acceptance.
- **Privacy:** Society may also be concerned about privacy, as UAM aircraft like air taxis and drones may fly above or close to places of residence.
- **Visual pollution:** Was mentioned as a potential nuisance, which may hamper public acceptance of UAM and is therefore a risk to its widespread rollout.
- **Job losses:** Some jobs may become obsolete due to the introduction of UAM, and this could lead to resentment against it. Affected industries could include logistics and taxi services.
- **Environmental issues:** The environmental impact of UAM may be almost zero on a local emissions level for battery electric vehicles, but the required electricity still has to be generated and the vehicle components have to be manufactured, assembled and eventually disposed of. Focus should be placed on reducing the overall environmental impact of UAM aircraft during the design phase.
- **Affordability:** Another risk for UAM is the affordability of the services for a large part of society. If the services are only available to more affluent individuals but the disadvantages (like noise) are borne by everyone, this could hamper the acceptance of UAM within society.

Figure 15: UAM risks for the EU and Europe

Noise

"..there are certain threats that could impede the sustainable and thus successful introduction of UAM to our cities, with **noise** being a prominent limitation." (26)

Safety

"The key areas of discussion to move forward will be to meet, or exceed, the current **safety** parameters with these new vehicles." (87)

Privacy

"Civil liberties groups have **privacy** concerns with widespread UAM adoption..." (20)

Visual pollution

"The sensitive topic of **visual** and noise **pollution** must also be addressed." (52)

Affordability

"Public acceptance of these new systems and services is imperative, driven by ... ...and **affordability**." (61)

Obsolete jobs

"There is concern that autonomous technology will render **jobs** obsolete across multiple industries" (20)

Environmental impact

"**Air pollution** caused by pollutants such as particulate matter, nitrogen oxides and ozone, as well as odour nuisance should be avoided." (53)

Source: Bibliography ID 20, 26, 52, 53, 61, 87

2. Assessment of urban European target markets

An extensive market analysis was performed to identify a list of EU cities where the deployment of local UAM markets appears plausible in the years to come, due to the local conditions and needs. A further objective was to identify six cities from this list where the quantitative survey could be conducted. As respondents to the quantitative survey needed to include sufficient representatives of the cross-sections of the local population, only large cities with a minimum number of inhabitants (300,000 for cities and 2,000,000 for cross-border regions) were pre-selected. This list is only indicative and not exhaustive, and the absence of a city does not imply that UAM would not work well in that location.

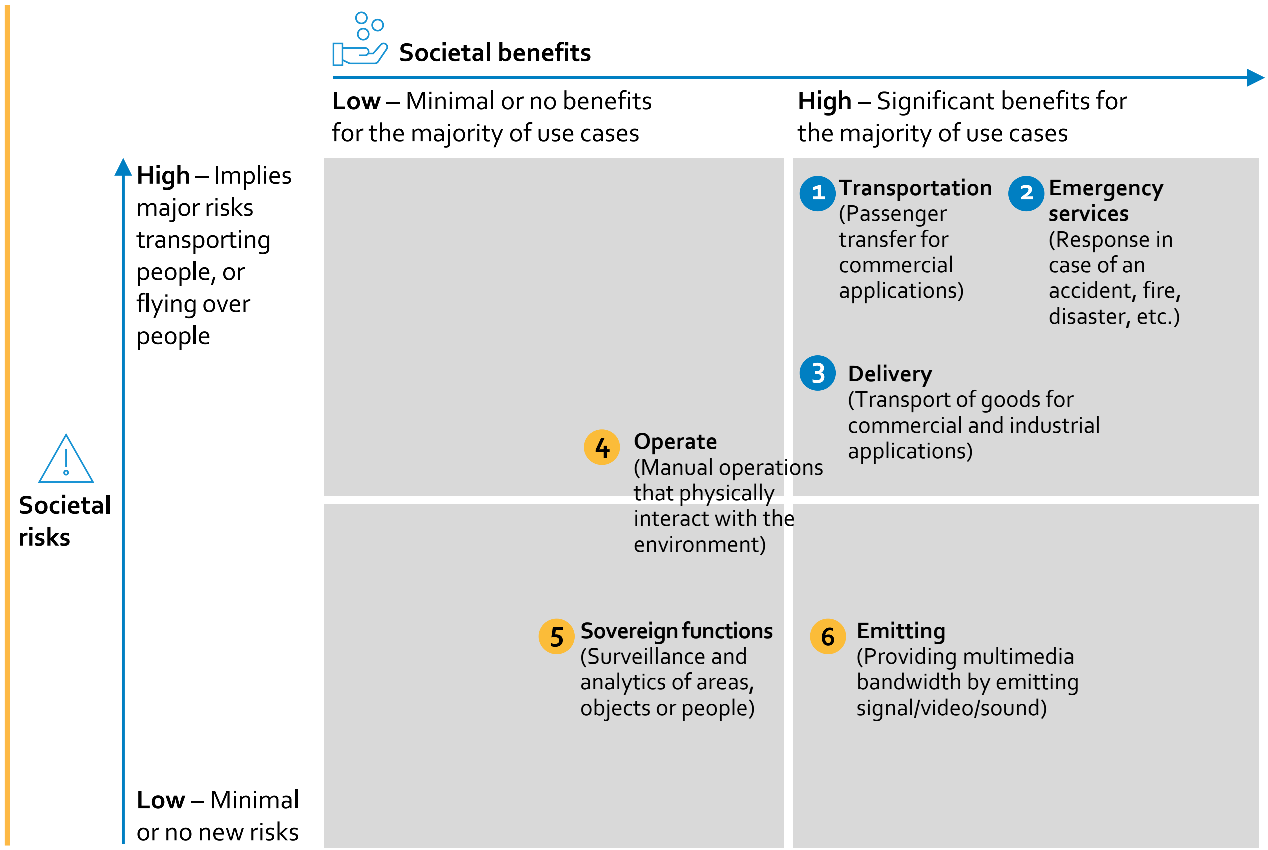
Since the selection process was very comprehensive, only an overview and its methodology is given below, together with the overall results. Further details can be found in the Appendix.

2.1 Use case prioritisation

The review of international literature identified six categories of principal use cases for UAM deployment (see Figure 16): Transportation (passenger transfer for commercial applications), delivery (transport of goods for commercial and industrial applications), emergency services (response in case of an accident, fire, disaster etc.), civil surveillance and other operations (manual operations that physically interact with the environment), sovereign functions (surveillance and analytics of areas, objects or people), and emitting (providing multimedia bandwidth by emitting signal/video/sound).

For each of these use case categories, societal risks and benefits were evaluated to identify those with the highest risks and benefits, and a framework was created to break down benefits and risks into categories. This allowed us to understand which use cases are likely to be deployed in the EU in the next five to ten years and to include them in the survey.

Figure 16: Transformation, emergency services and delivery are use cases with high risks and high benefits



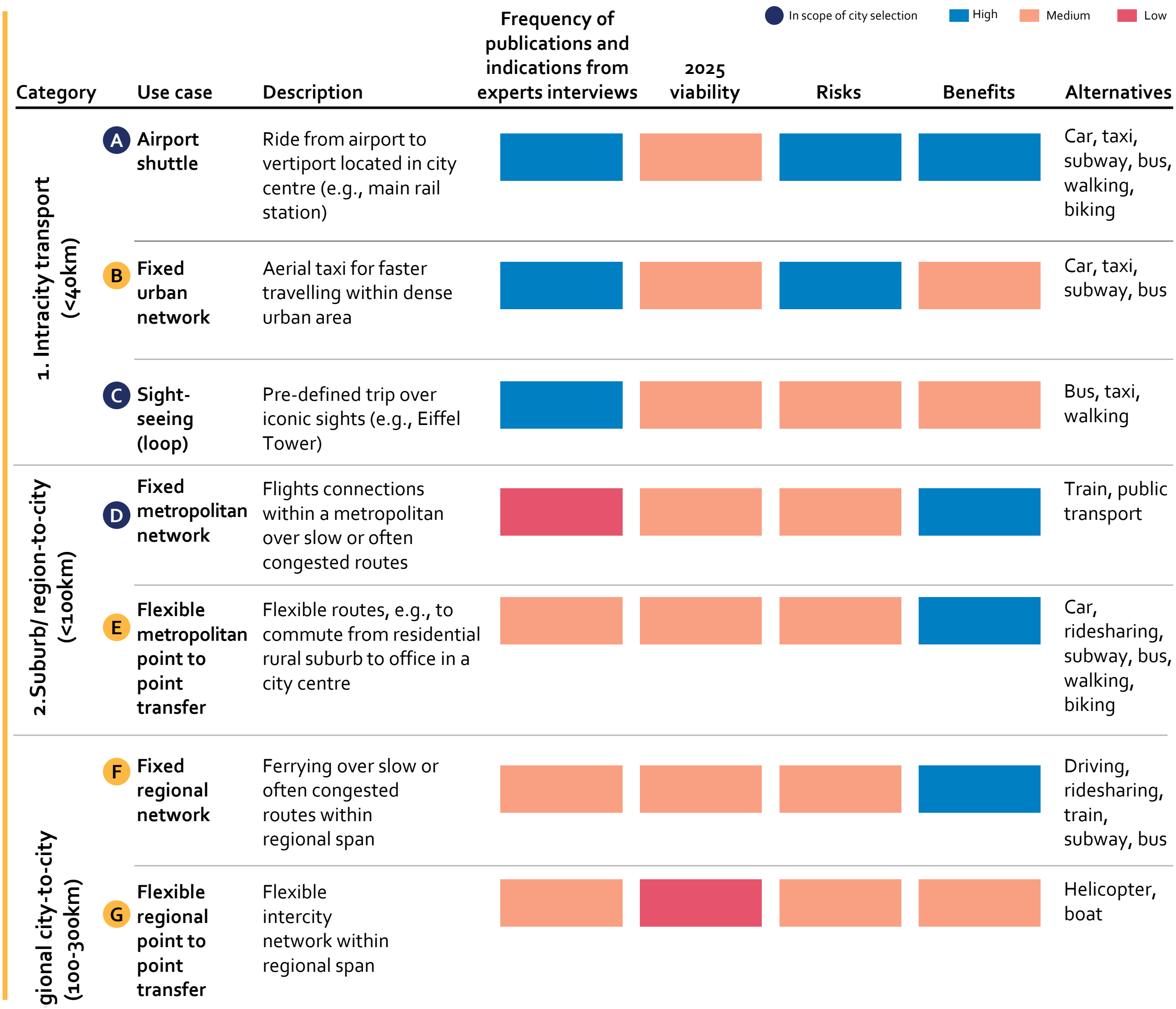
The results indicate that three use cases have the highest risk and benefits, and are therefore very important candidates for societal acceptance analysis: (1) commercial passenger transport by electric vertical take-off and landing (eVTOL) with a pilot onboard, (2) emergency services use cases (both medical equipment by drone and people transport by eVTOL with a pilot onboard), and (3) delivery transport by drones for commercial and industrial applications. These results also support the request from the European Union Aviation Safety Agency (EASA) to include only people transport, goods delivery, and emergency services in the scope of the UAM target market analysis.

These three main use cases were analysed in detail and sub-use-cases were defined for each. The analysis centered on how often sub-use-cases were mentioned in the literature review as well as during interviews with external and internal UAM experts. For each sub-use-case, this analysis indicated whether it was a likely candidate for initial implementation in the EU, its near-term viability for 2025 to 2030, and which benefits and risks it involved. Based on this evaluation, six priority sub-use-cases were chosen for further analysis.

1. Passenger transfer use cases for commercial application

The sub-use-cases for commercial passenger transport were divided into three categories (see Figure 17 below): intracity transport (under 40 km), suburb/region-to-city transport (under 100 km) and regional city-to-city transport (between 100 km and 300 km). Airport shuttle (A), sightseeing (C) and fixed metropolitan network (D) were identified as the sub-use-cases with the highest benefits, lowest risks, and the highest viability for the initial UAM introduction in 2025 to 2030. They have therefore been chosen for the survey city-selection process (for more details see Appendix). As can be seen in chapter 1.2 (UAM vehicle types), these operations will be piloted in the first years of introduction.

Figure 17: Airport shuttle, sight-seeing (loop) and fixed metropolitan network are most important passenger use cases for the survey

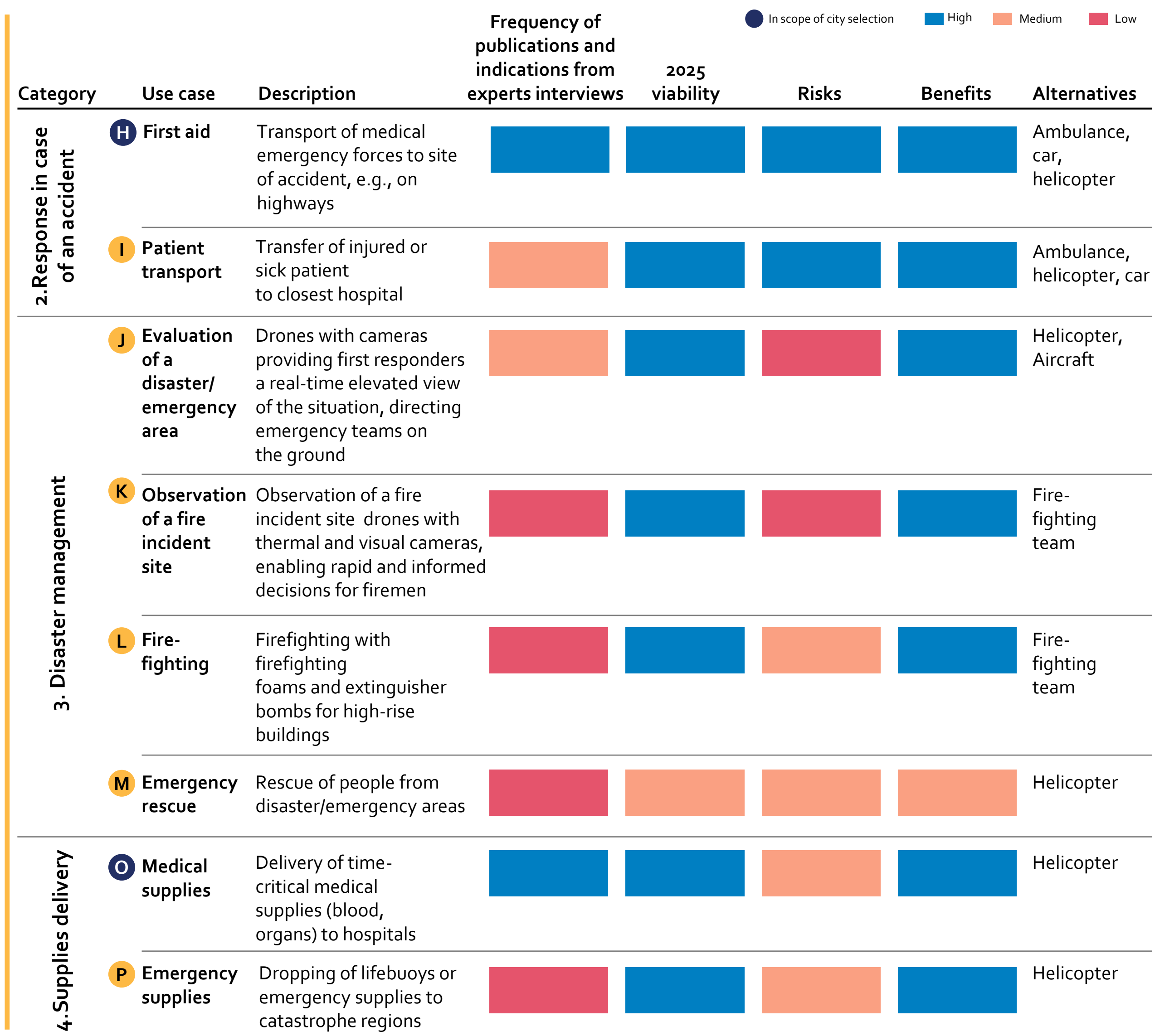


2.Emergency service use cases

The sub-use-cases for emergency services were divided into three categories: accident response, disaster management and supplies delivery (see Figure 18 below).

First-aid and medical-supply delivery sub-use-cases were identified as the sub-use-cases with highest benefits, lowest risks, and viability for initial UAM introduction in 2025. Therefore these have been chosen for the survey city-selection process (for more details see appendix). For our purposes, first-aid (H) includes transport of medical emergency forces to the site of an accident and these operations are expected to be piloted in the first years, as in the case of passenger transport. Medical supply delivery (O) refers to the transport of blood or organs to an hospital (for example) and can support even faster delivery than existing modes of transport (see section "UAM vehicle types" for more information).

Figure 18: First aid and medical supplies are most important emergency use cases for the survey



3. Goods delivery for commercial and industrial applications

The sub-use-cases for goods delivery were divided into two categories: last-mile delivery (e.g. the last section of the supply chain, which delivers goods to their final destination) and long-distance delivery (see Figure 19 below).

The last-mile delivery category was identified as the priority sub-use-case having the highest benefits, lowest risk, and best viability for the initial UAM introduction in 2025 to 2030 and has therefore been chosen for the survey city selection process.

Figure 19: Last mile delivery holds the most important sub-use-case for the survey 2.2 Target market identification

● In scope of city selection | High | Medium | Low

Category		Use case	Description	Frequency of publications and indications from experts interviews	2025 viability	Risks	Benefits	Alternatives
5. Last mile[1] delivery ●	R	Deliver to a private property (e.g. garden)	Fast delivery (e.g. food or last minute gift) in urban area to private residences	High	High	Medium	High	Car, bike, motorbike
5. Last mile[1] delivery	S	Delivery to a hub	Goods delivery (e.g. retail goods) in urban area to a hub along a pre-defined route	Low	High	Low	Medium	Truck, car
6. Long distance delivery	U	Heavy cargo	Forwarding of containers or bulk goods over a route with little infrastructure	High	Medium	Medium	Medium	Ship, boat, helicopter
6. Long distance delivery	V	Industrial applications	Transport of instantaneously needed goods for industrial applications, e.g., spare parts	Medium	High	Low	Medium	Truck
6. Long distance delivery	W	Rural delivery of supplies	Grocery delivery to home in area with long travelling distance to next shop	Low	High	Low	Medium	Truck

2.2 Target market identification

Use cases most likely to be deployed first (in the EU)

- airport shuttle
- sightseeing
- fixed metropolitan network
- first aid
- medical supplies
- delivery to a private property

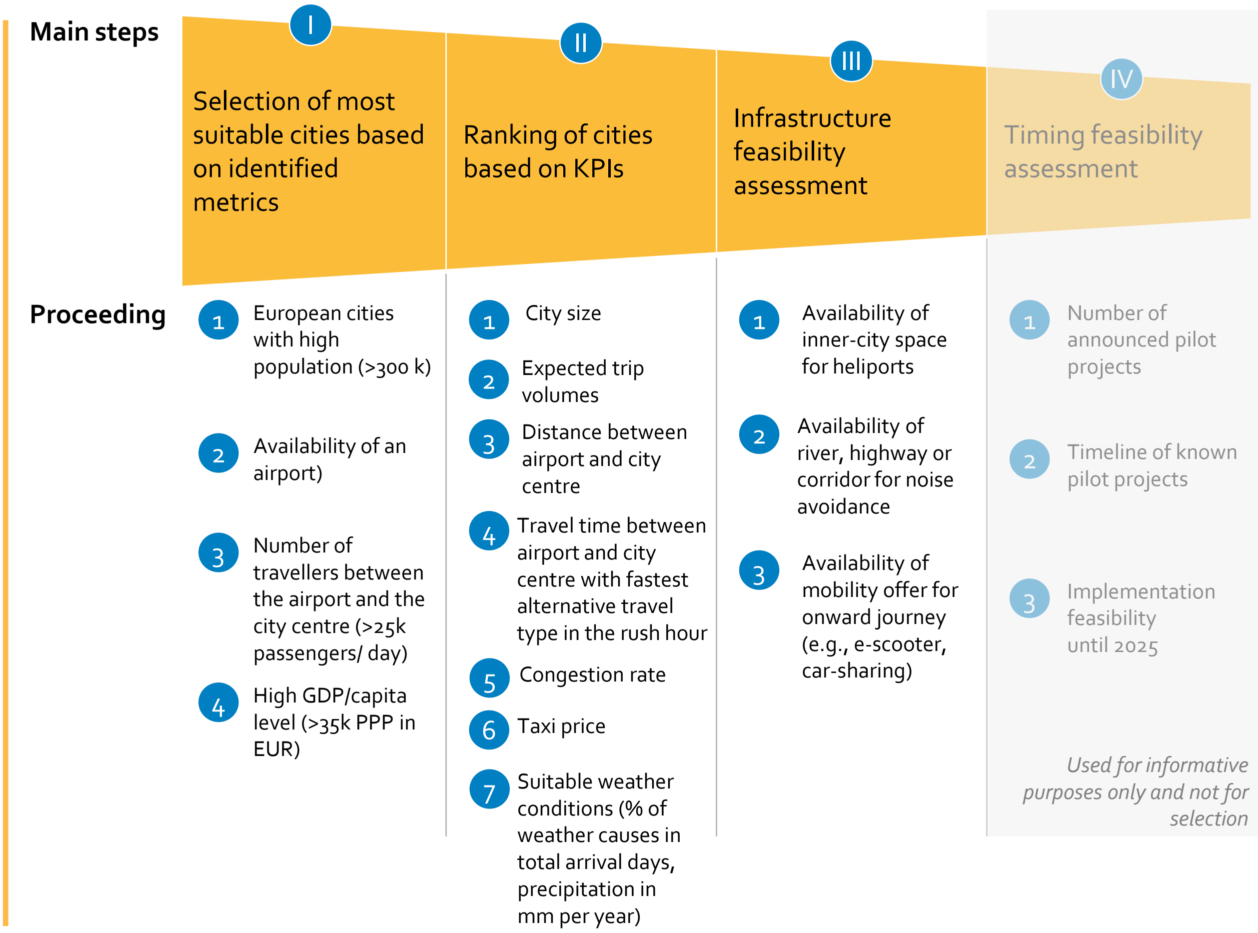
For each of the six prioritised sub-use-cases (airport shuttle, sightseeing, fixed metropolitan network, first aid, medical supply delivery and last-mile delivery), the project identified the most attractive EU urban target markets – from a business perspective – for UAM OEMs and UAM operators. These target markets are likely to see the first deployments of commercial UAM services in the EU and were therefore deemed to be important candidates for societal acceptance analysis.

To identify target markets for each use case, a four-step methodology was established:

1. European cities were pre-selected based on metrics relevant to the specific use case;
2. Pre-selected cities were ranked based on defined KPIs: the 15 cities with the highest ranking were selected for the next step;
3. An infrastructure assessment, relevant to the specific use case, was performed for these 15 cities;
4. A timeline assessment (number of announced pilot projects, timelines of known pilot projects, implementation feasibility by 2025) was performed for these 15 cities – this information was used for informative purposes only and not for further selection.

Figure 20 shows the city selection process on the airport shuttle use case, as an example.

Figure 20: City selection process for airport shuttle use case



The detailed evaluation per use case is provided in the Appendix 2. Please find further information on the viability 1) for airport shuttle use case, 2) for sightseeing use case, 3) for first aid use case, 4) for Last-mile delivery, 5) for Medical supply delivery, 6) for fixed metropolitan/regional network.

After applying this process, a number of cities remained which were further prioritised according to a KPI system tailored to the respective use case. Figure 21, on the example of the airport use case, shows how pre-selected cities were ranked by KPIs to arrive at the 15 highest priority cities. The KPIs included: city size; expected number of trips; distance between the airport and city centre; travel time between the airport and the city centre with the fastest alternative travel type (e.g. taxi, car, or public transport) in rush hour; congestion rate; taxi cost for the journey to the airport; and suitable weather conditions (percentage of weather causes in total arrival delays, precipitation in mm per year). A weighting factor was assigned to each KPI to adjust that KPI's impact on the overall ranking score.

Figure 21: Target cities ranking process for the airport shuttle use case

Ranking of cities based on further KPIs

KPI		Weighting
1 City size		25%
2 Expected trip volumes		25%
3 Distance between airport and city centre	Time saving	25%
4 Travel time between airport and city centre with fastest alternative travel type in the rush hour		
5 Congestion rate		
6 Taxi expenses for ride from airport to city-centre		15%
7 Suitable weather conditions (% of weather causes in total arrival delays, precipitation in mm per year)		10%

City	Ranking (100 = best suitability for UAM)
Paris	88.2
Berlin	78.3
Rome	75.4
Munich	75.3
Madrid	74.8
Budapest	73.8
Prague	72.8
Milan	72.1
Barcelona	71.4
Dublin	70.8
Vienna	70.4
Brussels	67.8
Bucharest	67.4
Warsaw	66.8
Amsterdam	65.6
Stuttgart	63.9
Stockholm	63.0
Hamburg	62.8
Lyon	60.8
Frankfurt am Main	59.9
Bologna	59.8
Bonn	59.6
Helsinki	58.2
Cologne	57.8
Dusseldorf	56.8
Copenhagen	56.2
Toulouse	55.2

Based on this methodology, 90 potential target markets (15 cities x 6 use cases) were identified for initial OEM introduction ('long list', see Figure 22 below).

Figure 22: Potential target markets for the six prioritised use cases

	People transportation			Cargo use cases		
	A **Airport shuttle**	C **Sightseeing**	D **Fixed metropolitan network (<120km)**	H **First aid**	3 **Last mile delivery**	Q **Medical supplies**
City shortlist	Paris	Paris	Belgian central metro (Brussels)	Paris	Rotterdam	Cracow
	Berlin	Rome	Rhein-Ruhr region (Cologne, Düsseldorf, Duisburg, etc.)	Berlin	Hamburg	Wroclaw
	Rome	Amsterdam	Rome metropolitan region	Hamburg	Helsinki	Bucharest
	Munich	Venice	Milan metropolitan region	Lyon	Tallinn	Warsaw
	Madrid	Prague	Barcelona metropolitan area	Marseille	Bonn	Poznan
	Budapest	Barcelona	Rhein-Neckar region (Mannheim, Karlsruhe, Heidelberg, Pforzheim, etc)	Nice	Hanover	Sofia
	Prague	Florence	Stuttgart metropolitan region	Genova	Cologne	Budapest
	Milan	Budapest	Oresund region (Copenhagen, Hillerod, Malmo, Lind)	Prague	Dortmund	Dublin
	Barcelona	Berlin	Munich metropolitan region	Brno	Dresden	Praha
	Dublin	Frankfurt am Main	Vienna metropolitan region	Budapest	Dusseldorf	Brno
	Vienna	Stockholm	Paris metropolitan region	Nurnberg	Essen	Vilnius
	Brussels	Madrid	Rhein-Main region (Frankfurt, Darmstadt, Mainz, etc.)	Stuttgart	Leipzig	Hamburg
	Bucharest	Athens	Warsaw metropolitan region	Milan	Bratislava	Berlin
	Warsaw	Nice	Stockholm metropolitan region	Rome	Prague	Gdansk
	Amsterdam	Lisbon	Noord-Brabant region (Eindhoven, Tilburg, Breda, etc.)	Dublin	Murcia	Paris

City selection for the survey

This long list was reduced to six major cities, taking into account the use cases with top rankings and city-average ranking scores (across all use cases where the city was on the top 15 list). In addition, five guiding principles were established to help ensure that the selected major cities were representative of different regions, cultures and city archetypes (see Figure 23).

Figure 23: Guiding principles for city selection

Aspiration	Guiding principle	Rationale
Different regions	1. Our research focuses on different regions of the European Union	Regional differences will influence the societal acceptance of UAM
Different Culture	2. We investigated regions with possibly large cultural differences	Different cultural values will have an impact on the societal acceptance
Different sizes	3. The focus of the research was on large cities with the population >100 K inhabitants	High traffic density, noise levels and UAM risks will significantly influence the societal acceptance in large cities
	4. Medium and small size cities were included, if they already announced the attention to start pilot projects	Public awareness about upcoming pilot projects will affect the societal acceptance in small/medium cities
Different Archetypes	5. We analysed different cities archetypes (dense/wide-spread, high/medium-income, urban/suburban city)	The societal acceptance will vary for different city archetypes

Cities selected for the survey

- Barcelona
- Budapest
- Hamburg
- Milan
- Paris
- Øresund cross-border region between Denmark and Sweden

As a result of this process, Barcelona (Spain), Budapest (Hungary), Hamburg (Germany), Milan (Italy), Paris (France) and Øresund (cross-border region of Denmark and Sweden) were chosen as sites for the quantitative survey (see Figure 24). For further details on use cases and the metrics used for the survey city-selection process, see Appendix 2.

Figure 24: Final city selection and ranking

Target cities selection › Final cities

Our final cities selection covers all demographics, cultures and cities archetypes dimensions

(X) Top cities from KPI based evaluation
(X) City added to fulfil the guiding principles

City/Country	Country/Region	Ranking	Use case	City archetype
1 Paris	Central Europe	100	**Airport shuttle**[1] Sight-seeing, First aid	Large, very dense, high–income city
2 Rome	South Europe	87	**Sight-seeing**[1] Airport shuttle, First aid	Large, medium dense, medium-income city
3 Barcelona	South Europe	79	**Sight-seeing**[1] Airport shuttle, First aid, Medical supply	Large, very dense, medium-income city
4 Hamburg	Central Europe	75	**First aid**[1] Airport shuttle, Sight-seeing	Large size, medium dense, medium-income city
5 Budapest	East Europe	68	**Medical supply**[1] Airport shuttle, First aid, Sight-seeing	Large size, medium dense, medium-income city
6 Oresund region *(Copenhagen, Hillerod, Helsingor, Malmo, Lund)*	North Europe	20	**Fixed metropolitan network** [1]	Network of wide spread medium size cities

1. Most relevant use case

3. Survey-based assessment of public acceptance of UAM in the EU

The stated goal of the survey was to assess and understand the most important societal-acceptance drivers for UAM across cultures and regions in the European Union, including perceived benefits and concerns. This served both to complement available data from literature and to confirm this data for the specific EU environment. The results of this survey will further support the impact assessment and regulatory work of EASA.

The survey itself contained three parts:

- A quantitative survey, with the participation of 3,690 citizens across six European cities, through a web-based questionnaire;
- A qualitative survey, consisting of one-hour interviews with more than 40 stakeholders at local, national and European level, informed by the results of the quantitative survey and aimed at better understanding the perspectives of different stakeholders;
- A special noise perception survey with 20 participants was initiated to gain even more insights on how the noise of UAM aircraft may be perceived by the public.

The following chapter describes the overall survey methodology (3.1) and provides the ten key survey results (3.2), aggregating results from across three parts.

3.1 Survey methodology

Advantages of an online panel

Online samples are considered very representative:

- A broad section of the population reacts to online surveys
- Office workers are easier to reach (filling survey during the workday and can participate at a time that's convenient for them)
- Respondents provide more authentic and detailed answers to open-ended questions (as they may take the time to reflect on their responses)
- Various visualisation options (videos, logos, product images, shelves, advertisements, TV spots, radio spots, etc.) arise and survey questions are better understood by participants.

Chapter 3.1 is divided into three parts: First, the methodology for the quantitative survey is explained (3.1.1) in detail, including information on how participants were chosen, how the survey was structured and how the questions were defined. This section also provides a deep dive into the methodology of the conjoint (or: trade-off) analyses. Then follows an overview of the qualitative survey methodology (3.1.2) and the methodology for the noise acceptance study (3.1.3).

3.1.1 Quantitative survey methodology

Information on the panel of participants

The participant target for the quantitative survey was at least 600 individuals from each of the six cities being surveyed. To ensure that participants were sufficiently representative of the populations of the surveyed cities, nationally representative distributions were chosen regarding gender, age, and employment status. As a sample can never be perfectly representative of a population's distribution, technical criteria were used to ensure the margin of error was kept as small as possible. Screening questions were used at the beginning of the questionnaire to ensure the fulfilment of quotas and to identify other demographic features. These questions related to, for instance, age, gender, type of household, place of residence, etc; More information on these screening questions can be found in the Appendix (Questionnaire). The final demographic distribution of participants be seen in Figure 25.

Figure 25: Panel selection across cities

Panel composition shows that representative distribution and quotas are met in total panel

Panel size = 3690 participants

Age, %

18-24	16
25-34	17
35-44	17
45-54	18
55-64	18
65-75	14

Gender, %

Male	49
Female	51

Family type, %

Singles	21
Couples	46
Families	33

Education, %

Low (up to higher schooling)	37
Medium (up to finished college or university)	44
High (post-graduates or higher)	19

Employment status,%

Full time (30+ h) incl. self-employed	53
Part time or student	19
Not working, retired and other	29

Gross household income per year

Low (< 20k EUR)	21
Medium (20k - 60k EUR)	45
High (> 60k EUR)	23
Prefer not to say	11

To summarise the figures shown in Figure 25: :

- Total numbers of participants across the six cities was 3,690;
- Balanced gender distribution, as number of male and female participants were nearly the same (0.2 percent diverse, other, or preferred not to answer). The shares of male and female participants had to be at least 48 percent each. As women usually tend to be more responsive to online panels than men, it was important to maintain a balance between the genders, but a margin of error of 1 to 2 percent is considered a statistically acceptable range;

- Participant age was relatively evenly distributed between 16 and 75 years. At least 15 percent of participants were required to be in each of the age groups 18 to 24, 25 to 34, 35 to 44, 45 to 54 and 55 to 64, and 10 percent in the 65 to 75 age group. The age group 65 to 75 years was not required to be as large as other groups as this group is generally less responsive to online panels and will be less affected by innovations in UAM, which are currently still in their infancy and will take years to develop;
- Most of the participants (46 percent) were employed full time (30 hours or more per week), 9 percent employed part time (up to 30 hours per week), 7 percent were self-employed (business owners, freelancers), 9 percent were college or university students or apprentices, 4 percent were homemakers, 16 percent were retired, 8 percent were jobseekers or other, and 1 percent preferred not to say;
- 99 percent of participants had EU citizenship; participants had to reside in the city or region where the survey was conducted, as the aim was to reflect the perceived benefits and concerns of residents potentially affected by the rise of UAM;
- The type of household was diverse as well: singles (24 percent), participants with two persons in household (51 percent), with three (16 percent), four (7 percent), five or more persons in the household (2 percent) participated;
- On the level of education, 2 percent had no school-leaving certificate, 9 percent finished basic schooling, 27 percent finished higher schooling (10 or more years), 13 percent had college or university education (no degree), 29 percent have a college or university degree (e.g. diploma or bachelor's degree), 19 percent have a postgraduate degree or higher (e.g. master's degree, PhD), 1 percent preferred not to say;
- The total gross household income per year shows that 21 percent of the participants receive less than EUR 20,000, 26 percent EUR 20,000 to 39,999, 19 percent receive EUR 40,000 to 59,999, 9 percent receive EUR 60,000 to 79,999, 5 percent receive EUR 80,000 to 99,999, 4 percent receive EUR 100,000 to 119,999, 2 percent receive EUR 120,000 to 139,999, 1 percent receive EUR 140,000 to 160,000, 2 percent receive over EUR 160,000, while 11 percent preferred not to say;
- The replies on employment industry show that participants work in: grocery or other food retail or manufacturing (3 percent), automotive and transport (4 percent), public sector and administration (6 percent), banking and finance (7 percent), clothing manufacturing or retail (2 percent), education (7 percent), healthcare (7 percent), computer science or IT (9 percent), in another field (25 percent) or are unemployed (30 percent). The maximum allowed share of the non-working population was 35 percent, to avoid a skewed distribution towards this very responsive group;
- To make sure we compiled a solid database on potential users of UAM, special attention was paid on ensuring to get a minimum number of respondents with generally positive attitudes towards UAM and who were identified classified as potential users. A minimum of 120 participants per city were identified as potential users of drone delivery – same for air taxis. A minimum of 200 participants per city were identified as potential users of either drone delivery or air taxis. And a minimum of 240 participants per city were not identified as potential users of UAM;
- People working in advertising, media, PR and marketing may typically encounter surveys and statistical models in their day-to-day work. They understand the underlying methodology and levers and this could have an influence on their responses and thus the outcome of the survey. Therefore, these professional groups were categorically excluded.

The survey was translated into the local languages of the participants (Spanish, Hungarian, German, Italian and French) to ensure understanding across the different cities and regions. The exception was for participants in the Øresund region where the survey was conducted in English, as non-native English skills are very good in Scandinavian countries according to the Education First English Proficiency Index[4].

4 https://www.ef.com/wwen/epi/

Information on the questionnaire structure and question types

The questionnaire was designed to assess, understand, and measure the most important societal-acceptance drivers for UAM, including perceived benefits and concerns and what it would take to increase societal acceptance. The questionnaire included 36 questions; the response time was estimated at twenty-five minutes.

Two use cases that are considered easy to imagine and self-explanatory for non-experts were used in the quantitative survey to determine levels of acceptance: the delivery of goods in the low single digit kilogram range by drone and the transport of passengers by air taxi. An in-depth analysis was conducted to measure the relative acceptance levels across cultures of three key concerns identified through the literature review: the perceptions of safety, noise, and visual annoyance in an urban environment. Finally, the questionnaire addressed the general attitude and expectations of respondents towards regulatory authorities. For an English version of the questionnaire that was distributed online to the participants, please refer to the Appendix.

The first part of the survey ensured that participants met the predefined criteria (see the predefined quotas above). An informational video of 1 minute and 36 seconds was presented to give participants' prior information as well as general and common understanding of UAM. The use cases shown in the video were passenger transport by air taxi, express delivery of food by drone, transport of emergency medical services to the scene of an accident, and delivery of medical supplies to a hospital. The selection aimed for a balanced representation of commercial and public service use cases, drone and passenger use cases, as well as use cases both with a pilot on board and remotely piloted. The vehicles depicted in the video were invented and did not correspond to any industrial product existing or in development. The objective was to give a general feeling and idea, rather than to reflect actual technical accuracy. The video concluded with the message that Urban Air Mobility is coming soon to Europe. The video did not include any sound other than music, as noise perception was evaluated in a separate survey.

Subsequently, this section checked whether participants could be considered a potential user for either or both of delivery of goods by drone and/or transport of passengers by air taxi.

The online questionnaire was divided into 6 areas:

1. Making participants familiar with what UAM means and assessing participants' general attitude towards new technology and UAM use cases
2. Testing acceptance of delivery drones,
3. Testing acceptance of passenger transport (air taxis)
4. Understanding their attitude towards regulators and their expectations
5. Understanding security and environmental aspects and concerns
6. Asking for additional demographic data

The subsequent parts of the survey focused on collecting insights about the following topics (in order):

- General attitude towards UAM
- Delivery by drone
- Passenger transport (air taxi)
- Regulators and their role
- Further understanding of security and environmental aspects
- Additional demographic questions

For more information on the structure of the questionnaire, see Appendix 2.

Deep dive into choice-based conjoint (trade-off) analysis

Conjoint analysis is a statistical technique that models the behaviour of survey participants in choice / trade-off situations. Among other things, it helps to explain and forecast the level of readiness for new technologies where trade-offs between objectives need to be made. In a survey situation, participants are asked to indicate their preferences when faced with different alternatives. The aim is to find out which factors are relevant to a decision and to what extent they influence that decision.

A conjoint setting is characterised by its attributes and the levels of those attributes. Attributes are characteristic properties of, e.g. products, services, or scenarios. In product design, typical attributes may be price, brand, and durability. Attributes should be relevant to decision making, consist of at least two levels with varying values, and are expected to influence preferences between products, services or scenarios. In product design, typical attributes may be price, brand and durability. Levels are expressions of the attributes, i.e. unambiguous, mutually exclusive and realistic possibilities of how an attribute could materialise. Levels for, e.g. the attribute price would simply be the different price points.

Participants are offered a choice between different bundles, in which each attribute is assigned one level only. To continue the above example, a bundle would be a theoretical product described by its price, brand and expected durability. As the number of attributes and levels to be assessed significantly influences the sample size and number of choices to be made, the number of distinct attributes and levels should be limited to keep the scope of the choice-based conjoint analysis manageable.

In a survey setting, the process for conducting a choice-based conjoint analysis is as follows: participants are shown a small number of different bundles represented by choice cards (see Figure 26), and are asked to choose their preferred bundle. This step is repeated several times.

Figure 26: Example of a choice in choice-based conjoint analysis

Safety	One drone has the **same likelihood** of hitting a pedestrian as one car	One drone has **1/10th** the likelihood of hitting a pedestrian as one car	One drone has **1/100th** the likelihood of hitting a pedestrian as one car
Noise	One drone Is as loud as a **leaf blower** (~90-r dB, unbearable)	One drone is as loud as a **leaf blower** (-90+ dB. unbearable)	One drone is as loud as a **car** driving by at city speed (~65 dB, noticeable)
Visuals	**1 or 2** drones per hour in one's field of view when walking down a street	**~5** drones per hour in one's field of view when walking down a street	**20+** drones per hour in one's field of view when walking down a street
	Select	Select	Select

Due to the high number of possible combinations of attribute levels into bundles, participants will not see every possible bundle, and will not be asked to compare every bundle to every other bundle. However, preferences can be extrapolated based on a few choices.

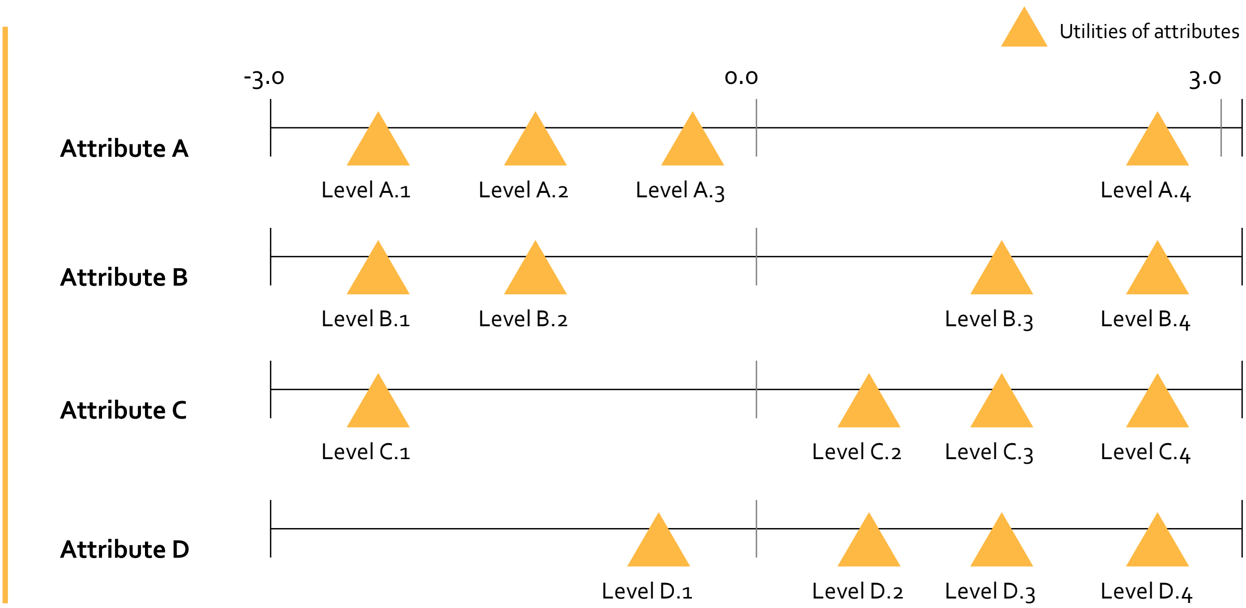
A specific two-stage process is used to estimate valid/stable utilities for each respondent: a latent class (LC) segmentation is followed by a hierarchical Bayes (HB) utility estimation within each latent class analysis (LCA) segment.

The model assigns a utility to each level (the expressions of the attribute). The utility describes numerically how (negative for rejection, positive for approval) and to what extent a level impacts decision making (small absolute value for little influence, large absolute value for great influence).

The greatest increase in utility within an attribute is equivalent to the greatest gain in approval rating (i.e. from the left-hand side to right-hand side of a number scale).

Arranging the utilities on a scale from -3 to 3 gives an overview of which levels lead to rejection and which to approval, e.g. level A.4 in Figure 27 has the greatest approval rating for attribute A. The ideal bundle would consist of levels A.4, B.4, C.4 and D.4. However, in a real-world setting this particular bundle might be unrealistic, and trade-offs may need to be made. This raises the question about which levels are still considered acceptable, i.e. what is the lower boundary. For example, a bundle composed from the levels to the right of the respective greatest increases, i.e. A.4, B.3, C.2 and D.1 in Figure 27, might provide an acceptable approval rate. However, this logic should be applied with caution to real-life applications and bundles should always be chosen with care.

Figure 27: Schematic illustration of utilities in choice-based conjoint analysis



Conjoint analysis was chosen for the joint assessment of concerns regarding safety, noise, and visual annoyance in two settings: the operation of drones and the operation of air taxis. The aim was to avoid participants choosing the option that indicated the least change from the status quo when asked about desirable levels. In the conjoint analysis they are forced to make trade-offs between three scenarios, thereby indicating real preferences and acceptable levels. The questions used can be found under B7 and C7 in the Appendix.

The bundle of levels accepted by the majority will serve as a basis for future regulatory projects. The initial setting of levels is therefore of particular importance. On the one hand, levels need to be specific enough to form a solid basis for specifications in regulatory projects; their formulations, on the other hand, need to be graspable for non-experts and relatable in a survey situation.

Safety

Two different scales for the safety attribute were selected because the air taxi use case poses risks to both passengers and pedestrians, whereas the drone use case poses risk solely to pedestrians.

The following levels were selected for the operation of drones: five-times higher likelihood of one drone hitting a pedestrian as one car; the same likelihood; one-tenth of the likelihood; and one-hundredth of the likelihood. The safety standard for the first level would translate to about 200 fatalities per year in Europe by 2025, compared to 22,800 fatalities caused by cars in the 27 EU member states in 2019[5] (i.e. 200 fatalities from drones would lie in a range of 1 percent of the fatalities from car accidents). The best level for the drone safety standard (a hundredfold improvement compared to passenger cars) lies within a factor of two of today's commercial aircraft safety standard (calculated on a passenger-kilometre basis and assigning a theoretical passenger to a drone).

The following levels were selected for the operation of air taxis: safety standards comparable to motorcycles (approximately 5 fatalities per billion passenger kilometres), cars (approximately 2)[6], buses (approximately 0.05)[7], and com-mercial aircraft (approximately 0.01)[8]. Motorcycles are widely regarded as an unsafe mode of transport, and commercial aircraft as one of the safest.

Noise

For the noise attribute, the following levels were selected to cover both the operation of drones and the operation of air taxis: volume of a leaf blower (over 90 dB, unbearable), volume of a truck driving by at city speed (roughly 82 dB, disturbing), volume of a car driving by at city speed (approximately 65 dB, noticeable), and volume of a bicycle riding by at city speed (around 57 dB, barely noticeable). By comparing scenarios to an example from everyday life, participants can imagine the background noise; moreover, the decibel indication can be used to inform a noise specification. For the first and loudest level, a noise was selected that is quite common in urban environments but not permanently conceivable as background noise. For the last level, a noise was selected that is not disturbing but still realistic for drones and air taxis.

5 https://ec.europa.eu/commission/presscorner/detail/de/qanda_20_1004
6 Eurostat
7 Eurostat
8 Eurostat

Visuals

For the visuals attribute, the following levels were selected for both the operation of drones and the operation of air taxis: more than 20 flying vehicles per hour in one's field of vision when walking down a street; around 10 vehicles; around 5 vehicles; and 1 or 2 vehicles. On a typical day and in a typical residential area, roughly 1 to 2 aircraft per hour are visible in the sky today. Helicopters, too, can be seen flying above cities in Europe and hospital pads are estimated to be busy at 1 to 2 landings per hour. The last level is chosen as a realistic lower limit. Multiplying this number by 20 for the first level amounts to a massive change from today but is in the range of the projected number of drones in urban areas in 2025.

Questions B8 and C8 in the Appendix ultimately serve to find upper and lower limits for the overall acceptance rate. For this purpose, the acceptance rate (without comparison or choice) for the bundle of consistently best levels is queried, as well as the acceptance rate for the bundle of consistently worst levels. The results from the conjoint analysis can then be fit into these boundaries.

3.1.2 Qualitative survey methodology

After there was a clear picture on the results from the quantitative survey, further qualitative interviews with more than 40 local, national, and European stakeholders took place (see Figure 28). To prioritise and select the stakeholders for these interviews, the long list of identified stakeholders from the literature review was taken and assessed along the three dimensions of concerns, level of influence and level of support for UAM. The stakeholders with the highest concerns and level of influence, as well as the lowest level of support for UAM, were ranked highest. The objective was to get their differentiated and specialised point of view on benefits and concerns around UAM. Around half of the stakeholders interviewed were local, covering all cities in which the survey took place and all stakeholder groups. In most cases, interviews with representatives of at least two of the cities were done in order to capture potential local differences.

Figure 28: Stakeholder interviewee overview

Stakeholders interviewed

Local level

Mayor and municipalities services
Local environmental protection associations
Local traffic and transport authority
Local resident association/Real-estate owners
Emergency response organization
Local airport, local ATC
Local urban and city planners
Local chamber of commerce
Local police

National and European level

Airports Council International (ACI)
National governmental authorities for aviation (e.g., DCGA)
European environmental protection associations
Alliance for new mobility Europe (ANME)
An insurance provider
European Commission
The European helicopters association
European business aviation association
CANSO
Smart City Initiative
The European Cockpit Association

3.1.3 Noise test methodology

Both the qualitative and quantitative surveys identified noise as one of the major concerns for societal acceptance of urban/advanced air mobility. UAM aircraft have a variety of noise profiles that differ from those of traditional aircraft. Characteristics of their noise signature such as tonality could potentially increase annoyance. Other health impacts associated with introducing this entirely new sound source into urban and suburban environments are not widely known. UAM aircraft pose another layer of complexity since, compared with other types of aircraft, they will fly closer to where people live and work.

Understanding how noise from UAM aircraft is perceived will therefore be essential to the introduction of this new technology. Designs of aircraft, legislation and planning for UAM infrastructure and routes will all be dependent upon understanding reaction to the sound.

To begin to understand people's response to UAM sound and investigate how a more comprehensive study would operate, a pilot study was undertaken with Arup featuring listening tests leveraging the Arup Soundlab. This is described in the following section.

Use of sound demonstrations for understanding environmental sound

Originally, Arup Soundlab was conceived and developed to inform the design of some of the world's best arts and culture venues. More recently, SoundLab has been used to enable clients and stakeholders to experience the impacts of major infrastructure projects during the design and planning process, helping to shape better outcomes. Through the process of continuous development, SoundLab pairs advanced visualisation with novel aircraft noise synthetisation tools to enable noise assessment in the early stages of aircraft design. SoundLab has also developed methods and transportable facilities for engaging people in their local areas, delivering sound demonstrations for schemes including aviation, railways, highways and windfarms. Compared with traditional methods of engagement on environmental sound issues, sound demonstrations have many advantages:

- helping identify stakeholders' needs and concerns;
- facilitating dialogue on implications of noise on public health and wellbeing;
- increasing transparency on how stakeholders could be affected by a proposed development or new noise source;
- building trust through impartial advice and integrity;
- ensuring proposals are inclusive and accessible; and
- supporting data-driven decision making.

The pilot study

The pilot study aimed to:

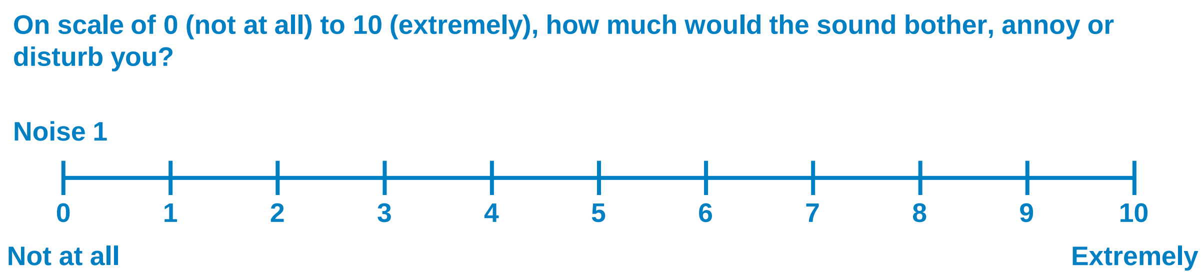
- Investigate whether sound demonstrations would be an appropriate way to engage with and understand people's responses to UAM sound;
- Test and develop approaches to undertake the tests, with a view to carrying out a larger study; and
- Gain initial insight into people's perceptions of UAM sound, noting that the sample would be far too small to yield statistically reliable results.
- Due to travel restrictions in place at the time as a consequence of the COVID-19 pandemic, the study was carried out using a transportable facility (MLab) currently installed in Arup's office in Amsterdam. As in SoundLab, MLab uses 3D ambisonic sound, focused at the listener's head height, from an array of 12 loudspeakers, four each at floor level, head height and overhead (plus bass loudspeakers) – see Figure 29 below.

Figure 29: Noise auralization setup in Arup MLAB in Amsterdam

A total of 20 listeners took part over a period of two days in April 2021. Each test was carried out with one listener at a time. Listeners were guided through the tests in the following way:

- The purpose of the tests and how they were being undertaken was explained. The listeners were told that the research was to gauge responses to different transportation sounds; drones and air taxis were not mentioned;
- The listener was settled into the listening environment by hearing background sounds of an outdoors urban location; A recording made in Dam Square, Amsterdam was used, to reflect the soundscape in the city in which the tests were conducted. This background sound contained no transportation sound and was reproduced at a level of $55dBL_{Aeq}$. It was played continuously as a backdrop to the transportation sounds;
- An image of Dam Square was presented on a display screen to help localise the listener. No visual representation of the sound sources was included in the test to avoid objectivity bias;
- Sounds from the following sources were each reproduced at a level of $80dBL_{Amax,F}$: jet aircraft, helicopter, bus, motorbike, large multicopter drone, smaller multicopter drone, air taxi and synthesised air taxi with different acoustic characteristics to the others. Additionally, the air taxi sound was reproduced at two lower sound levels (60 and 70 $dBL_{Amax,F}$). Each sound source recording was played for 30s. Normalisation of the sound levels to the maximum level may have resulted in the sound levels for each source being different, if they had been quantified using a different metric, such as the L_{Aeq}, due to the different durations and rise and decay times of the sounds;
- The listeners were asked to rank each sound according to how much the sound would bother, annoy or disturb them on a scale of 0 (not at all) to 10 (extremely) as Figure 30 shows. They were asked to consider their responses assuming the sound occurred five times in one hour. In addition to the annoyance scale, they were also asked to provide comments on the aspects of the sound that had contributed to their rating. Thirty seconds were allowed for each response before playing the next sound.

Figure 30: Scale to determine if sound was found to be bothering, annoying or disturbing



3.2 Survey results (10 key findings)

The overall objective of the survey was to generate new insights on societal acceptance of UAM by European citizens and so support the future impact assessment and further regulatory work by EASA.

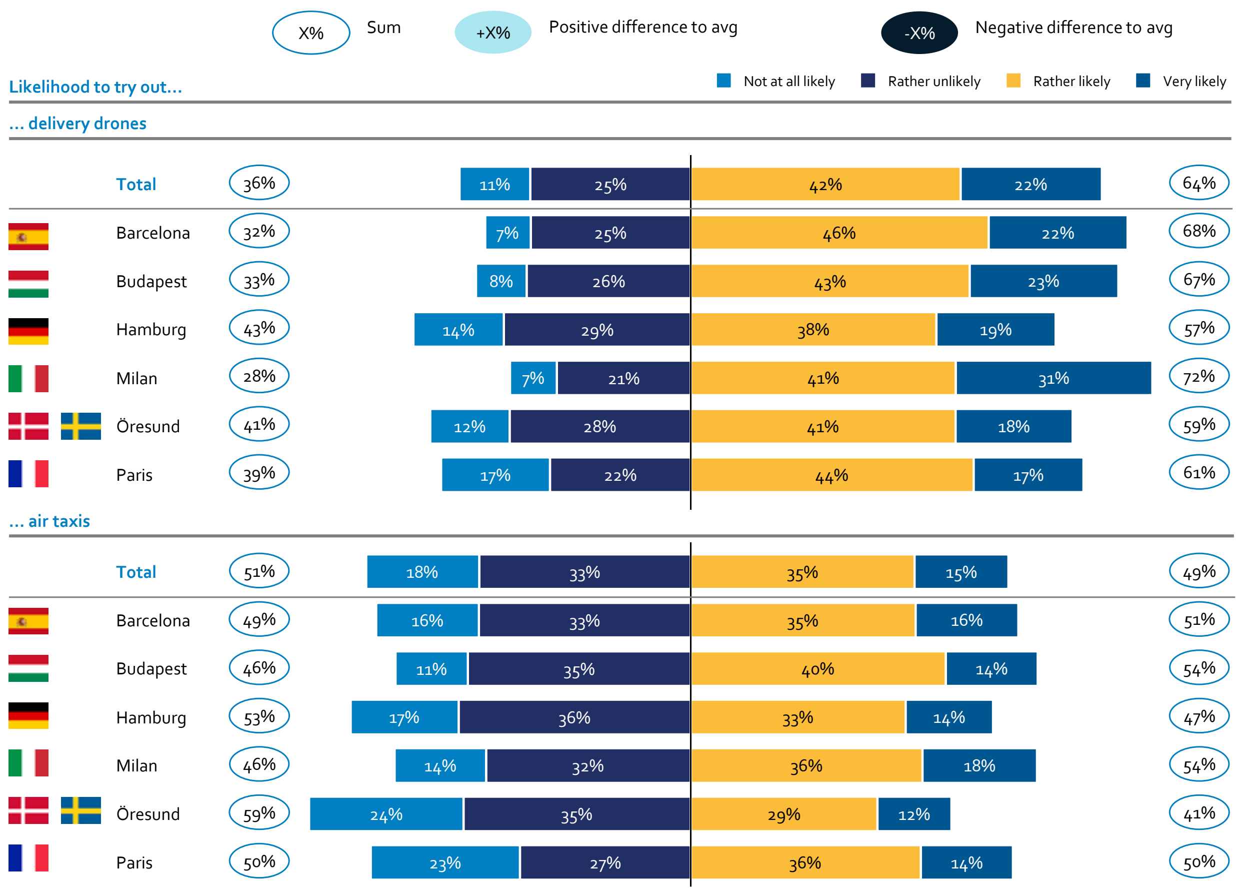
The following sections summarise the 10 key findings from the survey conducted between January and April 2021. For each key finding, the combined insights from the quantitative survey, the qualitative interviews and the noise test are presented. For the detailed survey results, please go to the EASA website.

3.2.1 A positive initial attitude to UAM throughout the EU

Homogeneous results

The survey was designed to capture potential divergence of opinion within various sub-groups, notably through screening questions covering age, household composition, affinity to new technologies, geographical/cultural differences, etc. (see Information on the panel of participants above). Unexpectedly, the results demonstrated **homogeneous replies:** a level playing field throughout Europe, with no major deviation between the respondents of the six cities (see Figure 31), and no major deviations according to age, household composition or affinity to new technologies or other differentiating criteria (see Figure 32). This was confirmed by the qualitative interviews.

Figure 31: Cities surveyed indicated a similar likelihood of using the services



Source: EASA UAM societal acceptance survey questions S6. How likely are you to make use of delivery of goods by drone (i.e.,delivery of parcels from an online shopping platform to a nearby delivery hub, your garden or private property or a publicly accessible area), if it were offered in your city? Please assume that delivery by drone would cost about double today's standard shipping fees and ensured guaranteed delivery within 2 hours from the time you place your order. S7. How likely would you be to use an air taxi (i.e., a flying vehicle that transports passengers from A to B) for a 25-50% higher price than current road passenger transport options like conventional (road) taxis or Uber-like offerings, if you assume the trip could be made in half the time in the air taxi?

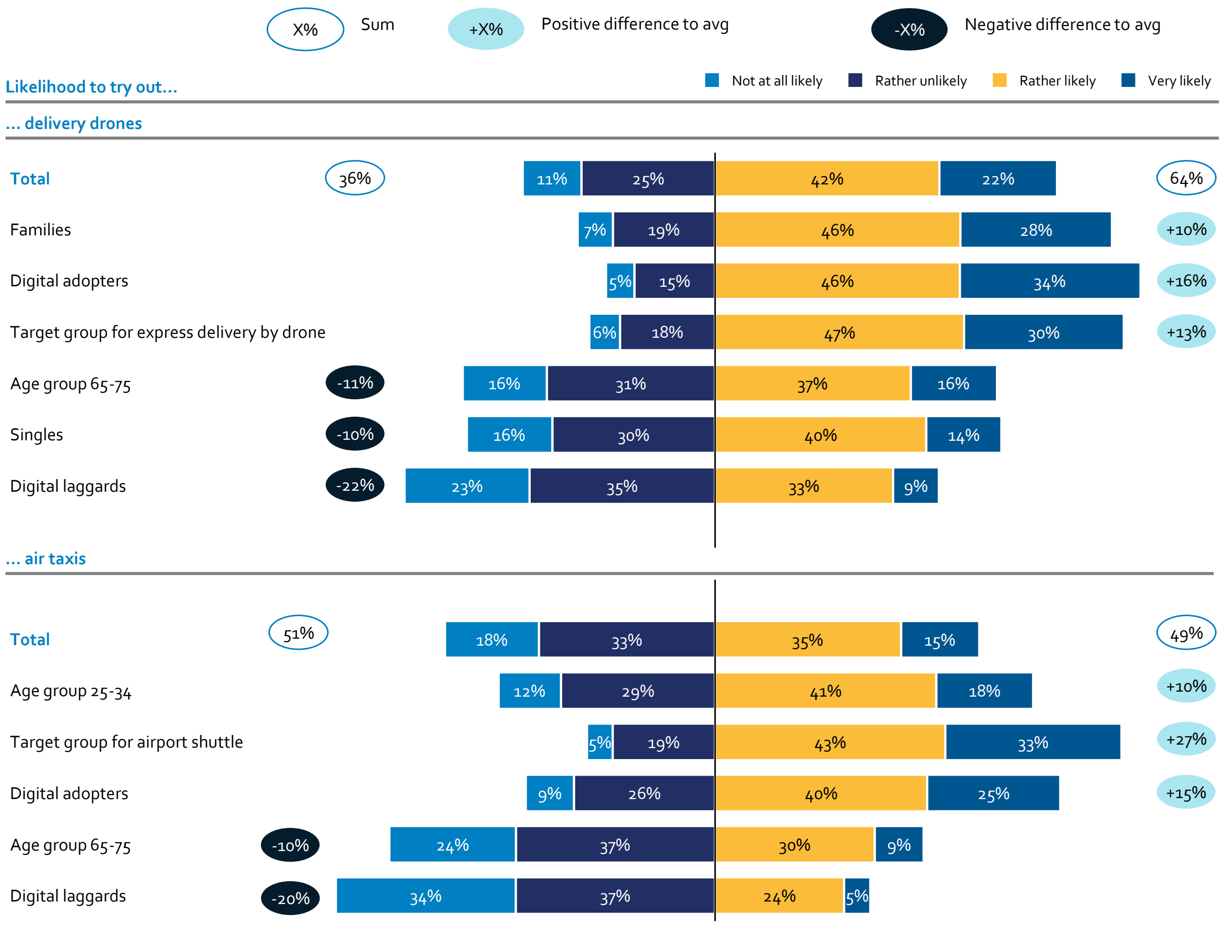
Only small differences were noticed:

- In general, respondents from the South of Europe (Milan, Barcelona) demonstrated a more positive attitude across all question types than those from the Northern part of Europe (Hamburg, Oresund region);
- On the readiness to use drone services: respondents from Milan (+8 percent) and Barcelona (+4 percent) had more positive attitude compared with the average, while Hamburg (-7 percent) and Oresund region (-5 percent) were more critical;
- On the readiness to use air taxi services: respondents from Milan (+5 percent) and Barcelona (+2 percent) were amongst those declaring a more positive attitude, and citizens from Budapest were more likely to try an air taxi service (+5 percent compared to average). Citizens from Oresund (-8 percent) and Hamburg (-2 percent) showed lowest interest in air taxi services.

The deviations in demographic groups and defined subgroups followed expectations:

- The positive demographic groups included younger people, such as the age group 25-34 (+7 percent more likely to try out drones, and +10 percent more likely to try air taxis compared to the average), men (+5 percent, +7 percent),

Figure 32: Overall interest in UAM services by subgroups deviating significantly from average



Source: EASA UAM societal acceptance survey questions S6. How likely are you to make use of delivery of goods by drone (i.e., delivery of parcels from an online shopping platform to a nearby delivery hub, your garden or private property or a publicly accessible area), if it were offered in your city? Please assume that delivery by drone would cost about double today's standard shipping fees and ensured guaranteed delivery within 2 hours from the time you place your order. S7. How likely would you be to use an air taxi (i.e., a flying vehicle that transports passengers from A to B) for a 25-50% higher price than current road passenger transport options like conventional (road) taxis or Uber-like offerings, if you assume the trip could be made in half the time in the air taxi?

the high income group (+6 percent, +7 percent) as well as digital adopters as participants accustomed to using other innovative services (+16 percent, +15 percent). It is possible that families (+10 percent each) were more positive than singles because the perceived advantages of UAM services (e.g. time saving) are felt to be more critical for a couple with a double burden of work and educational activities for their children;
- As expected, the subgroup defined to be the target group for services of delivery drones and air taxis were amongst those with the most positive attitude when asked how likely they were to use available services (+13 percent, + 27 percent).

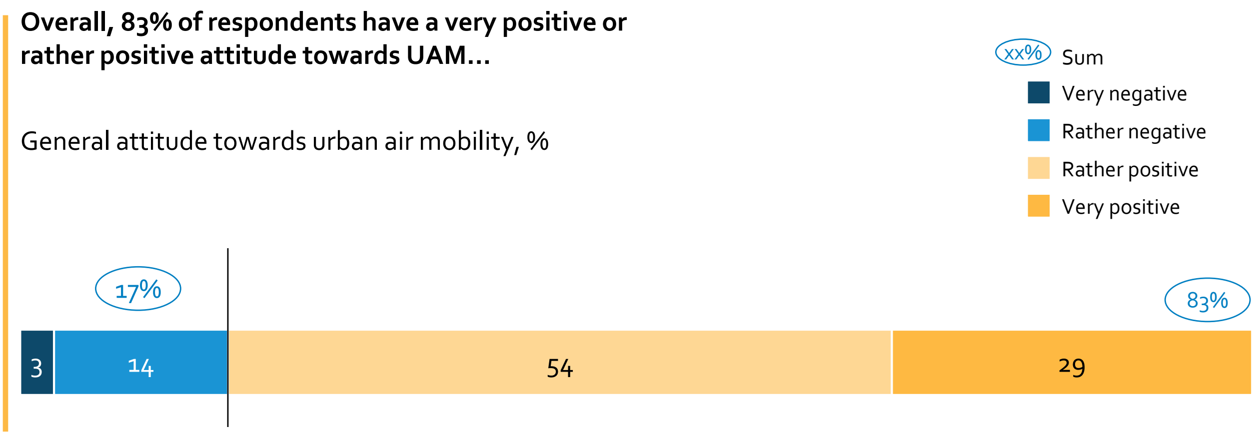
On the other hand, the slightly more reluctant groups included singles (-10 percent, -8 percent), older people such as the age group 65-75 (-11 percent, -10 percent), women (-5 percent and -6 percent) and digital laggards (-9 percent and -5 percent).

Positive initial perception

Early in the survey, participants were asked to indicate what their overall perception would be if Urban Air Mobility solutions were introduced in their cities.

Overall, the perception of UAM was positive: most (83 percent) of the respondents felt (very or rather) positive about the introduction of UAM overall. Across the surveyed cities, only 3 percent of the respondents had a negative perception of Urban Air Mobility and will probably be hard to win round to the introduction of UAM (Figure 32a).

Figure 32a: Vast majority of respondents were positive on UAM

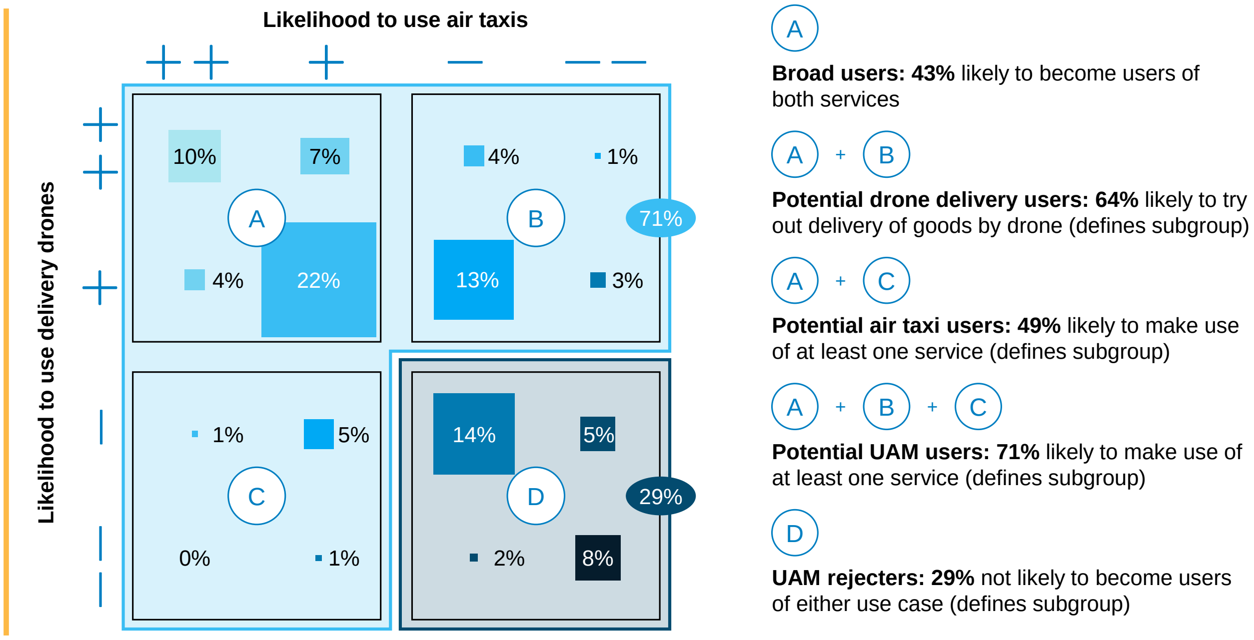


The qualitative interviews also indicated that the general attitude towards UAM is mostly positive. Surprisingly, this was even true for participants who could have been expected to have most concerns – for instance, those involved in security or environmental matters. The interviews indicated that UAM is seen as an exciting innovative development and the fact that Europe may be playing a leading role in this domain is triggering positive consideration and goodwill. However, the survey revealed that most stakeholders have not yet been exposed to UAM matters so far, except for those cities with pilot projects (e.g. Hamburg or Paris), and generally lack information on the topic.

Readiness to use UAM

As shown in Figure 32b, the results showed that a **large share of the population would be interested to use UAM services.** 64 percent would be interested in using drone delivery and 49 percent would be interested in using an air taxi. 43 percent would be interested in using both, 71 percent are likely to make use of at least one service. Only 29 percent would not use either of these services if they were available in their respective cities.

Figure 32b: Vast majority is positive on UAM



Level of comfort

The questionnaire also verified participants' basic comfort level with the idea of delivery drones and of manned and unmanned air taxis. To this effect, participants were asked to rank their level of comfort with respect to different scenarios (see question C4, Appendix).

Air taxis pose a potential safety threat not only to the passengers using them. Pedestrians will be affected by drones and air taxis, despite not necessarily choosing to use them themselves, and so the hypothesis was that the perceived safety of pedestrians will have a significant impact on the societal acceptance of drones and air taxi operations.

Overall, the results from the questionnaire were positive. The majority of respondents indicated that, as pedestrians, they would **feel safe with drones and manned air taxis flying above their heads.**

However, the results also showed that pedestrians always felt safer considering manned aircraft than considering unmanned ones, no matter the size or the characteristics of the aircraft. Therefore, the share of people feeling safe as pedestrians with manned air taxis (70 percent) flying above their heads was much greater than with unmanned ones (44 percent) – and still higher than those who feel comfortable with unmanned delivery drones (56 percent), as Figure 33 shows. As expected, the number that would be likely to try a manned air taxi (75 percent) was higher than those who would try an unmanned one (43 percent). It is also no surprise that those participants identified to be potential air taxi users had a higher level of comfort with manned air taxis (+13 percent) than the average.

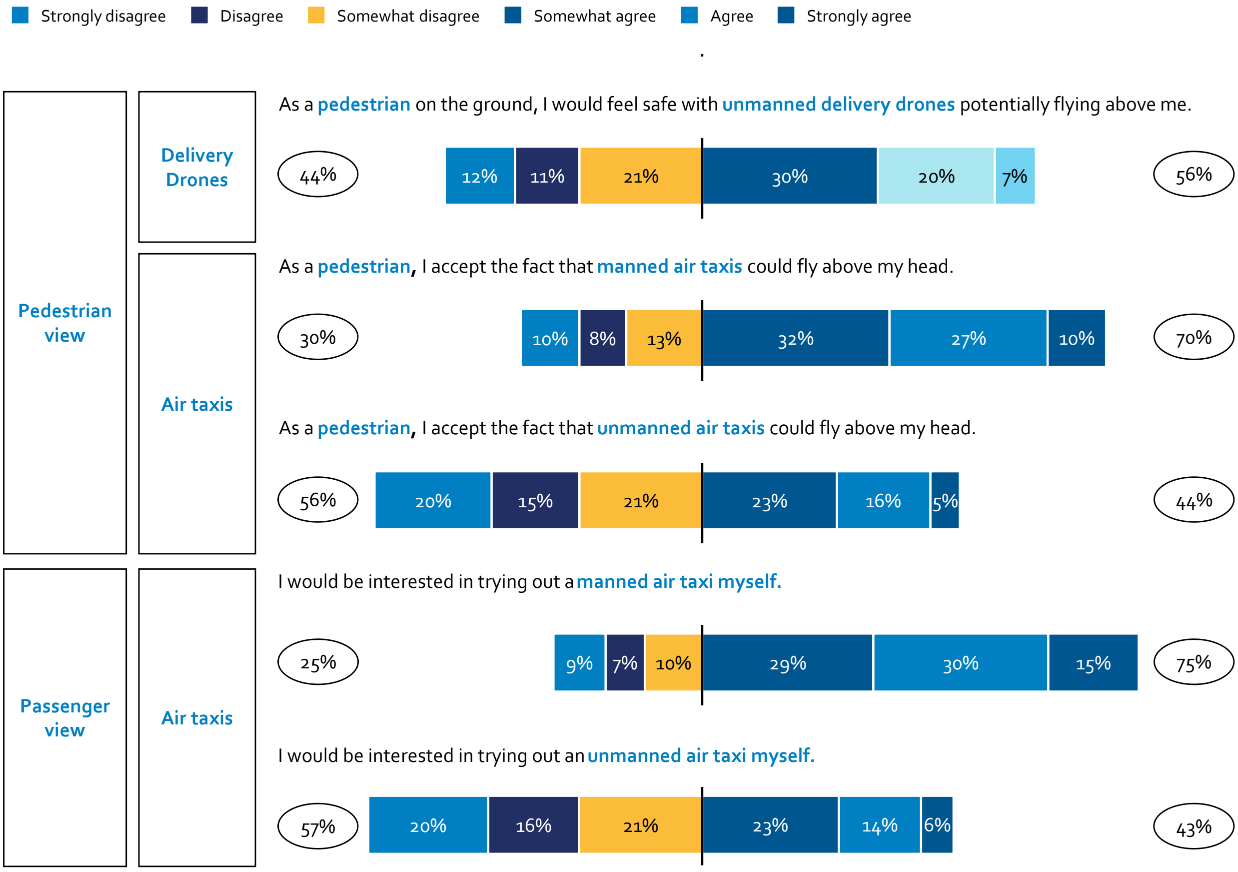
The qualitative interviews also showed that trust in manned services was higher, and that respondents felt more comfortable with initial manned operations of air taxis.

The high level of comfort of EU citizens with manned air taxis, either as pedestrians on the street or as passengers, may be explained by the fact that the aircraft and their operations may look to non-specialists very similar to traditional aviation vehicles and operations, and by the fact that traditional aviation is perceived as very safe by citizens, at least in Europe.

Figure 33: Participants feel more comfortable with manned than with unmanned aircraft systems

Respondents feel safer as a pedestrian with manned air taxis than with delivery drones

Level of comfort with manned & unmanned aircraft systems

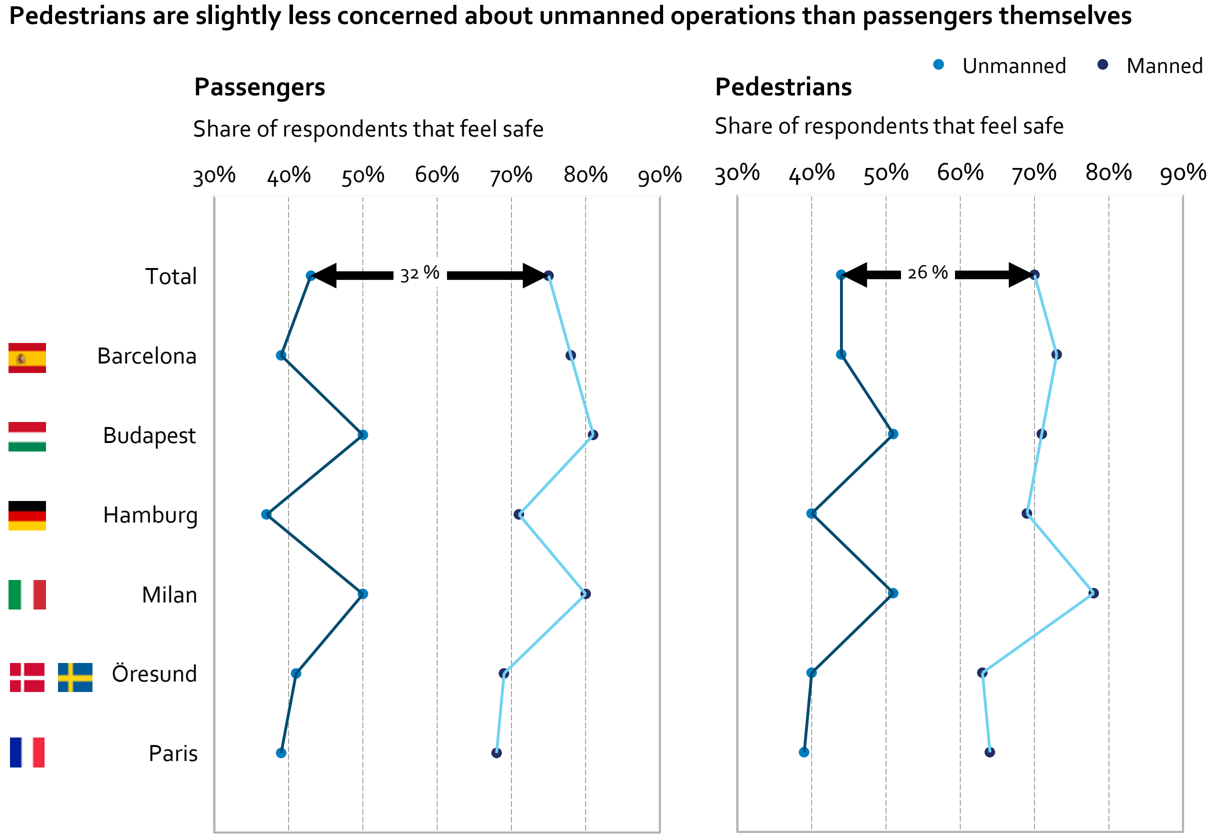


Source: EASA UAM societal acceptance survey questions B3. Drones intended for the delivery of goods are remotely piloted aircraft systems with no pilots on board. Assume that they have an average wingspan of 3 metres, would fly at between 120 and 150 metres altitude, and are certified by competent authorities. Please rate how much you agree or disagree with the following statement. C4. Recent studies extend the prospect of aircraft soon transporting passengers, either with a pilot on board or with a remote pilot. You will now see several statements that people might make about such air taxis. Assuming that all of the aircraft are certified by competent authorities, please rate how much you agree or disagree with each statement for each type of air taxi.

Some sub-groups were more comfortable with unmanned air taxis than others. This is true for: the target group for airport shuttle (+17 percent), digital adopters (+11 percent), potential air taxi users and men (both +10 percent), families and those with higher incomes (both +7 percent) and the younger age group of participants between 18 and 44 years (+6 percent). Those with a lower level of comfort compared to the average were: air taxi user rejecters (-16 percent), digital laggards (-15 percent), women (-10 percent), the older age group between 55 and 75 years (-8 percent) and singles (-6 percent).

In general, participants expressed slightly more concern about unmanned services when they thought of it as passengers (32 percent) than when they thought of it as pedestrians (26 percent), as can be seen in Figure 34. There was only small deviation in cities: citizens in Budapest and Milan felt safer (~ +6 percent) while Hamburg, Oresund and Paris felt less safe compared to average (~ -4 percent).

Figure 34: Pedestrians are slightly more concerned about unmanned operations than passengers



Source: EASA UAM societal acceptance survey question C4. Recent studies extend the prospect of aircraft soon transporting passengers, either with a pilot on board or witl a remote pilot. You will now see several statements that people might make about such air taxis. Assuming that all of the aircraft are certified by competent authorities, please rate how much you agree or disagree with each statement for each type of air taxi.

In addition, the results of each question were compared between the cities.

3.2.2 Strong support for use cases in the public interest

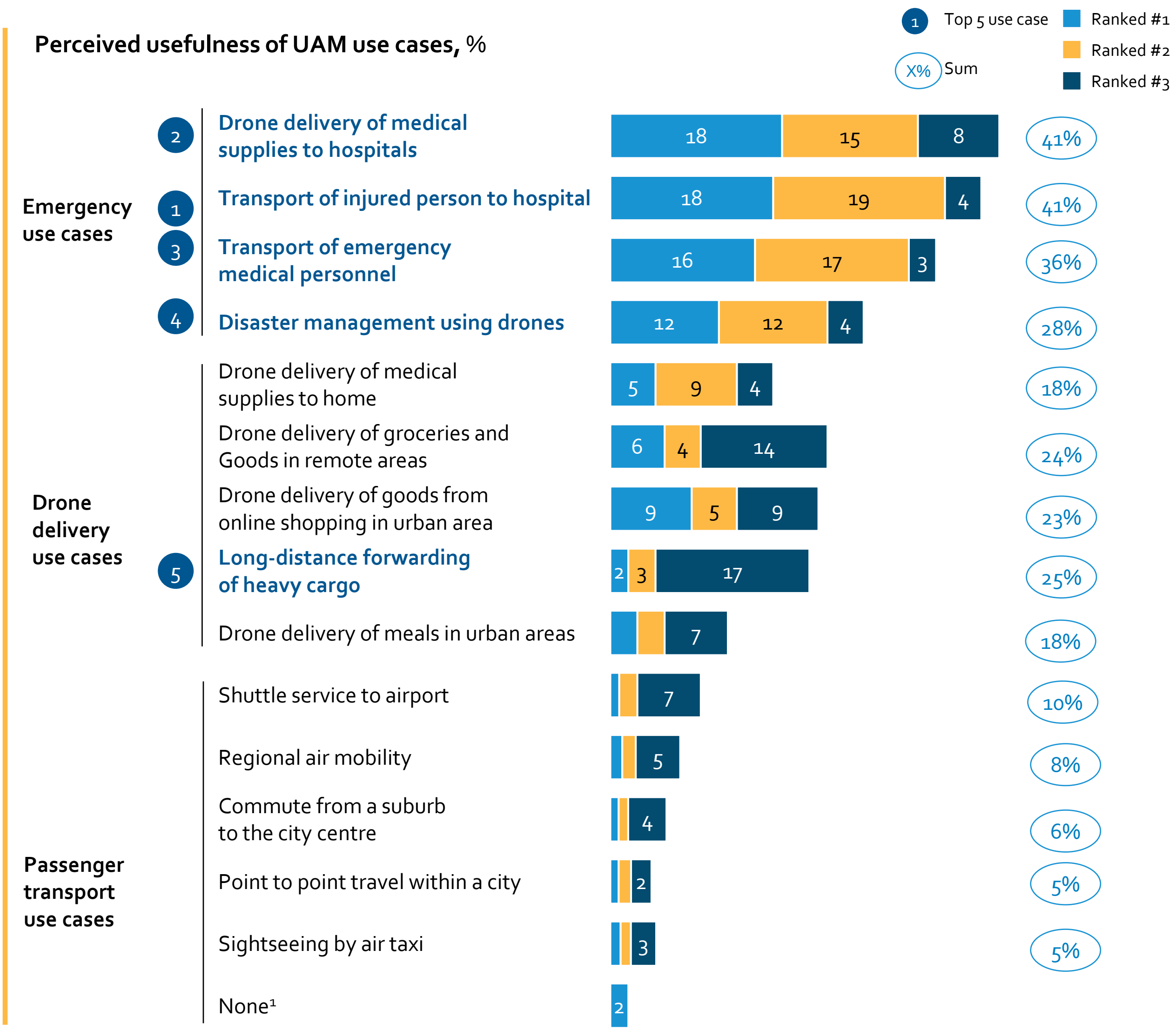
Several survey questions helped to identify use cases that respondents expected to be most useful and these, therefore, will probably receive highest acceptance by citizens.

As a first step, each participant's affinity to the new technologies was assessed. This was intended to help understand their attitude towards innovation in general, as this was assumed to impact their openness towards use cases. Participants were then asked to rank the usefulness of fourteen UAM use cases. In this way, the use cases considered the most important for the population were identified. Participants also received an overview of several conceivable use cases that go beyond those shown in the video.

Medical/emergency uses cases are seen as the most useful, whether consisting in drone delivery of medical equipment or urgent transport of persons.

As illustrated in Figure 35, the use cases related to **medical and/or emergency transport** were voted most often amongst the three as most valuable ones and therefore ranked highest: transport of injured persons to hospital (41 percent), drone delivery of medical supplies to hospitals (41 percent), transport of emergency medical personnel (36 percent), and using drones for disaster management (28 percent). Use cases related to the transport of individual passengers, such as sightseeing by air taxi or a flight from one point in the city to another, were considered to be less useful.

Figure 35: Emergency use cases are expected to be most useful



Passenger transport: high interest but less useful

Qualitative interviews showed that the main reason is the assumption that will only be accessible by a few and probably much more expensive than other modes of transport.

These figures indicate that use cases that are in general public interest, notably in the health and safety domains, would be better accepted than use cases fulfilling private and individual needs.

These results from the quantitative survey were confirmed by the qualitative interviews. Interviewees on local, national, and European level saw benefits in UAM preferably when it contributes to public services and interest. Those use cases expected to be most beneficial are linked to emergency and medical transport.

The qualitative interviews, however, also indicated that the emergency or medical character of an operation would not justify any deviation from the safety or security standards. In contrast, higher noise levels could be acceptable if the number of operations for emergency purposes was limited.

3.2.3 Top 3 expected benefits: faster, cleaner, extended connectivity

Through a multiple-select question, survey participants were asked to select up to three benefits and opportunities that the development of UAM could bring for the EU and its citizens. A list of seven possible selections was given (see question A4). This list was not use-case specific. Additionally, participants were invited to name up to three more benefits that did not appear in the survey and may not have been covered by the literature so far.

Again, the use of UAM in emergency situations was perceived to generate the greatest added value: 71 percent of participants expected an **improved response time** in case of an emergency (see Figure 36). It was also found that, compared to other participants, the age group between 55 and 75 years perceived this to be a more significant advantage on average.

The **reduction of traffic jams** ranked second (51 percent) on average, closely followed by an expected **reduction of local emissions** (48 percent). Better connection to remote areas (41 percent), and the creation of new jobs (32 percent) represented other perceived benefits. The latter was on average more often mentioned as an expected benefit by people younger than 24 years and participants in Barcelona expected this advantage more often than the average respondent (+9 percent). No additional benefits were proposed by respondents in the open question.

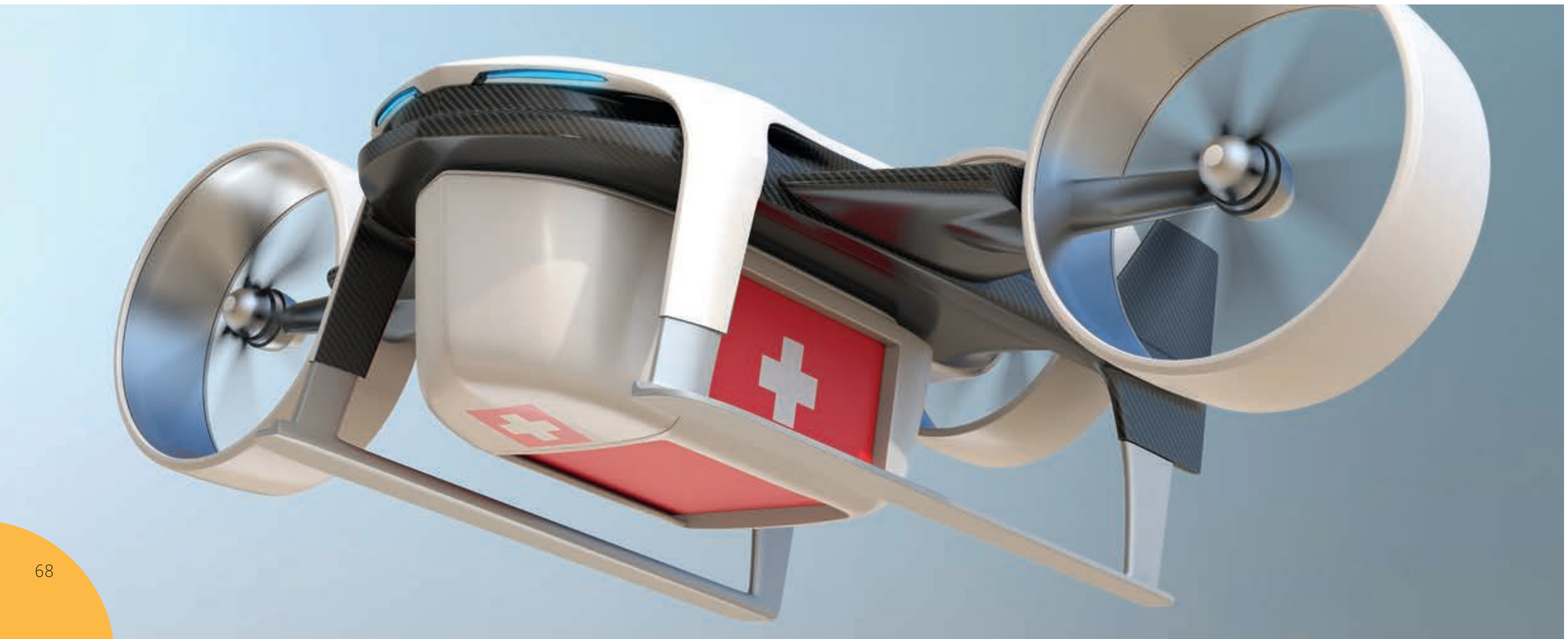
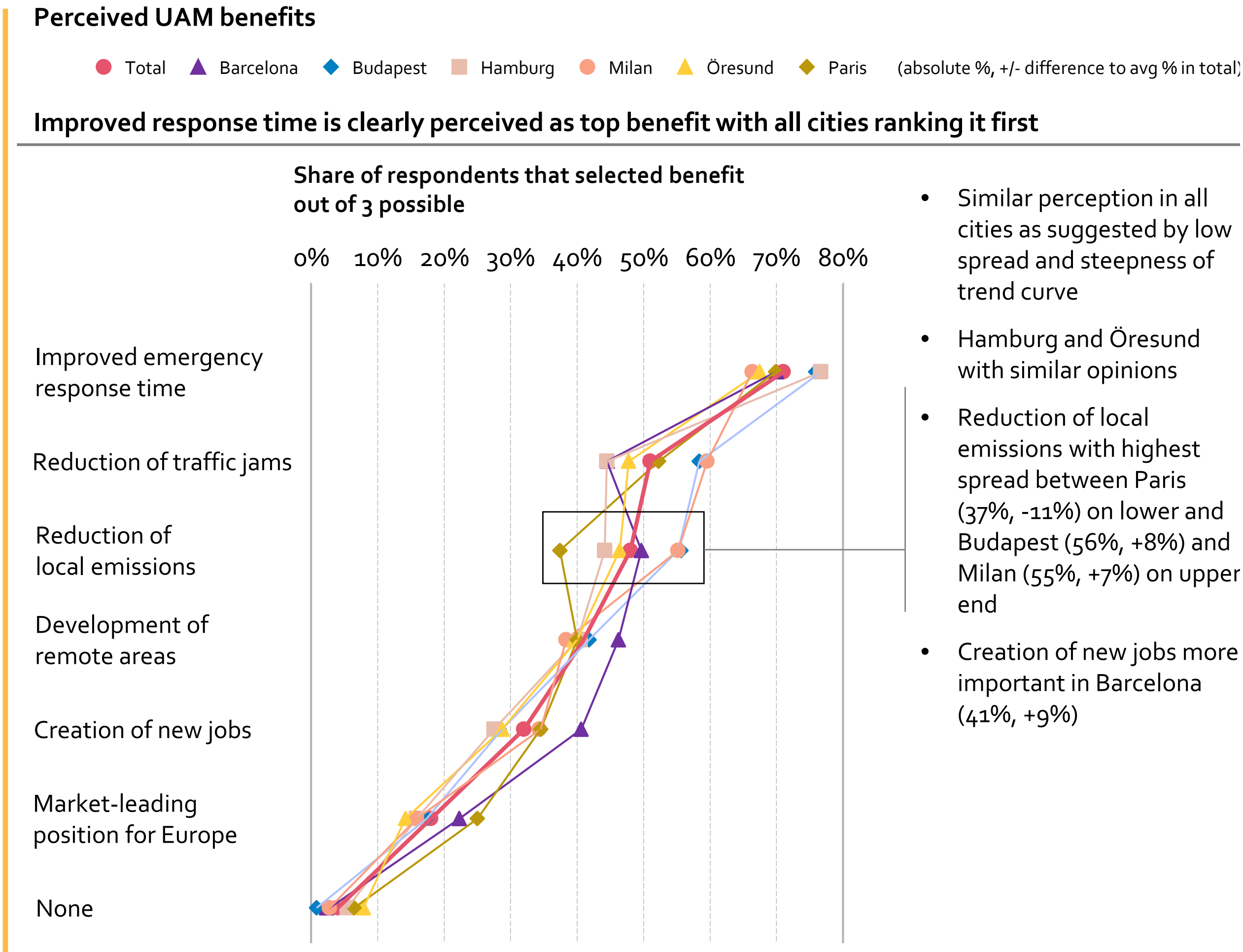


Figure 36: Improved response time is clearly perceived as top benefit



Source: EASA UAM societal acceptance survey questions A4. What benefits and opportunities can the development of urban air mobility bring for the EU and EU citizens? Please select up to 3 answers.

Overall, the replies indicated that participants attach a higher value to perceived positive impacts of UAM on their own security, health, and quality of life, than to other potential benefits – notably the economic ones.

These results from the quantitative survey were confirmed by the qualitative interviews. Interviewees saw and preferred benefits in UAM when it was perceived to be contributed to **public services/public interest,** such as emergency and medical transport. Connecting remote areas or areas that are currently not sufficiently connected by ground transport systems was also part of this public interest.

Most interviewees spontaneously and immediately referred to the reduction of congestion and emissions as a key benefit, but also at the same time requested that UAM would be integrated into local strategies on multi-modality.

Some of the interviewees considered UAM to have the potential to reduce noise in the city, for instance by replacing the noise of ground ambulances or of some helicopter flights. UAM was also perceived to potentially help citizens gain back green areas, as a result of 'moving' the traffic into the air and building less ground infrastructures (roads, bridges, tunnels, etc.). Finally, UAM was seen as a showcase for innovation and for the transition to smart and green mobility.

3.2.4 Top 3 concerns: safety, environment/noise and security

Through a multiple-select question, participants were invited to rank the six most important concerns, in their view, regarding the operation of drones in an urban environment, out of a list of nine potential negative effects (see Appendix). This indicative list of concerns was derived from the literature review. Participants were also free to add their own concerns in a free text field.

Survey results: Concerns on drones and air taxis are nearly the same

Drones

- safety (44 percent)
- security (39 percent)
- environment (36 percent)

Air Taxis

- environment (38 percent)
- safety (37 percent)
- security (29 precent)

To avoid confusion, the notions of safety and security were clarified in the questions: safety mainly referred to incidents resulting from a technical or human failure, while security related to incidents caused by harmful deliberate or intentional actions, such as cyber-attacks or the failure of mobile networks. The qualitative interviews confirmed that participants indeed see a clear difference in safety and security, although the translation in some European languages leads to the same wording (e.g. in Hungarian). Individually-stated definitions by participants were very close to each other and in line with the understanding and description in the quantitative survey. Noise was listed as a distinct concern, although it is sometimes included under the wide category of 'environmental concerns' in the reviewed literature. The reading of the results should take this element into account, for instance by adding or not the noise results to the results on environmental impact.

The overall results indicated that **safety, security, and environmental issues** were the top concerns of respondents – as can be seen in Figure 37, with **noise** ranking second for air taxis. The results showed that these concerns increase with age, education, and income. Four percent of the respondents expressed no concerns. Participants also had the option to add concerns in a free text field. However, no significant mentions were added.

The ranking of concerns for drones and air taxis was relatively similar – only two primary differences can be seen:

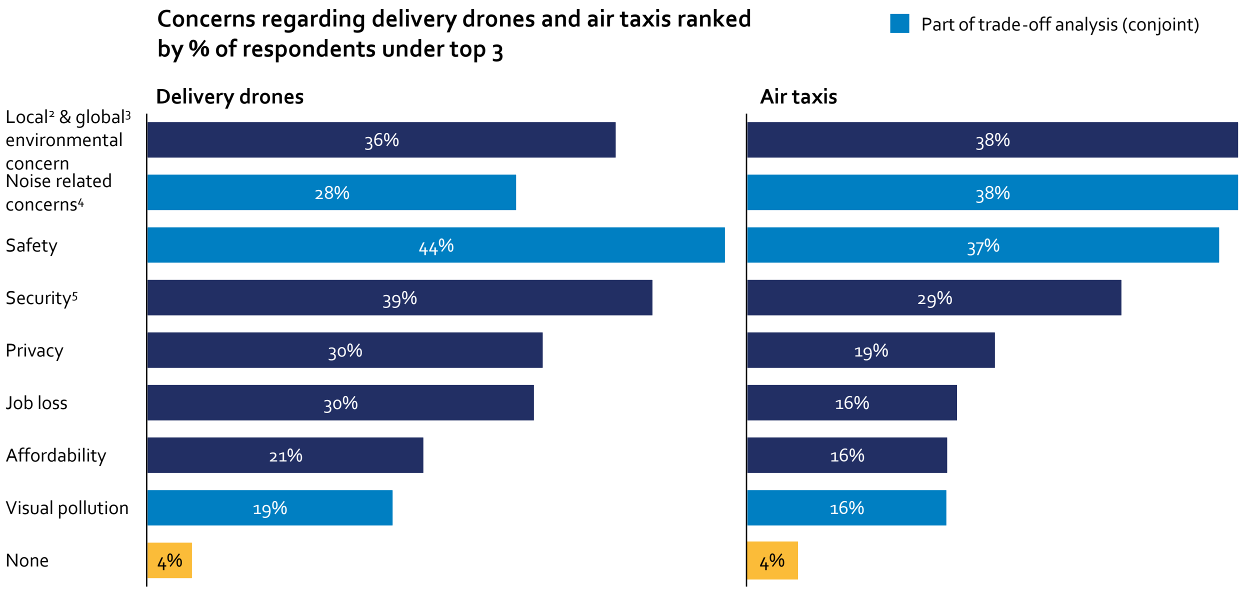
- Noise in the case of air taxis ranked second, but was significantly lower for drones coming in 6th place;
- Security ranked 10 percent higher for drones. Most likely, this is because drones are unmanned while air taxis are expected to be manned initially and thus might be less prone to security threats in the eyes of the general public. It can be assumed that air taxis operated by remote pilots or flying autonomously would increase the public concern for safety. In general, slightly more than half of the participants trusted security and cyber-security regarding drones, with men demonstrating more trust than women (+7 percent). See details in Appendix.

Concerns regarding drones

The main concerns for drones also related to safety, security, and environmental impact. Relative to the results for air taxis, the security threat was perceived to be around 10 percentage points higher, which might correlate with the fact that in the scope of this study air taxis were framed to be piloted for initial operation. In addition to Figure 38 it is worth mentioning that a notable demographic difference showed up: concerns related to safety and security increased with the age of participants, while privacy concerns decreased with age.

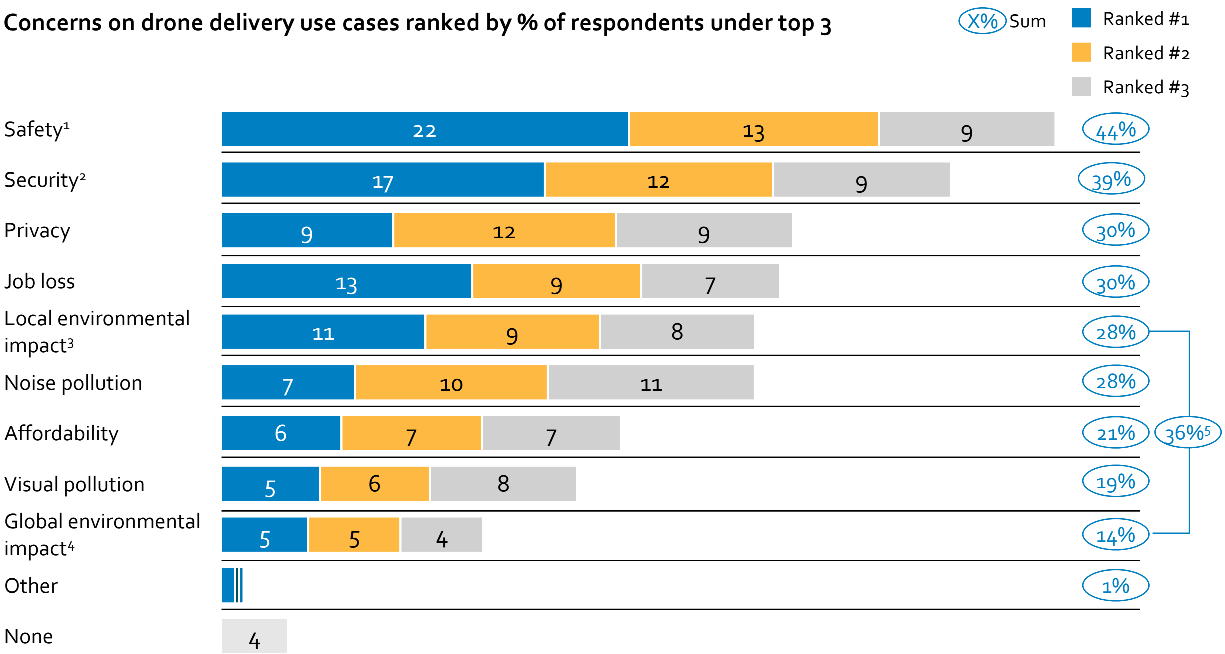
Concerns regarding the local environmental impact (named by 28 percent as a top-three concern) ranked much higher than those linked to the global environment. Younger participants expressed more concerns regarding the global environment than older respondents. Participants who feared job losses were most likely to be participants with lower incomes and level of education.

Figure 37: Respondents had similar concerns about delivery drones and air taxis



1. Incident due to technical or human failure
2. Local environmental impact includes air pollution, negative impact on bird life and insects, decreasing biodiversity
3. Global environmental impact covers climate change
4. Covers noise pollution for delivery drones, and noise related to flying aircraft and noise related to vertiports for air taxis
5. Incident due to deliberate harmful action, e.g. by criminal organization or terrorists

Figure 38: Safety is the leading concerns for drone delivery



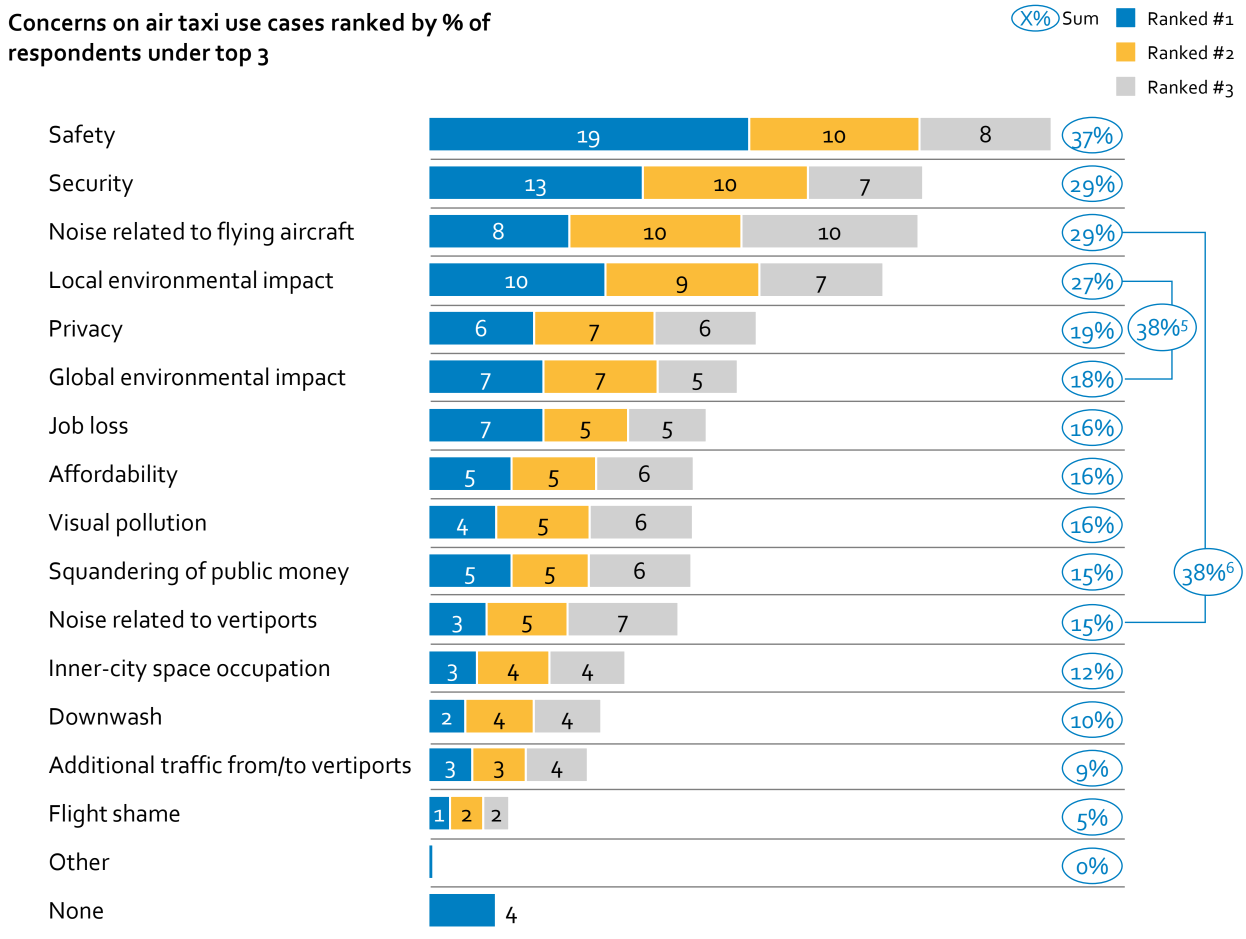
1. Incident due to technical or human failure 2. Incident due to deliberate harmful action, e.g. by criminal organization or terrorists 3. Local environmental impact includes air pollution, negative impact on bird life and insects, decreasing biodiversity 4. Global environmental impact covers climate change 5. Share of respondents that ranked any environmental concern among top 3 answers

Source: EASA UAM societal acceptance survey questions B4. What are you most concerned about regarding drone delivery, both fo r the delivery of day-to-day goods as well as medical supplies? Please consider your own usage of such a service as well as other people using it (e.g. your family or neighbours), which may affect you as well. Please select up to 6 answers. B5. Please sort your main concerns (selected in B4.) from 'most concerning' to 'least concerning'.

Concerns regarding air taxis

Additional concerns were considered in the ranking question for air taxis, including those around the infrastructure that enables air taxis to take-off and land, called vertiports. The main concerns related to air taxis as perceived by respondents were noise and environmental impact (both 38 percent, when combining mentions on air taxis and vertiports for the category of noise). These concerns were followed by safety (37 percent), security (29 percent) and privacy (19 percent), as can be seen in Figure 39. Job losses, affordability, and visual pollution (all 16 percent) were raised as well but appear to have a much lower importance to survey participants. Again, demographical differences can be found: concerns around safety and noise related to flying aircraft slightly increase with age, education, and income. Fear of job losses on the other hand decreased with age, education, and income. The results also show that women expressed slightly more concern around environmental issues. A large share of respondents (81 percent) assumed that shuttle services would only be accessible to a few – this is likely to be one of the highest barriers to societal acceptance of air taxis.

Figure 39: Noise produced by air taxis is expected to be much higher than that produced by drones



1. Incident due to technical or human failure 2. Incident due to deliberate harmful action, e.g. by criminal organization or terrorists 3. Local environmental impact includes air pollution, negative impact on bird life and insects, decreasing biodiversity 4. Global environmental impact covers climate change 5. Share of respondents that ranked any environmental concern among top 3 answers 6. Share of respondents that ranked any noise related concern among top 3 answers

Source: EASA UAM societal acceptance survey questions C5. What are you most concerned about with respect to air taxis? Please consider your own usage of such a service as well as other people using it (e.g. your family or neighbours), which may affect you as well. Please select up to 6 answers. C6. Please sort your main concerns from 'most concerning' to 'least concerning'.

The qualitative interview revealed that noise was the concern most mentioned by stakeholders as they expected noise to be the greatest reason for citizens to complain. Security was also mentioned frequently as a major concern, related for instance to the risk of hacking into the control link and equipping drones with dangerous or explosive goods.

Respondents often took for granted that safety would be guaranteed by authorities that authorise them to fly. Therefore, safety was not mentioned very often as a key concern. Privacy, such as potentially taking pictures of private areas was frequently mentioned in qualitative interviews, but not in the quantitative survey. In this regard, harassment was mentioned as a potential concern from drones operated by private users (e.g. stalking), particularly if more flights take place in densely populated areas.

Stakeholders also mentioned in interviews additional concerns that had not ranked high in the quantitative survey: insufficient public acceptance, problems of integration of airspace between drones and aircraft, lack of space availability for vertiports and integration into cityscape as well as insufficient integration into the existing transport ecosystem of the city (i.e. UAM just adding another layer of transport congestion, "moving traffic jams into the air"). Some respondents were also concerned by: the affordability of the services, the pressure on the electricity demand, the energy efficiency of transporting through the air, the visual impact on of cultural heritage in old European cities (visual pollution of flights and ground infrastructure), the compatibility of UAM with the "slow mobility" concepts adopted by more and more European cities. Finally, local stakeholders, in particular local authorities, were concerned by a potential lack of involvement in decision making and deployment of UAM in their city/region, especially with regard to topics that impact the local city, such as definition of routes and traffic frequencies.

3.2.5 Safety: existing aviation safety levels are the benchmark

With the help of a comprehensive survey-based trade-off analysis (conjoint methodology as explained in chapter 3.1), the relative importance of different levels of safety, noise, and visual pollution on the acceptance level of the survey respondents was assessed. While these results can give an indication of how different improvements in safety, noise and visual pollution are perceived by the public – and what measures could enhance public acceptance – the analysis cannot directly indicate precise regulatory measures, which must also be influenced by other considerations. One reason for this is that the perception of the safety dimension might be underrated in this survey as people are used to and expect high safety standards when it comes to aircraft. This particular fact was highlighted many times in the qualitative interviews performed after the quantitative survey.

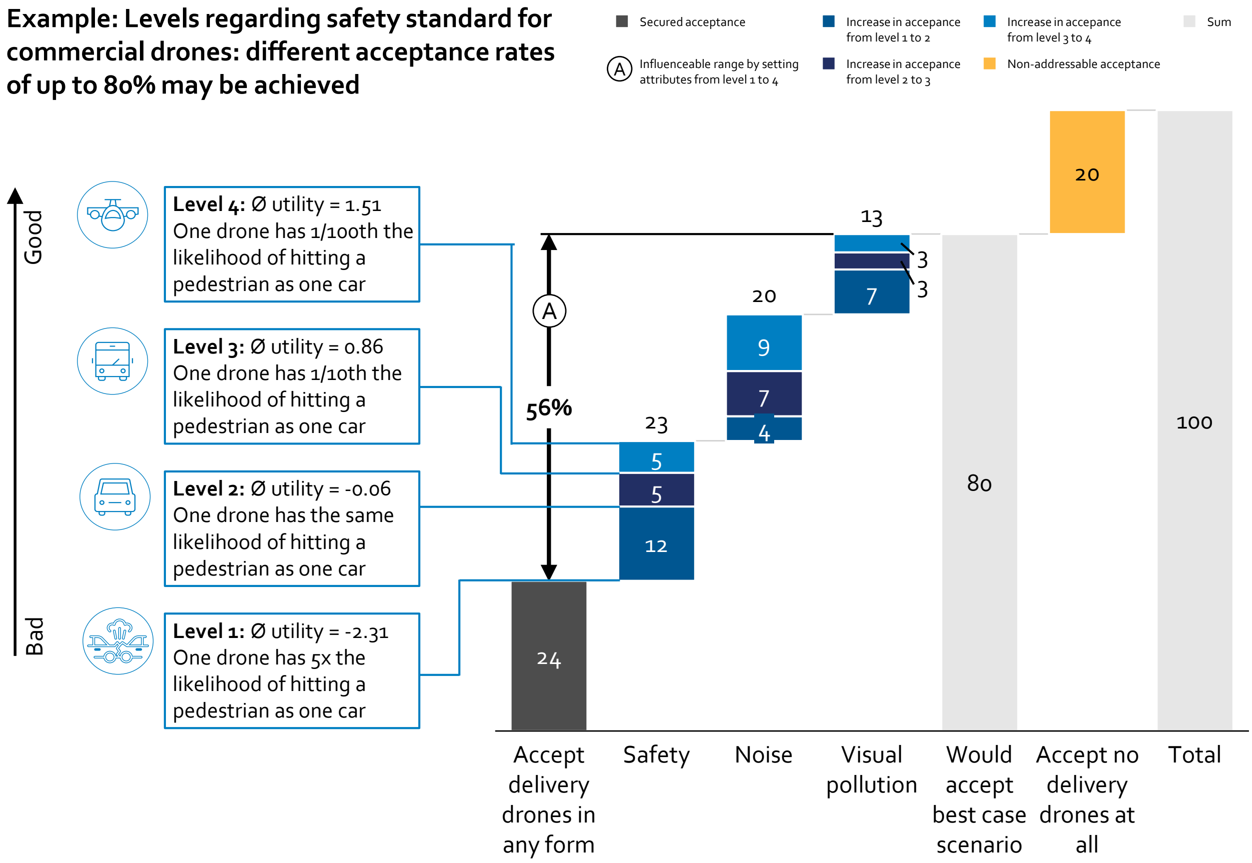
A separate analysis was done for drones and for manned air taxis as different responses were expected due to the different size and application of the aircraft. The details are shown in the following differentiated results both for drones and air taxis.

Detailed trade-off analysis for drones

When it comes to delivery drones, 24 percent of participants indicated that they would accept delivery drones in any presented scenario, given the worst safety, noise, and visual pollution level. In contrast, one out of five participants (20 percent) indicated they would not accept delivery drones at all, despite the best level of safety, noise, and visual pollution (see Figure 40).

The results from this simplified trade-off analysis indicated that citizens' acceptance could be improved by 56 percent by implementing the highest levels for the safety, noise and visual pollution dimensions. Within these 56 percent, the safety dimension is the main influencing factor (increasing acceptance by 23 percent). The results for delivery drones imply that a change of safety from level 1 (one drone has five times the likelihood of hitting a pedestrian as one car) to level 2 (one drone has the same likelihood of hitting a pedestrian as one car) could increase the public acceptance by 12 percent, which is also the highest incremental increase for all three dimensions and almost as much as the complete visual-pollution dimension. A change in the safety dimension from level 2 to level 3 (one drone has 1/10th the likelihood

Figure 40: Trade-off analysis results for drones



1. Figures may be used to assess different scenarios for regulation; however, survey participants are not expert in regulation efforts and may have misleading expectations (too low and too high); answers are always a snapshot

Source: EASA UAM societal acceptance survey questions B7. Put yourself in the year 2030: drones with about 3-metre wingspans, certified by competent authorities, are flying at altitudes of up to 150 metres. In the following section, you will be asked which scenario out of three alternatives is most acceptable from your perspective. Please choose your most preferred option out of the three alternatives shown. B8. Again, put yourself in the year 2030. How acceptable would you find the following scenarios for the future? Please rate each scenario based on the scale shown below.

of hitting a pedestrian as one car), or from level 3 to level 4 (one drone has 1/100th the likelihood of hitting a pedestrian as one car) could increase societal acceptance by 5 percent each.

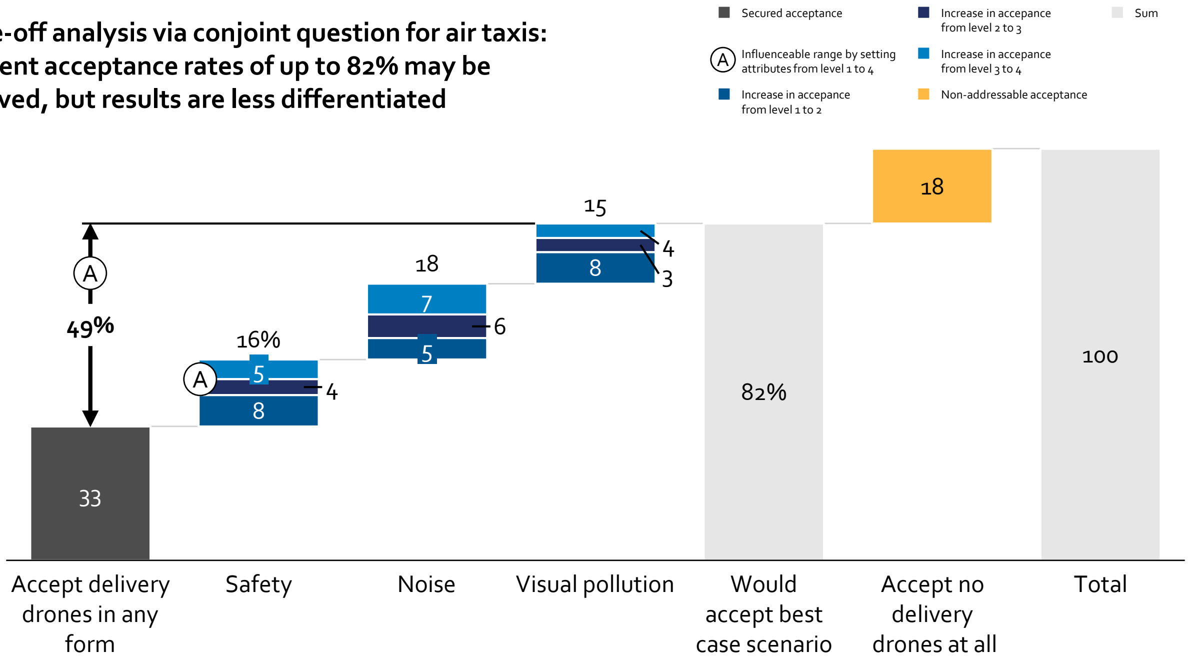
Detailed trade-off analysis for air taxis

Taking a closer look at air taxis (see Figure 41), the maximum achievable acceptance rate is 82 percent, as 18 percent of respondents said they would never accept an air taxi as part of urban transport system even if the best level of safety, noise and visual pollution could be achieved. However, nearly one third indicated that they would accept air taxis in any presented scenario, given the worst safety, noise and visual pollution level. This means the range of influence by different levels for the dimensions of safety, noise and visual pollution is 49 percent in the given simplified scenario.

Within these 49 percent, the noise dimension is the main influencing factor (increasing acceptance by 18 percent), followed by safety (16 percent) and visual pollution with (15 percent). In general, as well as for drones, visual pollution is the least important factor for citizens. Noise on the other hand moved to the first place for air taxis. The results for air taxis imply that a change of safety from level 1 (~5 fatalities per 10^9 PAX km) to level 2 (~2 fatalities per 10^9 PAX km) could increase the public acceptance by 8 percent. A change in the safety dimension from level 2 to level 3 (~0.05 fatalities per 10^9 PAX km), or from level 3 to level 4 (~0.01 fatalities per 10^9 PAX km) could increase societal acceptance by ~5 percent each. A reason why noise is perceived more important in relation to safety for air taxis could on the one hand be that vehicles are larger and thus more associated in respondents' minds to today's helicopters flying in cities, which are very noisy, and on the other hand that the safety of currently flying vehicles is already perceived as very high and thus is not a top concern for most citizens. The results on safety imply that a change of noise from level 1 (one air taxi is as loud as a leaf blower) to level 2 (one air taxi is as loud as a truck driving by at city speed) could increase the public acceptance by 5 percent. A change in the noise dimension from level 2 to level 3 (one air taxi is as loud as a car driving by at city speed), or from level 3 to level 4 (one air taxi is as loud as a bicycle riding by at city speed) could increase societal acceptance by 6-7 percent each.

Figure 41: Trade-off analysis results for air taxis

Trade-off analysis via conjoint question for air taxis: different acceptance rates of up to 82% may be achieved, but results are less differentiated



Source: EASA UAM societal acceptance survey questions C7. Put yourself in the year 2030: air taxis with wingspans of up to 12 metres, certified by competent authorities, are flying at altitudes of about 150 metres. In the following section, you will be asked which scenario out of three alternatives is most acceptable from your perspective. Please choose your most preferred option out of the three alternatives shown. C8. Again, put yourself in the year 2030. How acceptable would you find the following scenarios for the future? Please rate each scenario, based on the scale shown below.

3.2.6 Environment: priority is protection of wildlife

As indicated above, environmental impact was the second highest concern of citizens. In order to get a better understanding of the exact nature of this concern, the quantitative survey invited participants to separately rank detailed environmental concerns they have with regard to drones and air taxis. They were given a list of seven concerns each to rank from "most concerning" to "least concerning". Also, they had the chance to choose "none of these".

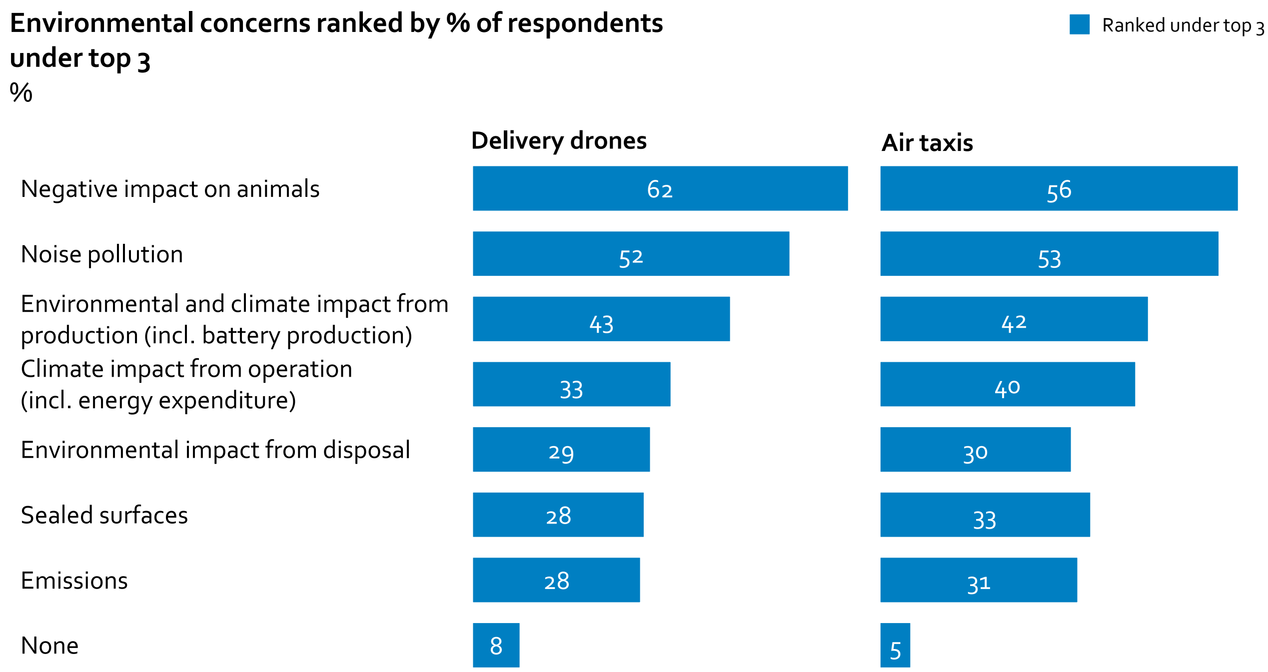
> The main environmental concerns relate to the risk of negative impact on wildlife (birds, insects, bats, etc). The results are identical across the six cities.

As the results in Figure 42 show, the top-three environmental risks that survey participants expected to see with delivery drones and air taxis were the same: nearly two out of three participants feared a **negative impact on animals** from drones, while 56 percent feared the same for air taxis. Negative impact on animals was more often mentioned as a concern by the age group older than 65. This age group was concerned, for example, that animals could be disturbed and that this could lead to a reduction of birds in urban areas. **Noise pollution** is also an environmental concern: for both delivery drones and air taxis more than half of participants named noise as one of their top-three-concerns. The third concern related to the environmental and **climate impact of the manufacturing and production** of the vehicles and of their batteries.

Environmental concerns on drones

When taking a closer look at the expected environmental impact of drones, three concerns clearly stood out: negative impact on animals (62 percent), noise pollution (52 percent) and environment and climate impact from production including batteries (43 percent). This last concern was significantly higher than climate impact from operation, with only one third of participants being concerned about the latter.

Figure 42: Details on environmental concerns

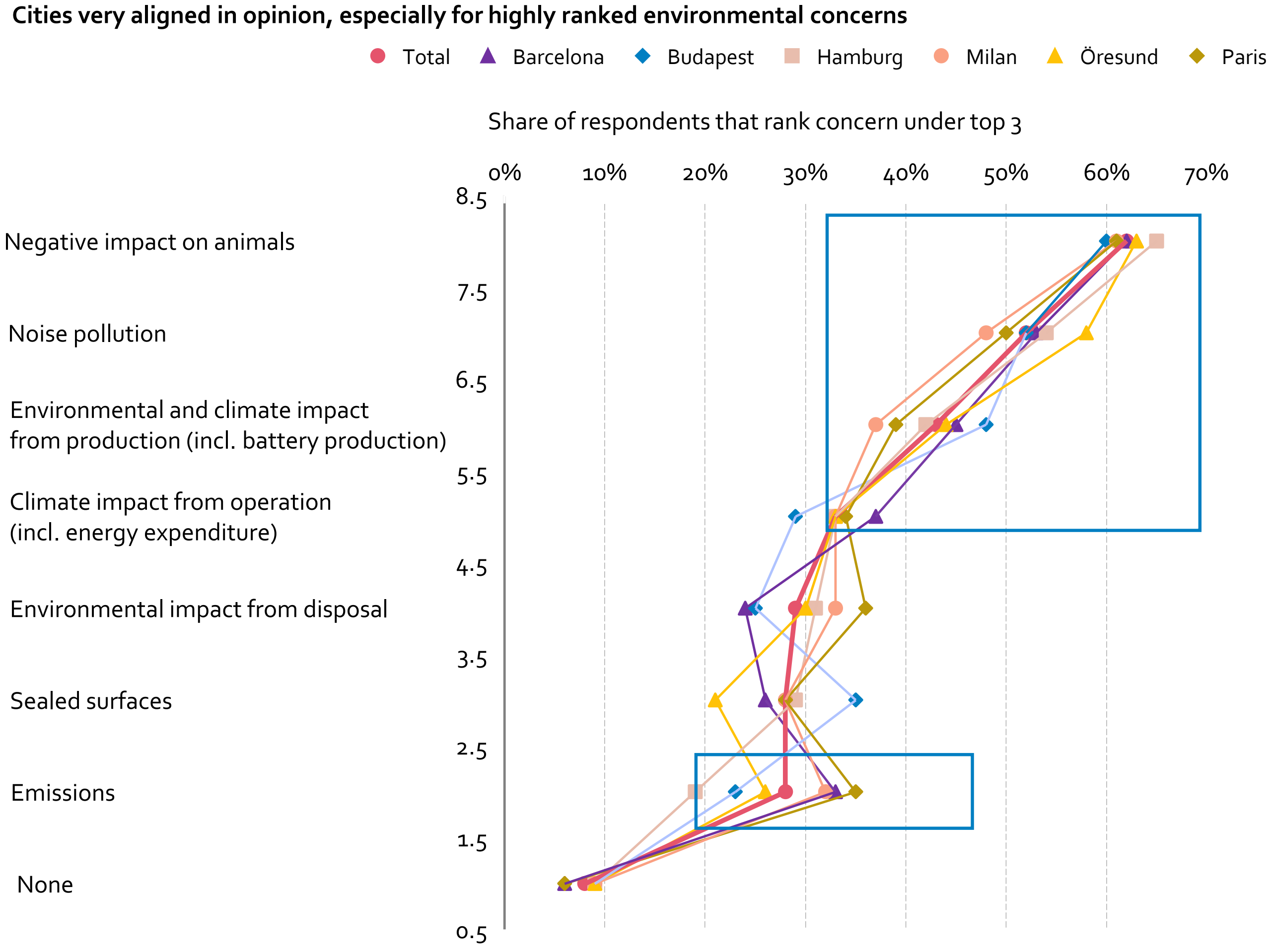


Source: EASA UAM societal acceptance survey questions B9. What are your greatest concerns when it comes to the possible envir onmental consequences of drone delivery? Please sort the following answers from 1 being 'most concerning' to 7 being 'least concerning' or select 'none of these'. C9. What are your greatest concerns when it comes to the possible environmental consequences of air taxis? Please sort the following answers from 1 being 'most concerning' to 7 being 'least concerning' or select 'none of these'.

At the end of the list, participants ranked lowest the concerns around disposal, sealed surfaces, and emissions (~28 percent). The concern about emissions decreased by age: the age group 55 to 65 years expressed less concern on this topic (-8 percent), while the youngest age group 18 to 25 year expressed higher concern (+12 percent).

The results demonstrate an amazing homogeneity across the cities, with responses and the rankings closely aligned when it comes to environmental concerns on drones (see Figure 43). It is to be noted however, that the largest differences in concerns between cities relate to the environmental impact of local emissions, likely driven by differences in perceived current air quality in the respective cities.

Figure 43: There is a major difference between cities on concerns around delivery drones and emissions

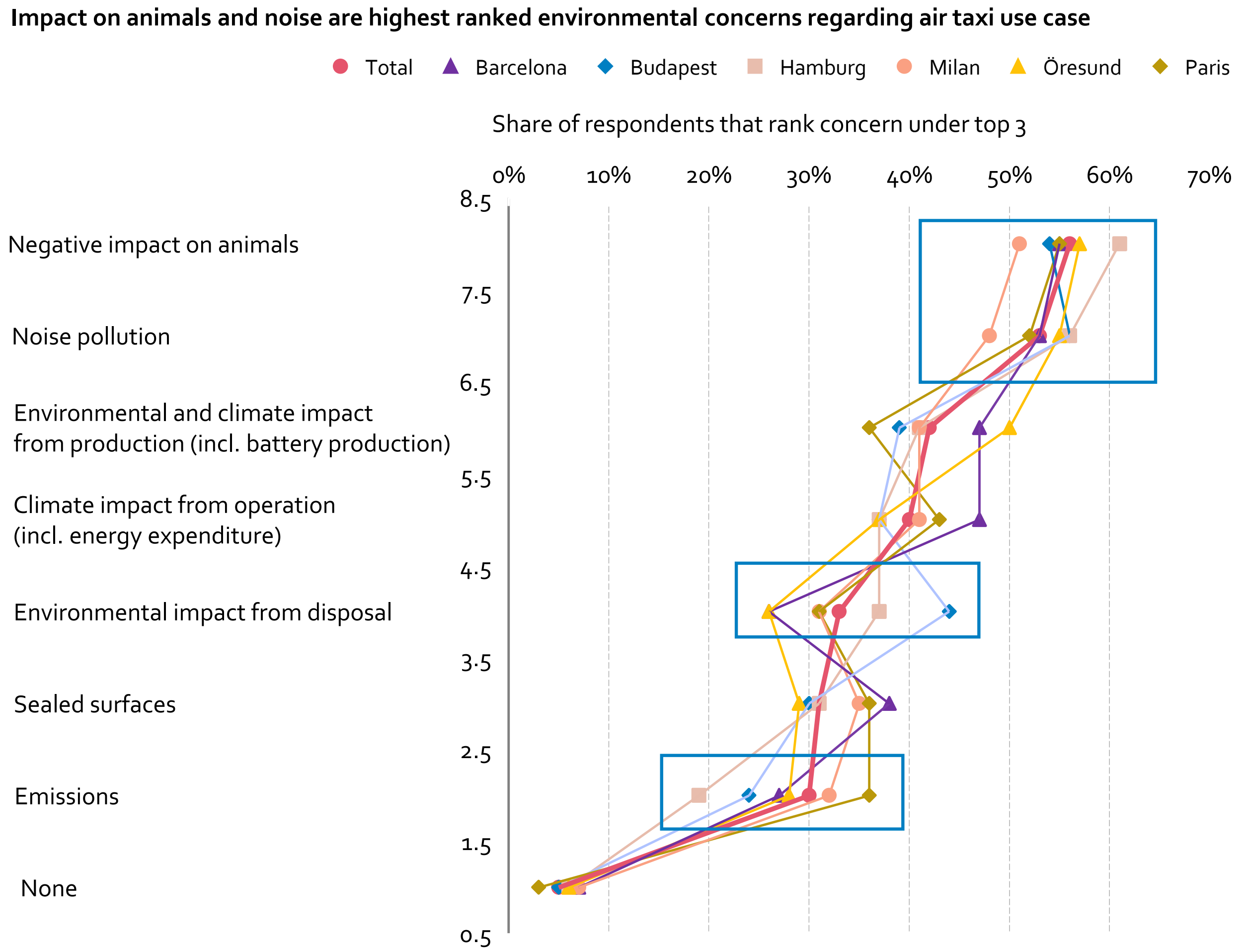


Source: EASA UAM societal acceptance survey questions B4. What are you most concerned about regarding drone delivery, both for the delivery of day-to-day goods as well as medical supplies? Please consider your own usage of such a service as well as other people using it (e.g. your family or neighbors), which may affect you as well. Please select up to 6 answers. B5. Please sort your main concerns (selected in B4.) from 'most concerning' to 'least concerning'.

Environmental concerns on air taxis

When it comes to air taxis, two concerns ranked significantly higher than others: the negative impact on animals (56 percent) and noise pollution (53 percent). Again, environmental and climate impact for production (incl. battery) and operations ranked third and fourth, but these concerns were mentioned nearly the same number of times (42 percent for air taxis vs. 40 percent for drones). While younger people were more concerned with climate change, they were less concerned by noise (-10 percent).

Figure 44: Concerns on air taxis are nearly the same across survey cities



Source: EASA UAM societal acceptance survey questions B4. What are you most concerned about regarding drone delivery, both for the delivery of day-to-day goods as well as medical supplies? Please consider your own usage of such a service as well as other people using it (e.g. your family or neighbors), which may affect you as well. Please select up to 6 answers. B5. Please sort your main concerns (selected in B4.) from 'most concerning' to 'least concerning'.

Just as for drones, participants were aligned across geographies on the top environmental concerns. However, the largest spread in opinion across cities showed up when considering environmental impacts both from disposal of air taxis and emissions (see Figure 44).

The risk to wildlife was repeated during the qualitative interviews, principally by local stakeholders. Examples mentioned were birds disturbed by noise, or bats and other animals disturbed by lights if aircraft was flying at night.

Possible mitigation option: the eco-label

As part of understanding potential solutions to societal acceptance and buy-in in relation to environmental impact, the questionnaire invited respondents to indicate whether, in their view, the environmental impact of Urban Air Mobility operations should be evaluated by the authorities and made public, e.g. via an eco-label, such as the one being developed by EASA for traditional aviation:

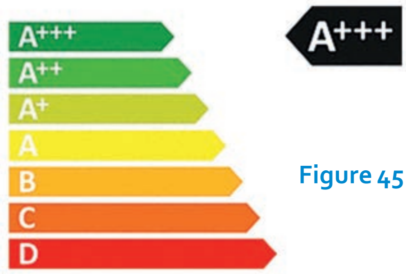
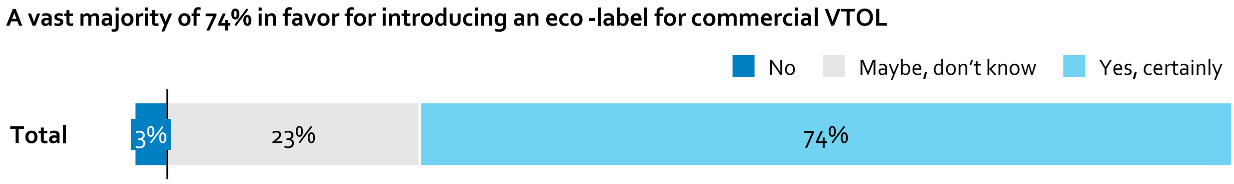


Figure 45

As illustrated by Figure 45, a large majority (74 percent) of survey participants saw advantages in introducing an eco-label for commercial Urban Air Mobility vehicles and operations.

Figure 45: An eco-label for commercial VTOL can increase societal acceptance



Source: EASA UAM societal acceptance survey question D4. Should the environmental impact of urban air mobility operations be evaluated by the authorities and made public, e.g., via an eco-label such as the one shown below (picture included in back-up)? Please select one answer.

Again, the responses were similar across all surveyed cities. Participants from Barcelona showed a slightly more positive attitude towards such an eco-label (+8 percent) compared to others. Oresund (-8 percent) showed the lowest enthusiasm.

3.2.7 Noise: acceptable at level of familiar city sounds

The findings of the noise perception study described in the survey methodology section (see § 3.1.3) are presented in this section.

Citizens' acceptance of noise expected to increase over time

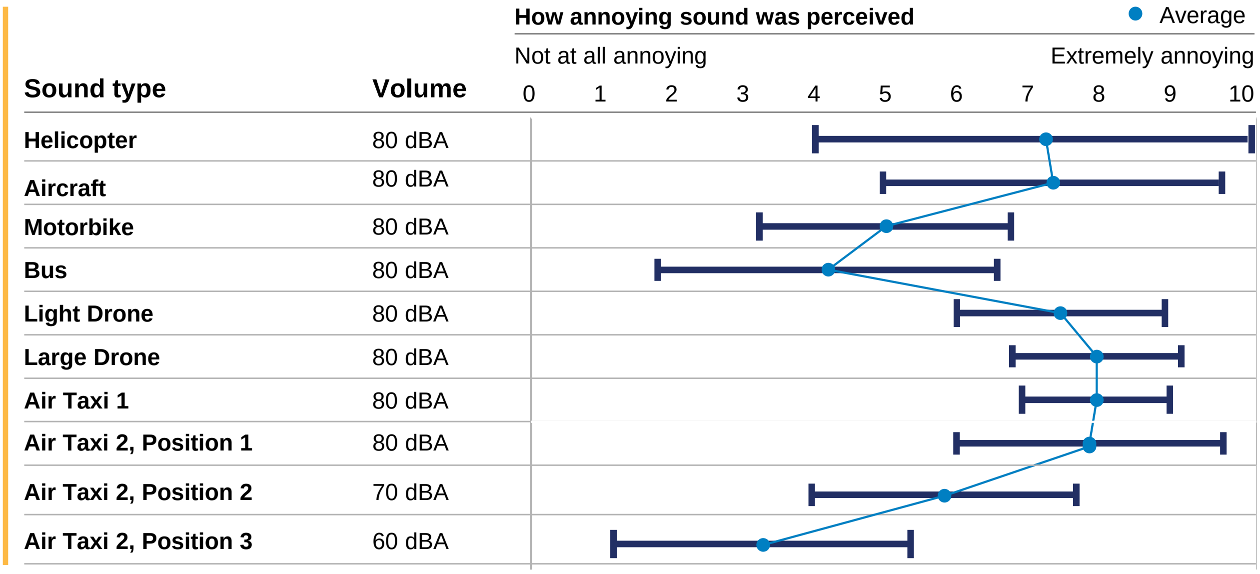
At the same sound level, participants of a noise test felt more annoyed by UAM vehicle sounds than by sounds that they already know.

Therefore, it can be expected that the level of annoyance will decrease as citizens become familiar with sounds of UAM vehicles, and provided that the sound level and character.

Figure 46 below presents a summary of the results in which the average ratings as well as the minimum and maximum ratings are shown. It must be noted that the worst ranking level was largely driven by two listeners, as their responses to most sources appears to have been much more adverse than the responses from others. These differences in responses were not due to any difference in the test methodology, such as listening at different sound levels: the conditions were identical for each listener.

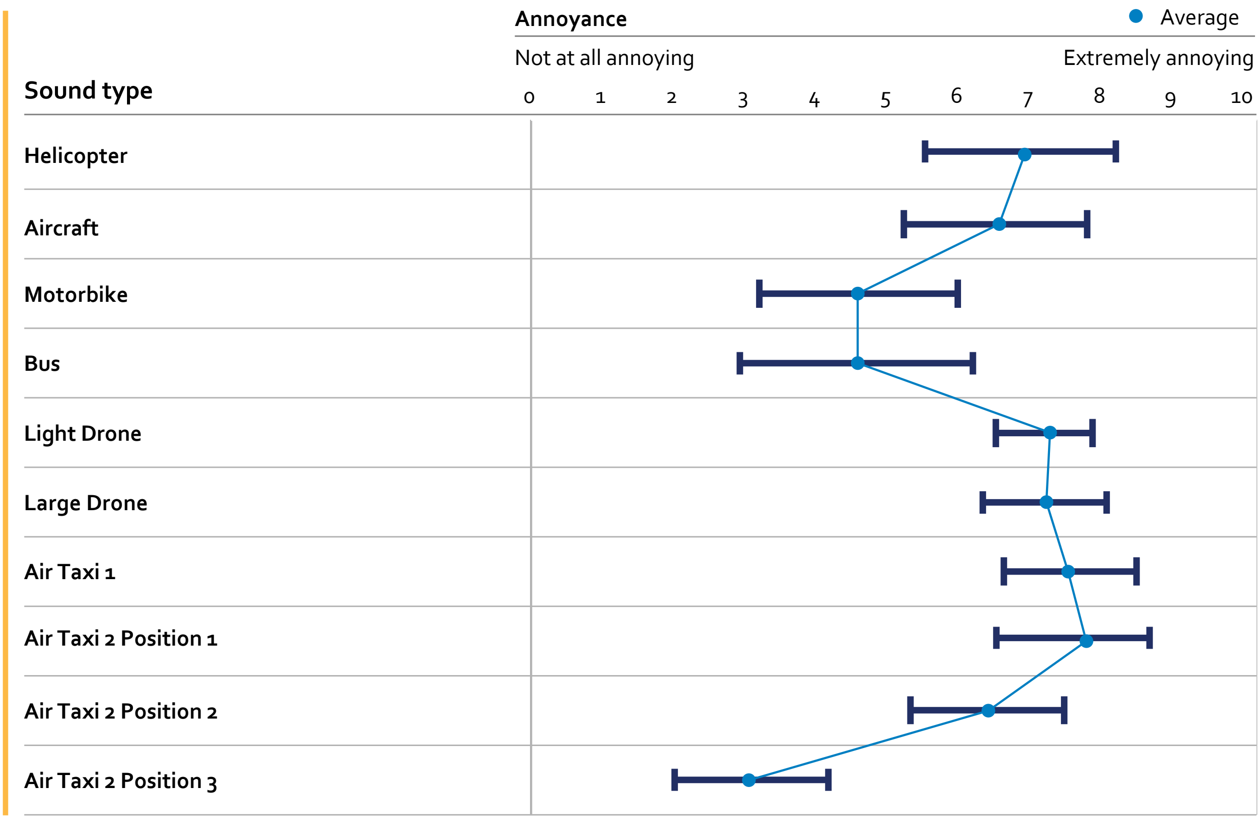
The volume values presented in dBA units in Figure 47 below correspond to maximum A-weighted noise levels and are not integrated over time. Consequently, they correspond to the loudest instant in the sound sample, but do not capture that noise events may be significantly different in duration from one another, and thus result in very different perceptions by the listeners. This aspect should be accounted for and soften the following conclusions.

Figure 46: Result overview of noise perception study



Although this is a small sample of results, the responses have also been analysed statistically. Figure 47 below shows mean response and the 95 percent confidence intervals for each source. A repeated measures ANOVA (analysis of variance) shows that there is a statistically significant effect of vehicle type on annoyance ($F(9, 180) = 24.17$, $p < 0.001$).

Figure 47: Statistical analysis of responses



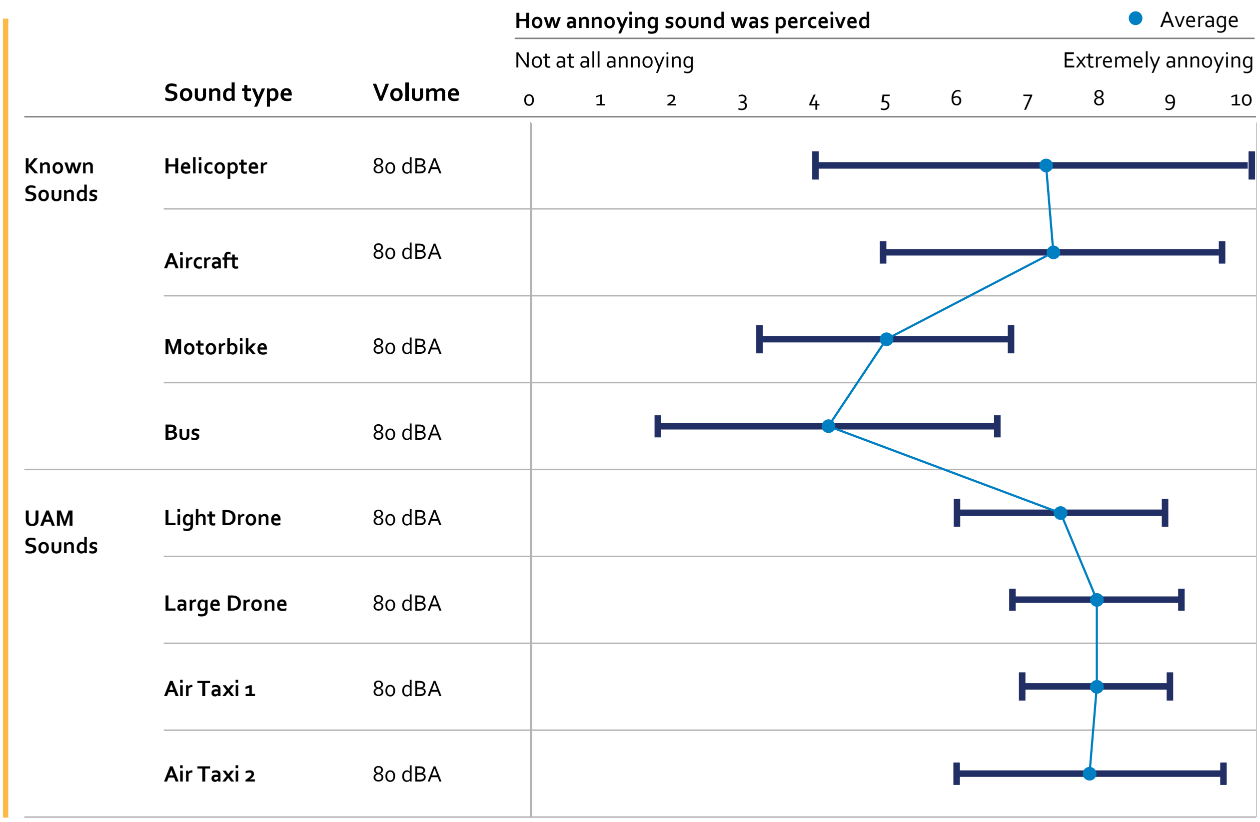
Some important information can be inferred from Figure 46 and Figure 47. Figure 48 shows the comparison between familiar sounds and UAM aircraft played at same maximum noise level. Figure 46 shows the noise perception rating for sources at different distances.

Observations of sounds played at the same noise level (see Figure 48):

- Responses showed a clear separation between the drone/air taxi sources and the others, at the same sound level;
- This separation is particularly marked between the drone/air taxis and the road vehicles;
- The air taxi and large drone scored the highest mean average result of 7.8. The synthesised air taxi at 80dBL$_{Amax,F}$ (Air Taxi Position 1) scored only slightly lower (mean of 7.7) but had the most instances of the highest score of 10 (5 times).

This could lead to conclusions that unfamiliar sounds, in this case UAM sounds, are perceived more negatively or that the sound characteristics of these aircraft lead to a more negative rating at the same maximum noise level compared to the other sounds to which the participants were exposed.

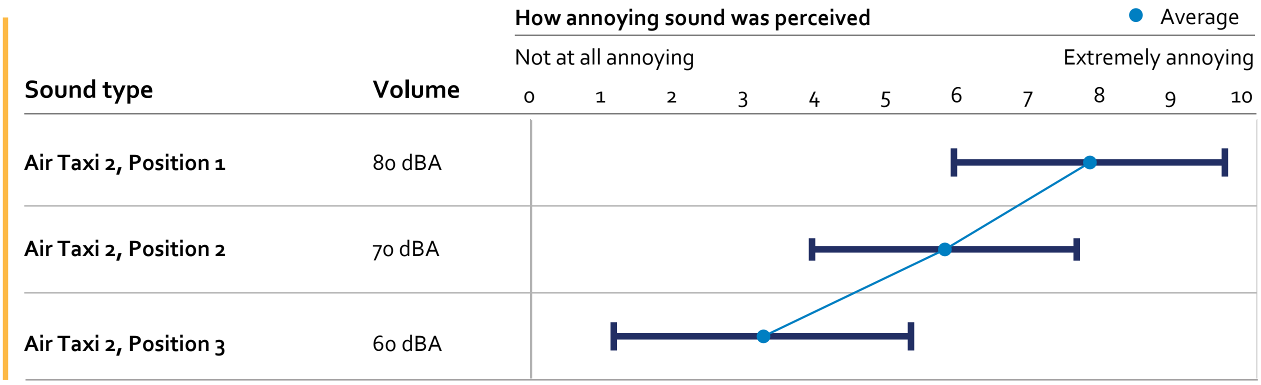
Figure 48: Result comparison between familiar sound and Urban Air Mobility vehicle sounds at same maximum noise level



Observations with respect to different distances (see Figure 49):

- As expected, the synthesised air taxi score dropped with distance/sound level, both in terms of individual ratings and the mean average. The difference in responses between Position 2 and Position 3 was greater than the difference in rating between Positions 1 and 2;
- As expected, the synthesised air taxi at the furthest distance (and 20dB quieter than the other sounds) scored the lowest ranking, with an average score of 3.2;
- It can be seen that at a distance equivalent to 60dB$L_{Amax,F}$ the annoyance level was below the annoyance for the familiar reference sounds at 80dB$L_{Amax,F}$. The level of 60dB$L_{Amax,F}$ on top of a background noise of 55dBL_{Aeq} seemed to be largely acceptable for the 20 test participants.

Figure 49: Noise perception at different distances



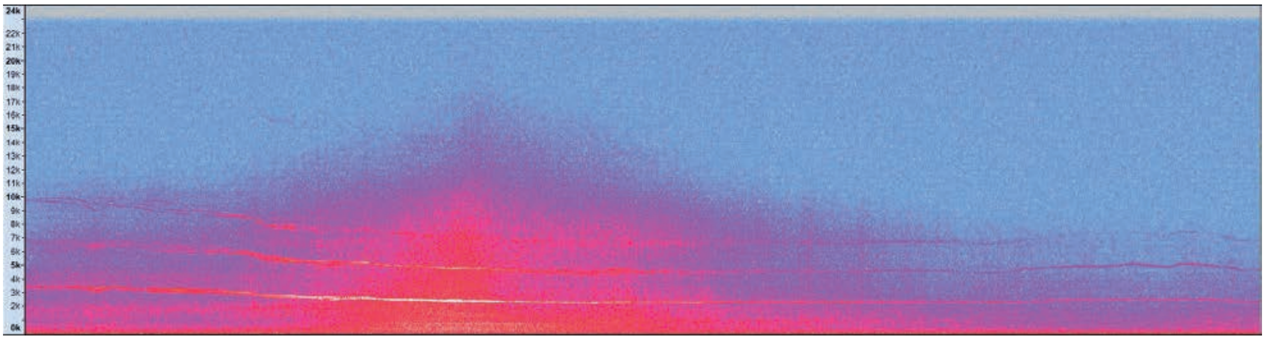
Additional response comments

The following summarises the main themes that were noted in the listeners' comments or mentioned after the listening tests to the Arup staff:

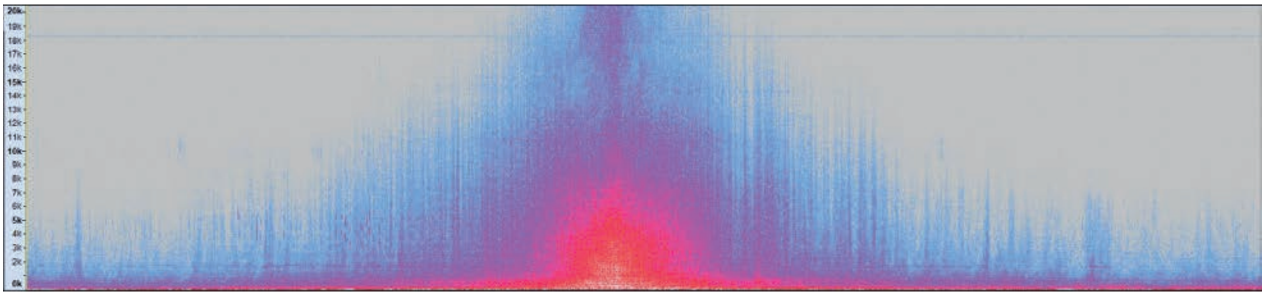
- Familiarity: Most comments featured recognition of or familiarity with the sounds being linked to lower (relative) annoyance scores (e.g. the aircraft and motorbike), with one commenting that these sounds were 'part of everyday life'. One listener linked the familiarity of the sound with perceived frequency of occurrence, i.e. 'I only hear an aircraft a few times a day, so I don't find the sound too annoying'. Similarly, some respondents said they owned a motorbike so were not annoyed by that sound.
- Unfamiliarity: In several cases participants did not understand what they were listening to or could not imagine the source of the noise sample, as evidenced by descriptors including 'lawnmower','swarm of bees'or 'boat'. The listeners had not been asked to try to identify the sources but several attempted to do so.
- A difference in response between familiar and unfamiliar sounds was also reflected in the response ratings, shown by Figure 49. No visualisation was provided during the tests that could have helped people understand the sound sources. It is not known whether this had a positive or negative effect on responses to UAM sounds.
- The relationship between familiarity and response should be investigated in any future tests, since it may be that responses would become more aligned with current transportation sources if such aircraft were to become a common feature of the urban soundscape.
- Whilst not intentionally part of the pilot study, the speed of the pass-by was also commented on by several participants. i.e. a slow pass by was more annoying than a quick one, possibly because of the amount of time exposed to the Lmax level or because the L_{Aeq} would have been higher for the longer exposure. This could be investigated further in a larger study, to consider the relationship with rise-time and startle, as well as duration of the sound.

Sound character and response

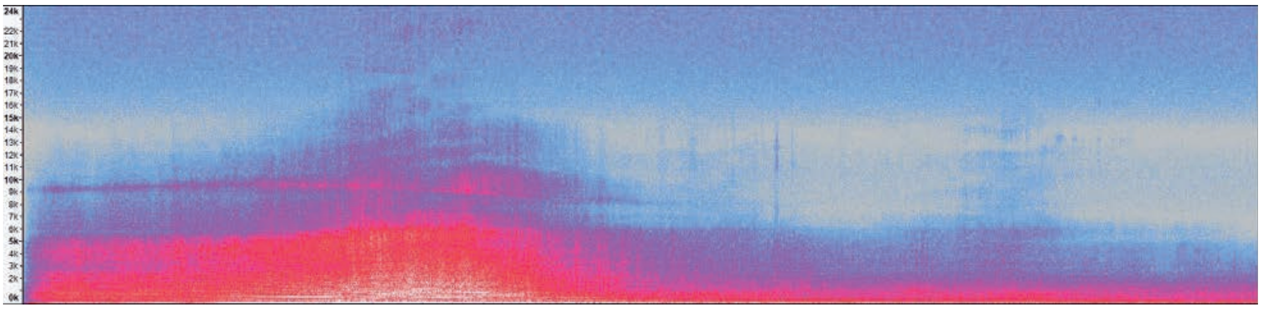
Spectrograms have been calculated for each sound source, to enable a preliminary assessment of the effect of sound characteristics on responses and show the change in the magnitude and frequency content of the sound with time. Examples are shown below. Time is plotted along the horizontal axis and frequency on the vertical axis. The colours indicate the sound pressure level: blues are the lower levels, with increasing levels being reflected in magenta, through red to white.



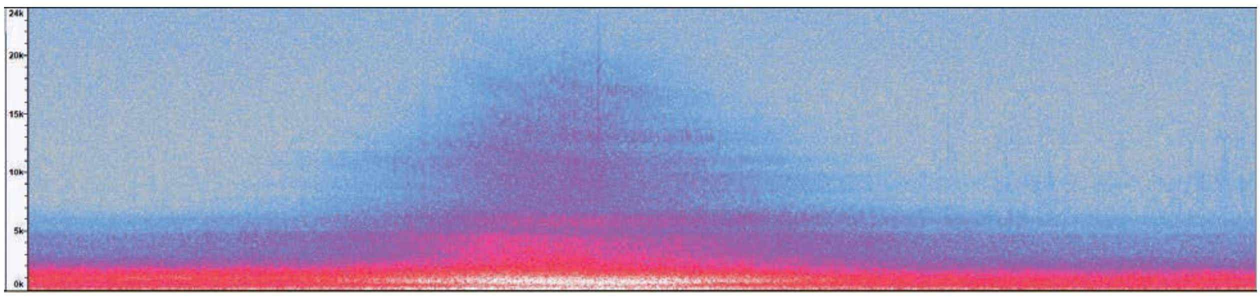
Air taxi



Large drone



Helicopter



Bus

There are elements of tonality at frequencies where they might be expected, such as low frequencies for the bus. There is generally a clear tonal component at around 3kHz for most drones/air taxis, which would correspond to frequencies where humans are most sensitive. However, the tonality is much more distinct with the air taxis than with the drones, which may be a factor in their higher annoyance rating.

The drones and helicopter exhibit a series of vertical transients with higher magnitude darker lines occurring in quick succession in their spectrograms. This characteristic is not evident in the other samples.

Conclusions of noise study

Initially it must be emphasised that this study was only meant to provide initial takeaways and insights. Results are not sufficiently significant and would have to be done at larger scale to draw conclusions. Nevertheless, the results provide insights that can support the design of further and more detailed studies.

It is apparent from this small study that there was a difference between reaction to sounds of drones/air taxis (at the same sound level) and reaction to other sound sources. This may be due to differences in sound character or differences in familiarity with the sounds. Participants more easily accepted sounds they were familiar with (even helicopters or motorbikes) and expressed annoyance towards unfamiliar sounds at the same maximum noise level.

This conclusion must be weighed alongside the fact that, despite being played at the same maximum noise levels, the noise samples exhibited very different time durations or rise-and-fall dynamics. This introduces a clear bias in the perception, as longer noise events are always perceived more negatively than shorter ones.

This consideration would benefit from further investigation through a larger set of tests. It may follow that sound level limits for these types of aircraft may need to be assessed and treated differently to other sources. Conversely, increased familiarity with such sound may lead to a greater acceptability in future.

A larger study would also allow the relationship between annoyance and other acoustic characteristics to be investigated.

As expected, people reported lower annoyance to sounds at lower sound levels. A statistically significant sample to test this in relation to unfamiliar sounds would be a beneficial part of a future study. For this pilot study, the tests adjusted only the level across three different sound levels, and not any other acoustic characteristics that would arise from the same source being at increasing distances: at a greater distance, the same noise source is attenuated, but its rise-and-fall dynamic (perceived duration) can increase.

The duration for which the sound was at a high level appears to have affected the responses. This should be assessed further to establish whether there is any relation between the duration of the sound and potential 'startle' effects of steep rise times. These issues could be particularly important when defining and assessing the potential locations of vertiports.

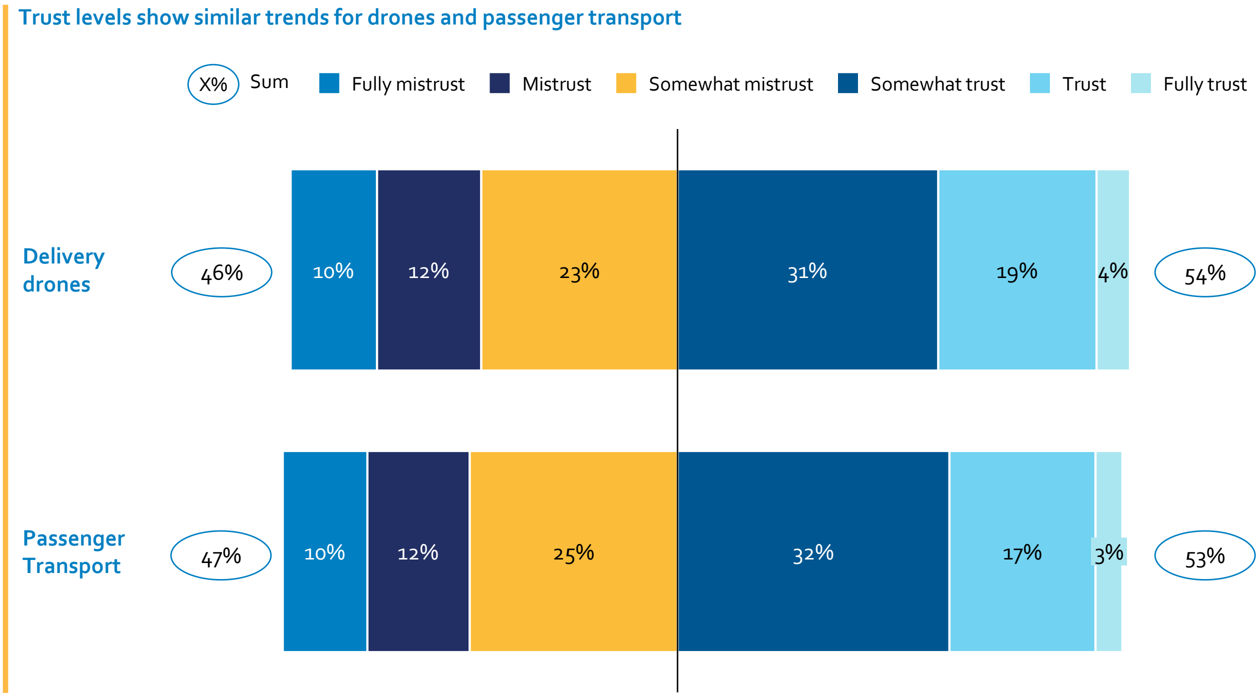
Further consideration should be given to whether visual representation of the sound sources should be included in any future wider study and how this might affect the outcomes.

3.2.8 Security: need to build confidence and trust in citizens

As indicated by the results to the generic concerns questions, security was the third highest concern of respondents. The survey looked into more detail at the trust level of citizens regarding the security and cyber-security of UAM, both for drones and air taxis. Participants were invited to indicate to what extent they trust that advanced aircraft flying in an urban environment will be technologically secure and protected against malicious threats and actions. The participants could then indicate different levels of trust ranging from fully trust to fully mistrust.

The results can be seen in Figure 50: The level of trust for delivery drones as well as for air taxis is just above 50 percent and therefore could be improved.

Figure 50: Trust levels in VTOL technology incl. security and cybersecurity

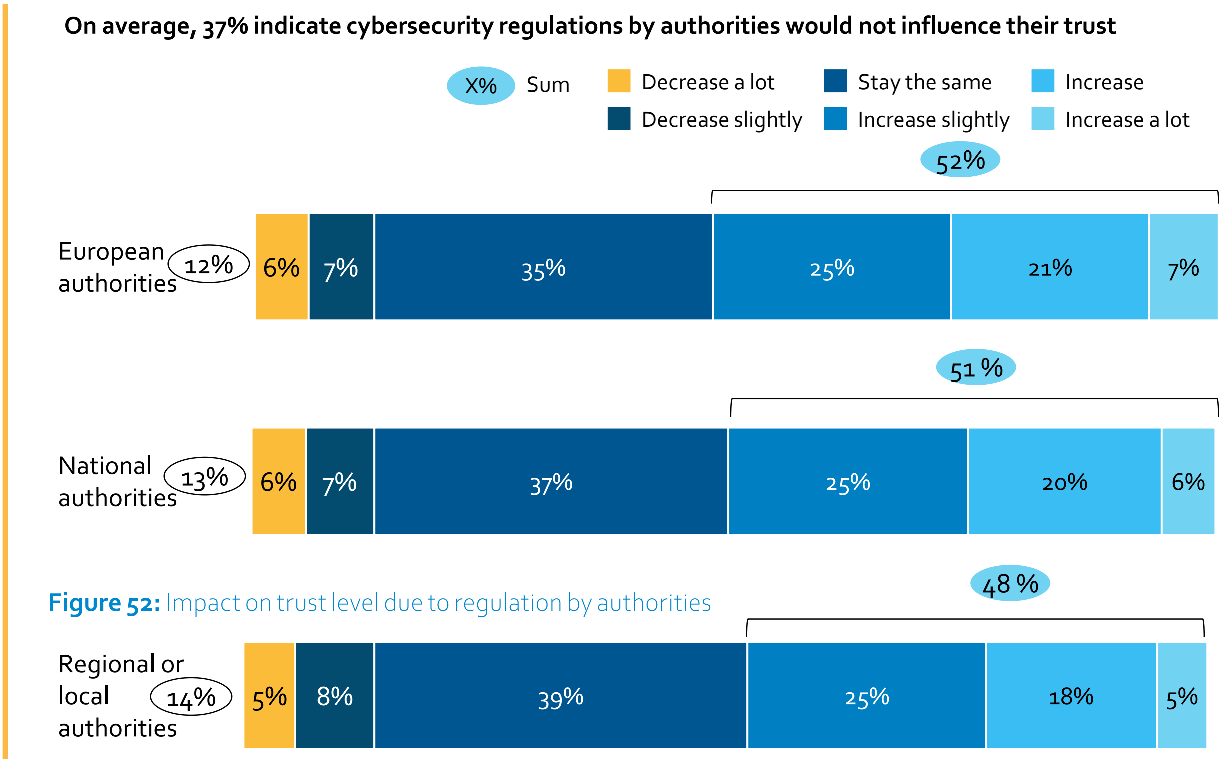


A minor difference can be seen between the demographics: while men were more likely to trust UAM services (~+7 percent), women (~-7 percent) and the older age group between 65 and 75 years (~-8 percent) were more likely to show mistrust. It is no surprise that the ones that during the survey answered to be rejecters of delivery and/or air taxi usage as well as digital laggards are amongst those with lowest trust level towards UAM (-16 to -27 percent less trust).

Some small local differences in trust were observable: The highest level of trust showed up in Milan (+10 percent for drones, +7 percent for air taxis) and Budapest (+7 percent, +10 percent). The lowest trust level showed up in Paris (-10 percent, -8 percent).

Another question tested whether the trust level of respondents would increase if the regulators were to develop regulations to manage cybersecurity risks (certification and operation of aerial vehicles). Figure 51 shows that on average 37 percent indicated that cybersecurity regulations would not influence their trust in vehicles. Also it can be seen that the public has no preference if these topics are regulated on European, national or regional level.

Figure 51: Impact on trust level due to regulation by authorities



Source: EASA UAM societal acceptance survey question D3. Would your trust increase if the following regulators were to develop regulations to manage cybersecurity risks (certification and operation of aerial vehicles)? Please select one answer per row.

On the contrary, the survey results regarding concerns related to vertiports (see below, Figure 53) showed that security issues linked to the vertiport operations are not a major concern of respondents (ranking 5th). This could be explained by the fact that vertiports are still at the conceptual stage and that very few representations are available to the general public at present.

Interview respondents on local and national level indicated that they would prefer a regulation on European level that they can rely on.

3.2.9 Ground infrastructure: must be integrated well

The survey also looked at the attitude of citizens towards emerging UAM ground infrastructure for drones and air taxis.

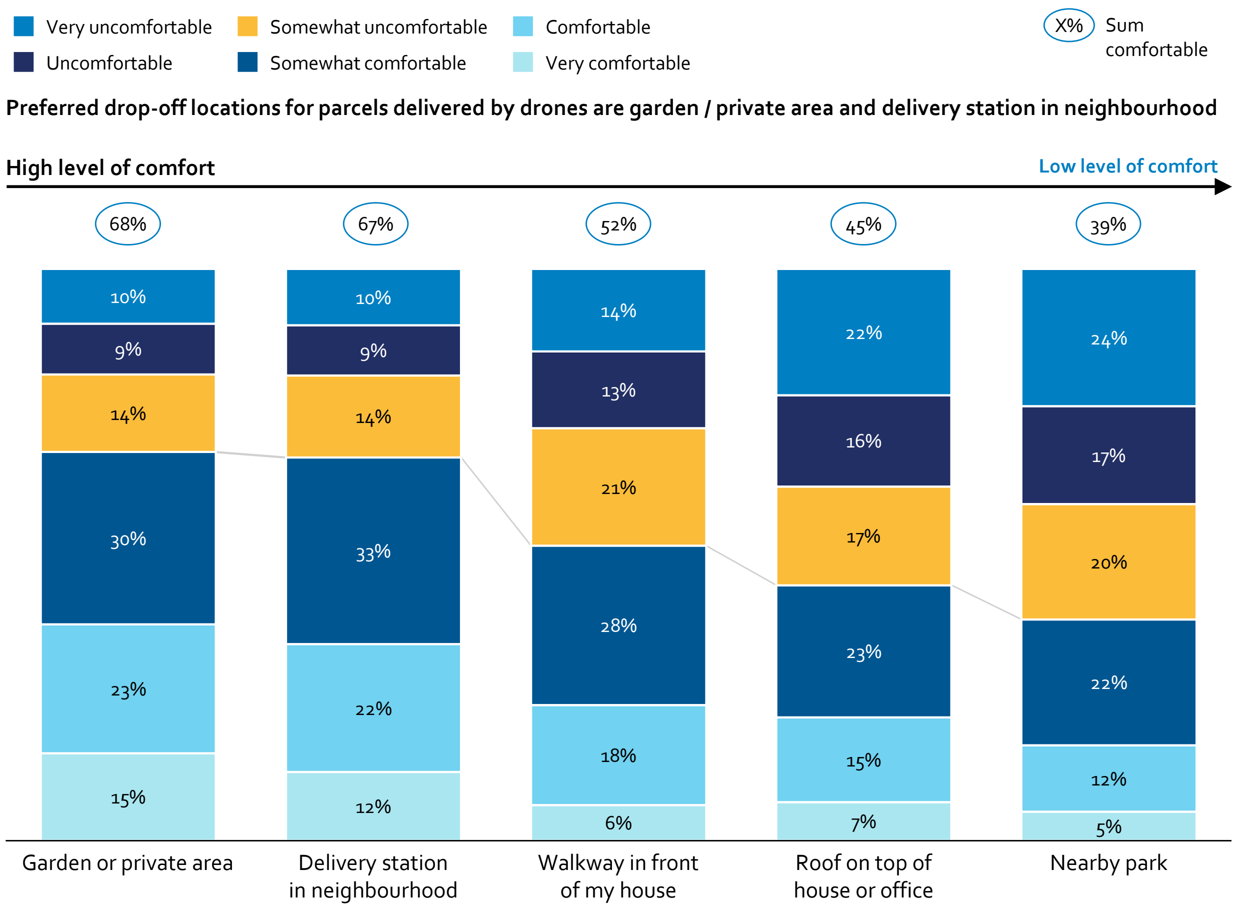
Integration into the city and local transport network

UAM services need to be integrated into the existing local mobility system. Visual impact of aircraft and infrastructure should be limited and preserve city landscape.

Infrastructure for delivery drones

To get insights on drone delivery, participants were asked how comfortable they would be with different modes of drone delivery for medium-sized parcels (max. 120 x 60 x 60 cm, up to 5 kg). Overall, participants said that the closer to a private area that a drone can deliver, the more comfortable they would feel (see Figure 52). Some 68 percent would prefer delivery to their own garden or private space, 67 percent delivery to a station within the neighborhood, 52 percent on walkway in front of the house, 45 percent would like a delivery on the top of the house or to their office. Still 39 percent said they would be satisfied with delivery to a nearby park. The option of delivery to garden was especially popular in Budapest (+16 percent) and Milan (+11 percent) and least popular in Oresund (-13 percent). The option of delivery in front of the house and on the roof of the house were in the midfield – but showed high deviations: The approval was for example higher within the groups of participants aged 25 to 44 (+2 percent for delivery on walkway, +8 percent for delivery on top of house) and families (+7 percent, +6 percent), while it was lower within the older age group aged 55 to 75 (-6 percent, -10 percent) and within the group of singles (-7 percent, -4 percent).

Figure 52: The closer to the house the better is what counts for drone delivery

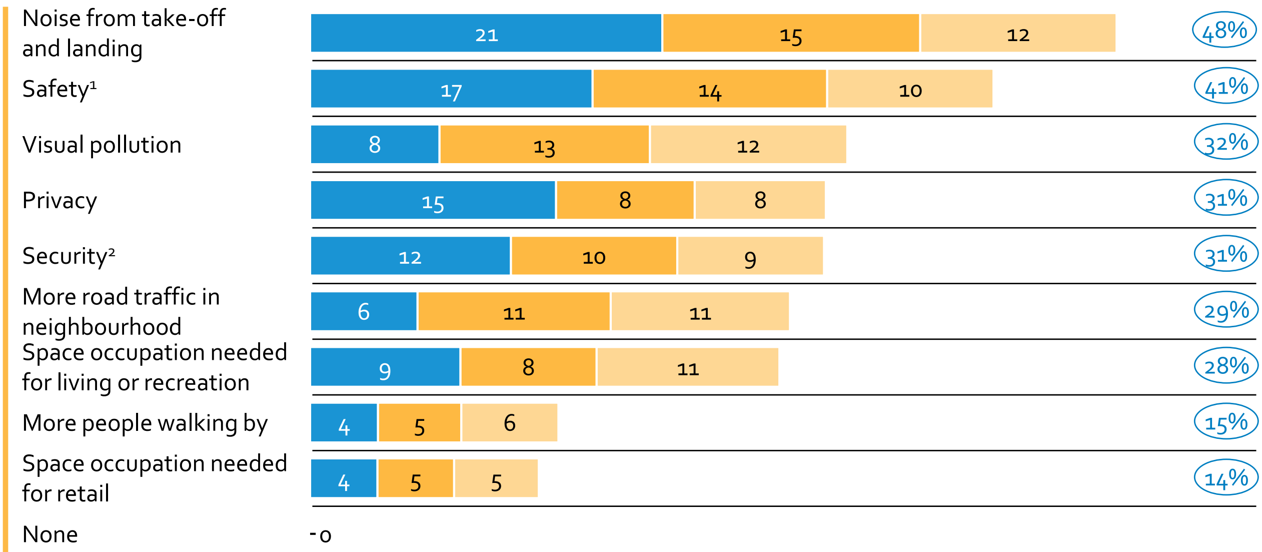


Source: EASA UAM societal acceptance survey question B6. How comfortable would you be with the following modes of drone delivery for medium-sized parcels (max. 120 x 60 x 60 cm, up to 5 kg) at places near your home? Please select one answer in each row.

Infrastructure for air taxis

It is assumed that air taxis will need specific infrastructure on the ground to embark and disembark passengers, as well as to recharge their batteries, as their autonomy will be limited. Assuming that a take-off and landing-station would be close to them, i.e. close to their living or working place (under 50 metres), the respondents to the questionnaire were requested to indicate what they would be most **concerned** about. They replied that (Figure 53), **noise** from take-off and landing (48 percent) and safety (41 percent) are their main concerns. In line with the concerns on drones and air taxis in general, the fear of noise pollution increased with age and education. The third concern mentioned most often for vertiports is on visual pollution (32 percent). Participants also feared that vertiports close to where they are living could negatively influence their privacy (31 percent).

Figure 53: Concerns related to vertiports



1. Incident due to technical or human failure
2. Incident due to deliberate harmful action, e.g. by criminal organization or terrorists

Source: EASA UAM societal acceptance survey questions C11. Assuming that a take-off and landing-station is close by (under 50 metres), what are you most concerned about? Please select up to 6 answers. C12. Please sort your main concerns from 'most concerning' to 'least concerning'.

These results are to put in parallel with the notion of "not in my backyard" regularly expressed during the qualitative interviews. UAM was seen as positive and attractive as long as the impact does not affect specifically and negatively an individual or a group of individuals.

3.2.10 Regulatory authorities: must work together at all levels

As one objective of the study was to support future regulatory work on UAM, participants' expectations towards European, national, regional or local authorities were assessed. The survey polled participants' trust levels towards local, national and European authorities to handle the risks associated with UAM and to adopt adequate regulations (see questions D1 to D3).

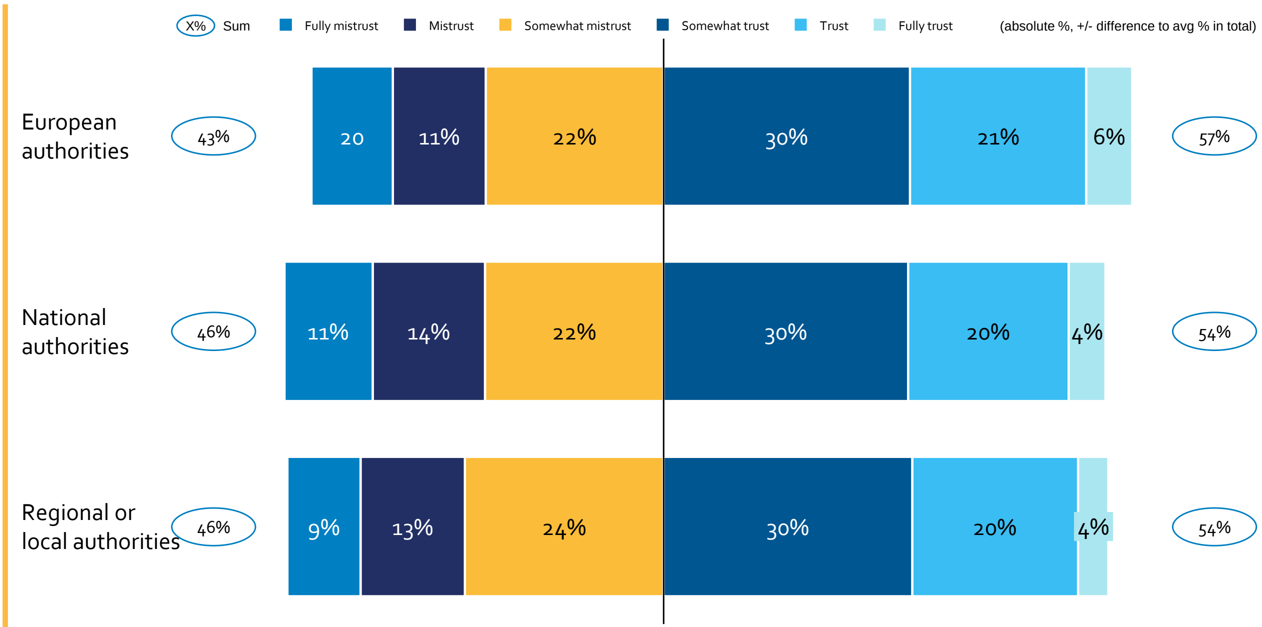
As results in Figure 44 indicate, the participants' trust towards local, national, regional and European authorities came with nearly the same proportion, with a slightly higher level of trust overall towards European regulatory authorities.

A closer look at the results in each of the six cities reveals local differences. As demonstrated by in Figure 55. participants form Budapest, Italy and Spain expressed better trust towards European authorities, while participants from Germany and Oresund trusts better national and local authorities. It is to be noted that respondents from Paris were the most sceptical and express a low trust level towards all authorities, below 50 percent in all cases.

> Public acceptance will most likely increase if authorities on all levels work together. This will also allow to link the UAM operations to the different local conditions.

Qualitative interviews with local stakeholders reinforced this finding. Most of them, except those coming from cities where pilot projects or demonstrators are taking place, had more questions than answers to the interview questions, as UAM is new and information on it has not yet reached the local decision-making level. Many of them are concerned by potentially insufficient information to take informed decisions as

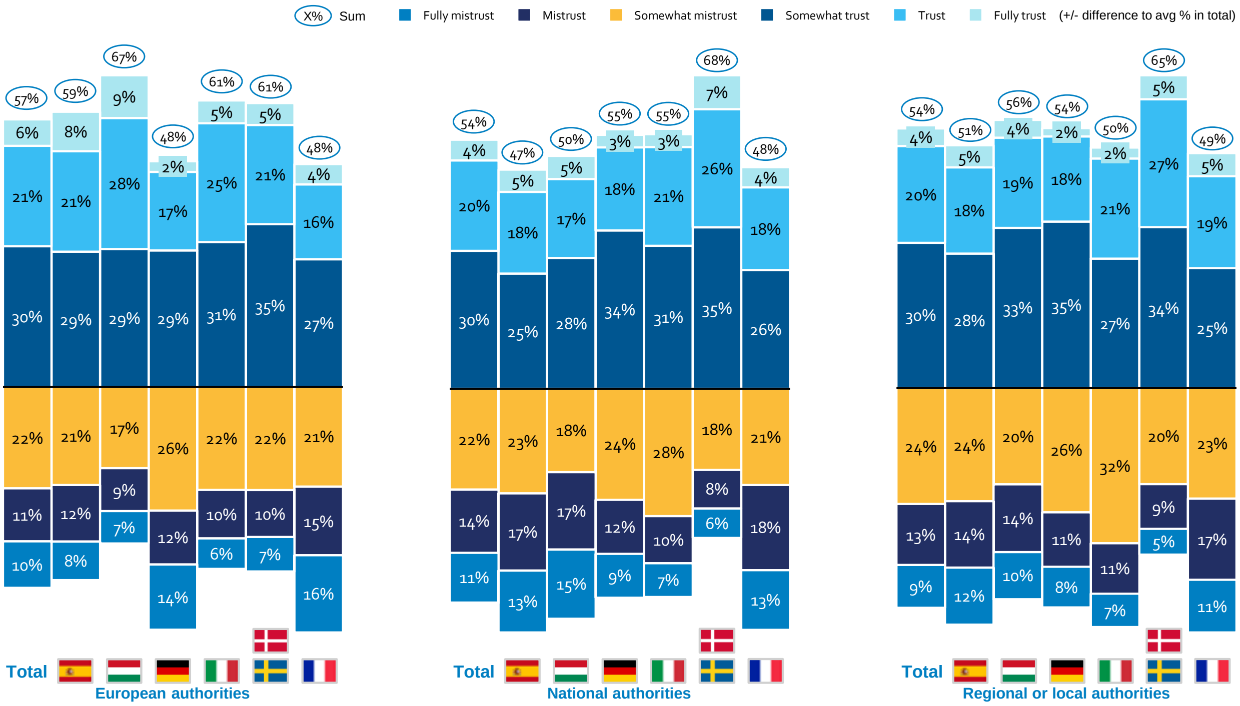
Figure 54: Overall, participants trust European authorities a bit more than national, regional or local ones



Source: EASA UAM societal acceptance survey question D1. To what extent do you trust the following authorities to handle the risks and adopt regulations needed to manage urban air mobility (including safety, noise control, environmental protection, security, cybersecurity, etc.)? Please select one answer per row.

Figure 55: Whom citizens trust most depends on where they come from

Budapest with highest trust in European authorities, Oresund with higher trust in local and national authorities



Source: EASA UAM societal acceptance survey question D1. To what extent do you trust the following authorities to handle the risks and adopt regulations needed to manage urban air mobility (including safety, noise control, environmental protection, security, cybersecurity, etc.)? Please select one answer per row.

well as on insufficient involvement of local authorities in the deployment of UAM locally. They did not see easily how the role of local authorities would be articulated with that of national and European authorities.

Overall, the study highlighted the expectations by respondents and stakeholders that all levels of authorities play a role in the deployment of UAM. The very specific nature of UAM operations, closely linked to the local conditions, needs and constraints can explain this expectation.

4. Expectations and options for action

This chapter considers possible actions and measures that could be taken to address stakeholder concerns and increase social acceptability levels of UAM. Preliminary qualitative assessments of costs and benefits for some measures are considered.

4.1 Citizens' and stakeholders' expectations

The cumulated results of the quantitative survey, qualitative interviews and noise simulation reveal some general trends in public acceptance in the EU.

EU citizens initially and spontaneously expressed a positive attitude toward and interest in UAM, seeing it as a new and attractive means of mobility able to offer faster, cleaner and extended connectivity. However, they also expressed significant concerns. When prompted to reflect upon the concrete consequences of potential UAM operations in their city, EU citizens want to limit their own exposure to risks and expect authorities to pro-actively respond to these concerns.

Public acceptance is a critical success factor of the future deployment of UAM, and it must be secured by a number of preventive actions. Some of these actions fall under the competence of regulatory authorities :

- Address safety, ensuring that UAM has a safety level equivalent to that of current aviation operations for passengers and for people on the ground;
- Ensure local environment protection by less local emissions, less congestion and sufficient protection of wild life;
- Ensure global environmental protection from a life-cycle point of view;
- Ensure birds and insects are not affected by the production of the aircraft and their operations;
- Address UAM noise, ensuring that the level, frequency and duration of the related sounds is kept at acceptable levels, notably when first UAM operations start, as unfamiliar sounds are perceived as more annoying than familiar ones; to this effect, further research should be conducted to confirm the survey results with larger panels;
- Prevent security and cyber security risks, particularly for drones, as manned aircraft are perceived as more secure, probably due to the presence of a pilot onboard;
- Ensure coordinated actions between all authority levels (European, national and local); EU citizens trust them equally and expect all levels to be involved in decision-making. Local authorities expect more information and guidance, and want to be involved at an early stage in the decision-making, concerning the roll out of UAM in their territory. This association will be key for buy-in and acceptance;
- Conduct prior studies, for example measuring local noise and wild-life impact and defining quiet zones and times; this could help reduce affected stakeholders' uncertainty or fear regarding the introduction of UAM;
- Ensure that UAM fits with the notion of "public interest" by making it affordable to all, and integrating it into the local (multimodal) mobility system/network accessible to all;
- Support the deployment of UAM supported by timely, sufficient and transparent information and dialogue with to citizens and local stakeholders groups;
- Encourage demonstration and pilot projects in order to show that UAM can actually work and is safe. Gradually introducing use cases with the highest benefit for the general public, e.g. transporting medical goods with manned eVTOLs could also reinforce societal acceptance;
- Regulate airspace/aviation and aircraft design dimensions carefully. The integration of airspace should also be clarified, as this can provide a framework for the operation of conventional and UAM aircraft in the same airspace, e.g. around airports.

4.2 High level cost-benefit analysis of options

Some of these possible actions, notably the first four, fall at least partly under the competence of the EU regulator, in particular EASA.

A qualitative cost benefit analysis was therefore conducted to assess the options available to act on the safety, security, noise and environment dimensions. The following assessment, which was not the core subject of the study, is provided as a high level indication of the options available to EASA to address these four specific concerns.

Possible safety measures

For safety, two different levels were evaluated: A high safety bar for UAM, similar to the one established in commercial aviation today and a slightly lower safety bar similar to the highest requirements in the automotive industry.

If the high safety bar were adopted for UAM, it could lead to significant higher costs for the business cases of the companies in this field, but it could result in a very low number of injured people and damaged property. This in turn may facilitate a higher societal acceptance of UAM, as can be seen in the results of the survey. Indeed, the societal acceptance increases by 10 percent for the drone delivery use case and 9 percent for air taxi use case, if a safety bar similar to commercial aviation was implemented instead of one similar to the highest automotive one. Among the assessed cost dimensions were extensive redundancy requirements in the UAM system, longer duration of UAM introduction due to extended design and testing periods, as well as shorter intervals between maintenance checks of UAM aircraft and infrastructures. This was then qualitatively assessed to have a high impact on UAM system costs.

For the slightly lower safety bar, the associated increased risk to the population could be unacceptably high, and incidents or accidents could severely hamper the emerging UAM market. From a potential benefits point of view, this approach could offer a faster introduction of UAM services and therefore also provide faster assistance in battling ground-based traffic congestion. The cost impact was assessed as medium, due to a lower redundancy requirement, faster introduction of UAM services, and longer maintenance intervals for UAM aircraft and systems.

However safety is not a dimension where a business trade-off is acceptable in our society. Even a low number of accidents such as seen for autonomous cars can quickly cause a deterioration of public perception, thus the highest standards should be applied to UAM to foster its acceptance.

Possible security measures

In the security domain, possible measures on cyber security, security checks of passengers and counter UAM systems were assessed.

Cyber security should prevent the hacking of UAM communication and therefore avoid the malicious use or control of UAM. This could be done by encrypting the communication signals in the UAM system through hardware and software-based encryption. The cost impact could be medium and would potentially come from securing and monitoring the communications network and/or establishing a private command and control (C2) communication link.

Secondly, security checks of passengers similar to those carried out at airports could reduce the risk of malicious UAM use by the passengers. Equivalent checks could also offer the potential for passengers to directly connect to commercial aircraft at an airport gate. Measures could potentially include scanning of luggage and passengers, as well as limiting the carrying of liquids. The capital expenditure for the security technology, the increased personnel requirements at vertiports, and the potentially reduced competitiveness of UAM from the point of view of passenger time saving were some of the evaluated cost points which could result in a medium to high overall cost impact for UAM.

Finally, counter UAM systems, such as geofencing, might be needed to protect no-go areas from access by UAM. The acquisition and operation of counter UAM systems comes at a cost, but this was assessed to be low for the overall UAM system.

Possible measures on noise

The strength of focus on reducing the noise footprint of UAM will affect the overall cost impact on the UAM system.

The strong focus on reducing the noise footprint could risk significantly impacting the UAM business case due to high aircraft costs, but might bring the benefits of higher societal acceptance. This is indicated by the survey results, where a strong, rather than low, focus on reducing noise footprint increases public acceptance by 11 percent for the drone delivery and air taxi use cases. A strong focus on noise production could include measures like limiting aircraft noise to the level of a car at city speed and limiting the maximum aircraft on flight routes. Limiting the maximum number of aircraft on flight routes could also aid the societal acceptance of visual pollution. This would result in high aircraft costs, but could result in lower operating costs on defined routes due to a lower possible flight altitude and therefore shorter flight time for a set noise footprint on the ground. The overall cost impact of a strong focus on the UAM system could be medium to high.

A low focus on reducing noise footprint could severely reduce societal acceptance, but would make UAM more quickly available and could reduce the aircraft complexity. If the aircraft noise were limited to the level of a leaf blower or an old motorcycle, the aircraft costs could be lower. However, the operating cost might be higher, due to a higher flight altitude in order to achieve a set noise footprint on the ground. There could also be more noise-related complaints or law suits than for the strong focus on the noise footprint. This cumulates in a medium overall UAM system cost impact.

Possible measures on environment

From an environmental point of view two dimensions, wildlife protection and lifecycle sustainability, were each evaluated in a stronger and weaker form.

Strong environmental wildlife protection could help counteract a general reduction in biodiversity by increasing protection of local wildlife, but it could risk an economic impact on the UAM system. Potential measures in this domain could be the establishment of wildlife protection areas with no overflights, the implementation of bird avoidance systems, or specific onboard equipment like lights. This could lead to longer flight routes in order to avoid the wildlife protection areas, and the installation of bird avoidance systems either on the ground or in the UAM aircraft. For the overall UAM system, the implied costs of these potential measures were assessed as medium.

Weaker environmental wildlife protection could help local wildlife by simply establishing protection areas with limited or no overflights. The implied smaller restrictions to flight routes would result in an overall low-cost impact on the overall UAM system.

A high lifecycle sustainability of UAM could reduce the risk of accelerating global warming and might bring create additional jobs in the value chain, while lowering the indirect cost of climate change. Possible measures could for example be a mandate for only using renewable power for the operations of UAM and requiring a recycling rate of more than 90 percent for the UAM aircraft and infrastructure. This could lead to higher costs for aircraft manufacturing and operations of the system, therefore the overall cost impact could be high.

A lower lifecycle sustainability of UAM could still somewhat reduce the risk of accelerating global warming, while maintaining a potentially low UAM system cost impact. A potential measure for this would be a mandate for some use of renewable power for operations and this could result in a lower cost impact for vehicle manufacturing and operations.

5. Conclusions

This comprehensive study is the first of its kind and scope to measure the societal acceptance of UAM in the EU. New modes of transportation rarely appear, a recent example being autonomous cars, and their broad acceptance by society is typically linked to a series of factors. These include the maturity of certain technologies and how they are perceived in terms of threats or benefits by the public. The case of autonomous cars has demonstrated how difficult it is to predict exactly how a technical innovation will be adopted by users and by society in general.

For instance, as it was indeed difficult at this stage to provide real noise simulations or to quantify with certainty the number or frequency of UAM aircraft flying in a given city on a given day, it was also difficult to fully appreciate the annoyance this could cause.

It must therefore be kept in mind that this study has measured the attitude of the EU society towards the UAM at a given moment, i.e. early 2021, well in advance of future deployment in EU cities foreseen around 2024-2025. At this stage, information on UAM has been mostly reserved to specialised press and media and has not really reached the general public. Citizens therefore variously still perceive Urban Air Mobility as “science fiction” or “an exciting new concept”, but have not yet been exposed to actual operations and therefore lack tangible experience and feelings.

Globally, the study results tend to show that Urban Air Mobility concepts and operations benefit from a positive image and could be accepted by EU citizens, who are open to solutions improving the quality of life in the city and offering benefits for the common good. The acceptance would however be subject to respecting a number of guarantees and conditions to ensure that adequate levels of safety, security and environmental protection will be granted and that no citizen will suffer an undue and unbalanced nuisance from UAM.

It is now up to the UAM actors concerned, and in particular the regulatory authorities at all levels, to build on this initial positive premise and take measures to meet citizens’ expectations, so as to ensure that this initial open attitude translates into actual adoption by future users and acceptance from city residents.

For this reason, more specific studies, demonstrations and early implementation projects will likely be necessary as the concept further develops. Further information for the general public and guidance to national and local actors concerned will also be useful.

Appendix

Appendix 1: EASA's UAM enabling activities

Aircraft airworthiness

certification of aircraft that are going to be flying in UAM environment on the basis of special Condition

a. For airworthiness certification for Manned VTOLs for operation in urban environment: SPECIAL CONDITION Vertical Take-Off and Landing (VTOL) Aircraft, Doc.Sc-VTOL-01, issue 1, 2 July 2019 Publication 2nd July 2019 - Special Condition for small-category VTOL aircraft;

b. For airworthiness certification of Light UAs medium risk that can also be operated in an urban environment: Special Condition Light Unmanned Aircraft Systems - Medium Risk, Doc. SC Light-UAS Medium Risk 01, Issue 1, 17 December 2020 Special Condition Light UAS Medium Risk ;

c. Guidelines on Design verification of UAS operated in the 'specific' category and classified in SAIL III and IV, Issue 1, 31 March 2021 Publication 8th April 2021 - Guidelines for the design verification of drones operated in the 'specific' category.

Operations

Launch of the regulatory developments aimed at introducing requirements for pilots/remote pilots/operators of these vehicles, operational requirements for operators, infrastructure such as vertiports, airspace integration aspects.

a. Open and Specific category: ED Decision 2020/022/R of 15 December 2020: Amendment 1 to the Acceptable Means of Compliance and Guidance Material to Commission Implementing Regulation (EU) 2019/947 and to the Annex (Part-UAS) thereto 'AMC and GM to Commission Implementing Regulation (EU) 2019/947 — Issue 1, Amendment 1' 'AMC and GM to Part-UAS — Issue 1, Amendment 1 ED Decision 2020/022/R

b. Certified Category: Terms of reference for rulemaking task RTM.0230; Introduction of a regulatory framework for the operation of unmanned aircraft systems and for Urban Air Mobility in the European Union aviation system, Issue 2 — 04.06.2018; Introduction of a regulatory framework for the operation of unmanned aircraft systems and for Urban Air Mobility in the European Union aviation system, Issue 3 — DD.MM.YYYY (not yet published)

Airspace integration

Adoption by the European Commission of the U-space regulatory package based on EASA technical Opinion (Opinion No 01/2020, High-level regulatory framework for the U-space, 13 March 2020 Publication on 13th March 2020 - Opinion 01/2020).

The U-space regulatory package is due to enter into force in autumn and applicable as from January 2023. The implementation of U-space will enable UAS operations in urban environment in safer and efficient manner and having due regard to other societal acceptance aspects such as environment and privacy and security.

Commission Implementing Regulation, amending Commission Implementing Regulation (EU) 2017/373 as regards requirements for providers of air traffic management/air navigation services and other air traffic management network functions in the U-space airspace designated in controlled airspace (publication expected in Autumn 2021)

In addition, EASA has signed the Manifesto of the UAM initiatives by European cities under the UAM Initiative Cities Community (UIC2) of the EU's Smart Cities Marketplace – formerly known as EIP-SCC Urban Air Mobility (UAM) Initiative 30th May 2018 - European Innovation Partnership in Smart Cities and Communities (EIP-SCC).

Finally, EASA is also engaged in a number of European research and demonstration projects, providing guidance and advice on the regulatory aspects.

Appendix 2

In addition to chapter 2.2 (Target market identification), this chapter holds further information on identification of target markets. It also hols more detailed information on the surveys structure and on the methodology of quantitative survey question types (additions to chapter 3.1.1). Last but not east, the survey questions are attached in this Appendix.

Detailed information on target market identification

As explained in 2.2, for each of the six prioritised sub-use-cases defined in 2.1, the project identified the most attractive EU urban target markets for UAM OEMs and UAM operators from a business perspective. These target markets are likely to see initial deployment of commercial UAM services in the European Union and were therefore deemed to be important candidates for societal acceptance analysis.

The 4-step-methodology, explained in 2.2, led to an identification of 90 potential target markets (15 cities x 6 use cases) for initial OEM introduction.

Results of city selection

The following pages hold additional information to chapter 2.2 on use cases and metrics used to decide for the most relevant cities within the survey.

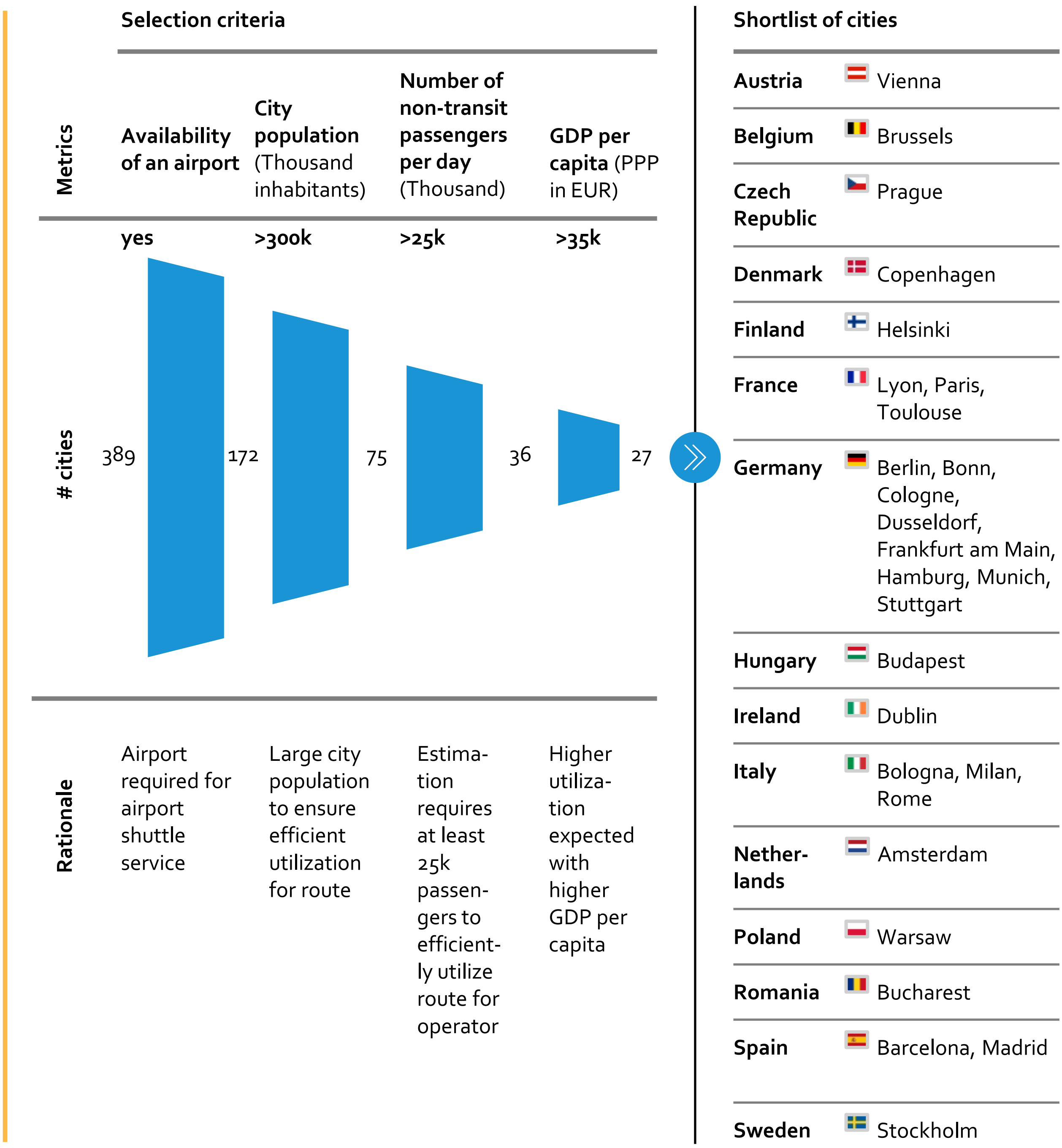
1. City viability for airport shuttle use case

Pre-selection for the airport shuttle use case was based on the following metrics:

- **Availability of an international airport.** An airport is required for an airport shuttle service.
- **Population size.** A large population of minimum 300,000 citizens is needed to ensure sufficient route utilisation.
- **Amount of non-transit passengers travelling between the airport and the city centre.** An estimation of at least 25,000 passengers are required for efficient utilisation of a route from an operator's perspective.
- **GDP per capita level.** Higher route utilisation rates are expected in cities with higher GDP per capita levels.

This led to a shortlist of 27 cities (see Figure 56).

Figure 56: Target cities pre-selection process for the airport shuttle use case



These 27 cities were then ranked through a process based on the following KPIs: city size; expected number of trips; distance between the airport and city centre; travel time between the airport and the city centre with the fastest alternative travel type (e.g. taxi, car, or public transport) in rush hour; congestion rate; taxi cost for the journey to the airport; and suitable weather conditions (percentage of weather causes in total arrival delays, precipitation in mm per year). A weighting factor was assigned to each KPI to indicate how significant that KPI's impact was on the overall ranking score (see Figure 57):

Figure 57: Target cities ranking process for the airport shuttle use case

Ranking of cities based on further KPIs

KPI		Weighting
1 City size		25%
2 Expected trip volumes		25%
3 Distance between airport and city centre	Time saving	25%
4 Travel time between airport and city centre with fastest alternative travel type in the rush hour		
5 Congestion rate		
6 Taxi expenses for ride from airport to city-centre		15%
7 Suitable weather conditions (% of weather causes in total arrival delays, precipitation in mm per year)		10%

City	Country	Ranking (100 = best suitability for UAM)
Paris		88.2
Berlin		78.3
Rome		75.4
Munich		75.3
Madrid		74.8
Budapest		73.8
Prague		72.8
Milan		72.1
Barcelona		71.4
Dublin		70.8
Vienna		70.4
Brussels		67.8
Bucharest		67.4
Warsaw		66.8
Amsterdam		65.6
Stuttgart		63.9
Stockholm		63.0
Hamburg		62.8
Lyon		60.8
Frankfurt am Main		59.9
Bologna		59.8
Bonn		59.6
Helsinki		58.2
Cologne		57.8
Dusseldorf		56.8

The 15 top-ranking cities were further analysed in terms of the infrastructure available for UAM operations: availability of inner-city space for a heliport and availability of a river, motorway or corridor for noise avoidance; availability of mobility options for onward journeys (e-scooter, car-sharing etc.), as Figure 58 shows. All 15 cities passed the infrastructure assessment and entered consideration for final selection as a survey city.

Figure 58: Cities infrastructure assessment for the airport shuttle use case

Pre-selected city	Ranking from previous steps (100 = best suited)	Availability of inner city space for heliport	Availability of river, highway or corridor for noise avoidance	Availability of mobility offer for onward journey (e-scooter, car-sharing, etc.)	Information for timeline assessment
Paris	88.2	✓	✓	✓	Volocopter pilot in 2021
Berlin	78.3	✓	✓	✓	
Rome	75.4	✓	✓	✓	
Munich	75.3	✓	✓	✓	Not feasible until 2025 as distance to airport too long
Madrid	74.8	✓	✓	✓	
Budapest	73.8	✓	✓	✓	
Prague	72.8	✓		✓	
Milan	72.1	✓	✓	✓	Not feasible until 2025 as distance to airport too long
Barcelona	71.4	✓	✓	✓	
Dublin	70.8	✓	✓	✓	
Vienna	70.4	✓	✓	✓	
Brussels	67.8	✓	✓	✓	
Bucharest	67.4	✓	✓	✓	
Warsaw	66.8	✓	✓	✓	
Amsterdam	65.6	✓	✓	✓	

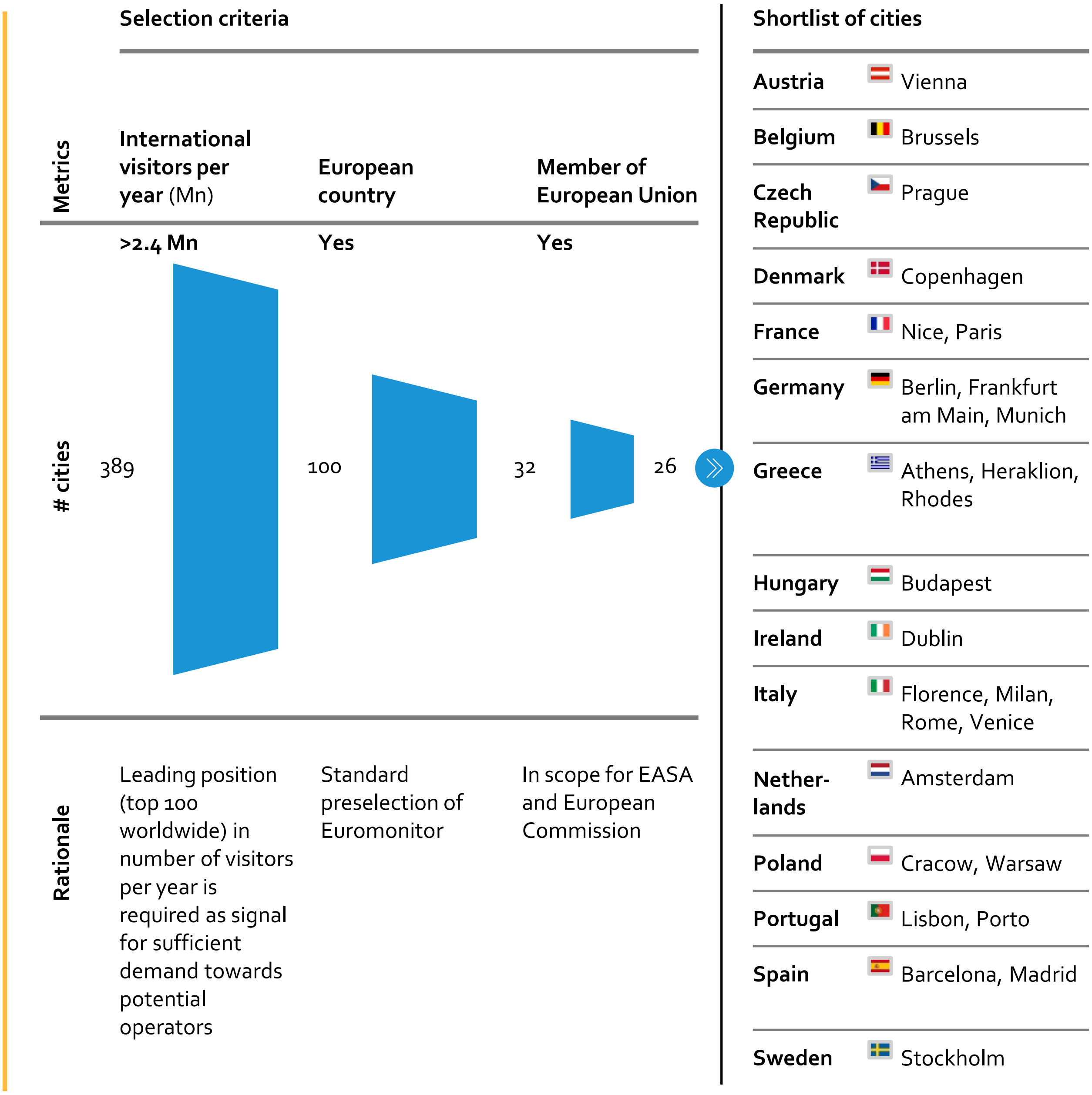
2. City viability for sightseeing use case

Pre-selection for the sightseeing use case was based on the following metrics:

- **Number of international visitors per year.** A leading position in terms of number of visitors per year is required as a signal for sufficient demand for potential UAM operators.
- **EU membership.** Only EU cities were in scope.

From 389 EU cities, 100 were identified as having a large amount of international visitors per year (over 2.4 million), as Figure 59 shows.

Figure 59: Target cities pre-selection process for the sightseeing use case



The 26 pre-selected cities were then ranked in accordance with the following KPIs: addressable market (number of international visitors per year, expenditure on entertainment and sightseeing per visitor and per trip); number of similar tourism offerings in terms of scope (e.g. architectural tour, towers and viewing platforms, helicopter trips) and budget (price over EUR 100) as found on getyourguide.com; suitable weather conditions, measured on the basis of ATFM delays due to bad weather; and attractiveness (e.g. architecture) of city for aerial sightseeing according to expert opinion. A weighting factor was assigned to each KPI to indicate how significant that KPI's impact was on the overall ranking score (see Figure 60):

Figure 60: Target cities ranking process for the sightseeing use case

Ranking of cities based on further KPIs

KPI		Weighting
1 Number of international visitors per year	Addressable market	25%
2 Expenditure for entertainment & sightseeing per visitor and per trip		
3 Number of similar touristic offerings[1]		25%
4 Suitable weather conditions, measured as annual precipitation		25%
5 Attractiveness (e.g., architecture) of city for aerial sightseeing according to expert opinion		25%

City	Country	Ranking (100 = best suitability for UAM)
Paris		93.75
Rome		87.50
Amsterdam		81.25
Venice		81.25
Prague		81.25
Barcelona		81.25
Florence		75.00
Budapest		75.00
Berlin		68.75
Frankfurt am Main		68.75
Stockholm		68.75
Madrid		68.75
Athens		68.75
Nice		62.50
Lisbon		62.50
Vienna		56.25
Warsaw		56.25
Porto		56.25
Cracow		50.00
Munich		43.75
Milan		43.75
Rhodes		43.75
Brussels		37.50
Dublin		37.50
Heraklion		37.50
Copenhagen		31.25

The top-ranking 15 cities were finally analysed in terms of the infrastructure available for UAM operations: availability of space near tourist hotspots (see Figure 61). All 15 cities passed the infrastructure assessment and were selected for the next step.

Figure 61: City infrastructure assessment for the sightseeing use case

City	Country	Ranking from previous steps (100 = best suited)	Availability of space near tourist hotspots
Paris		93.75	✓
Rome		87.50	✓
Amsterdam		81.25	✓
Venice		81.25	✓
Prague		81.25	✓
Barcelona		81.25	✓
Florence		75.00	✓
Budapest		75.00	✓
Berlin		68.75	✓
Frankfurt am Main		68.75	✓
Stockholm		68.75	✓
Madrid		68.75	✓
Athens		68.75	✓
Nice		62.50	✓
Lisbon		62.50	✓

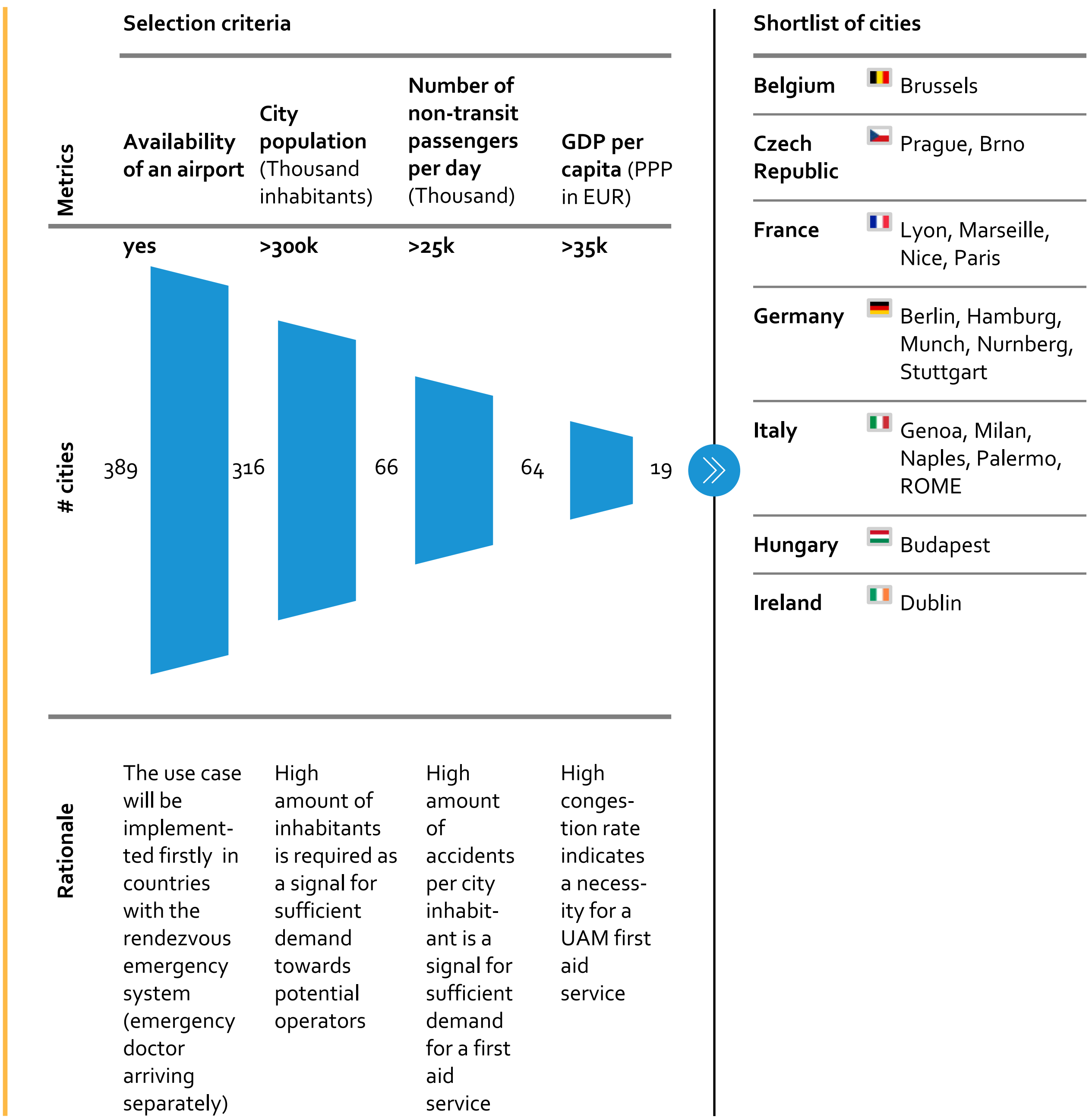
3. City viability for first aid use case

Pre-selection for the first aid use case was based on the following metrics:

- **Availability of an emergency rendezvous system (emergency doctor arriving at an accident location before and separately from an ambulance vehicle).** This sub-use-case is most likely to be firstly implemented in countries with the rendezvous emergency system.
- **City population.** A high number of inhabitants (more than 300,000 citizens) is required as a signal for sufficient demand for potential operators.
- **Accident statistics.** A high number of accidents per city inhabitant is a signal for sufficient demand for a first aid service.
- **Congestion rate.** A high congestion rate indicates the added value of UAM first aid service.

From a long list of 389 EU cities, 316 were identified as being in countries that have a rendezvous emergency system, and 66 of these were further selected as having a large population (over 300,000 citizens). In the next step 64 of the 66 were identified as having a high number of accidents per city inhabitant (more than 1 accident/1,000 inhabitants). In the last step 19 of these 64 cities, which have a high congestion rate (over 30 percent), were pre-selected for the ranking process (see Figure 62).

Figure 62: Target cities pre-selection process for the first aid use case



The 19 pre-selected cities were ranked in accordance with the following KPIs: number of accidents per 1,000 inhabitants and number of hospitals per 100,000 inhabitants. A weighting factor was assigned to each KPI to indicate how significant that KPI's impact was on the overall ranking score (see Figure 63). Cities with the highest number of accidents and lowest number of hospitals obtained the highest ranking score.

Figure 63: Target cities ranking process for the first aid use case

Ranking of cities based on further KPIs

KPI		Weighting
1	Number of accidents per 1K inhabitants	50%
2	Number of hospitals per 100K inhabitants	50%

City	Country	Ranking (100 = best suitability for UAM)
Paris		83,3
Berlin		75
Hamburg		75
Lyon		66,7
Marseille		66,7
Nice		66,7
Genova		62,5
Prague		62,5
Brno		62,5
Budapest		62,5
Nurnberg		58,3
Stuttgart		58,3
Milan		45,8
Rome		45,8
Dublin		45,8
München		45,8
Brussels		45,8
Napoli		45,8
Palermo		45,8

The 15 top-ranking cities were analysed in terms of the infrastructure available for UAM operations: availability of inner-city space for a heliport and availability of a river, motorway or corridor for noise avoidance (see Figure 64). All 15 cities passed the infrastructure assessment and were selected for the next step.

Figure 64: Cities infrastructure assessment for the first aid use case

Metropolitan area	Ranking from previous steps (100 = best suited)	Availability of innercity space for heliport	Availability of river, highway or corridor for noise avoidance
Paris	83,3	✓	✓
Berlin	75	✓	✓
Hamburg	75	✓	✓
Lyon	66,7	✓	✓
Marseille	66,7	✓	✓
Nice	66,7	✓	✓
Genova	62,5	✓	✓
Prague	62,5	✓	✓
Brno	62,5	✓	✓
Budapest	62,5	✓	✓
Nurnberg	58,3	✓	✓
Stuttgart	58,3	✓	✓
Milano	45,8	✓	✓
Roma	45,8	✓	✓
Dublin	45,8	✓	✓
München	45,8	✓	✓

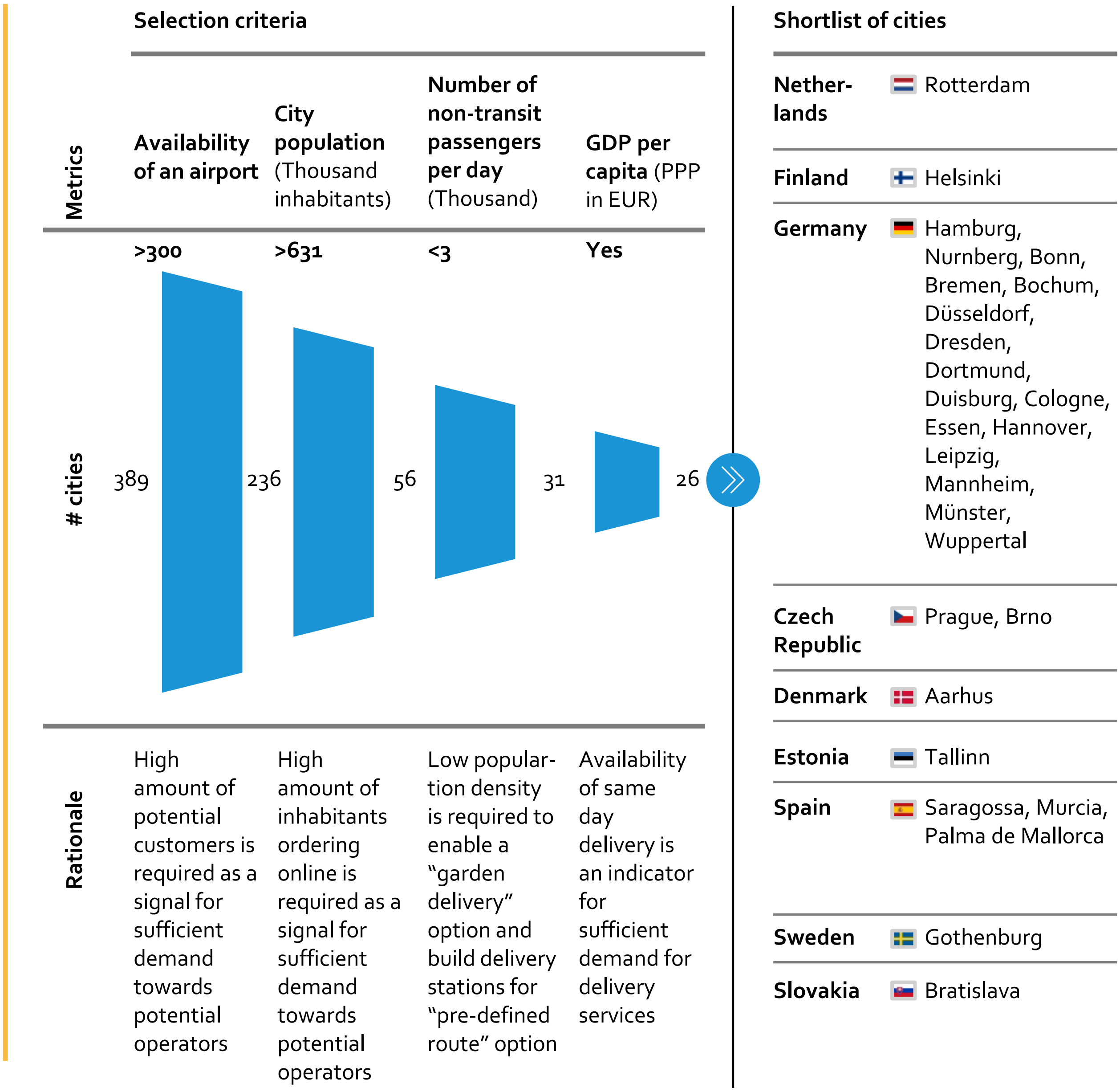
4. City viability for Last-mile delivery

Pre-selection for the last-mile delivery use case was based on the following metrics:

- **City population.** A high number of potential customers is required as a signal for sufficient demand for potential operators.
- **Percentage of online ordering.** A high number of inhabitants ordering online is required as a signal for sufficient demand for potential operators.
- **Population density.** Low population density is required to enable a 'garden delivery' option and build delivery stations for a 'pre-defined route' option.
- **Availability of same day delivery.** Availability of same day delivery is an indicator for sufficient demand for delivery services in the city.

From a long list of 389 EU cities, 236 were identified as having a large population (over 300,000 citizens). 56 of these were further selected as having a high percentage of online ordering (over 63 percent, which is the average percentage of online ordering in the EU). In the next step, 31 of these 56 cities were identified as having low population density (less than 3,000 inhabitants/km2). In the last step, 26 of these 31 cities that have a same day delivery option were pre-selected (see Figure 65).

Figure 65: Target cities pre-selection process for the last-mile use case



7.4.2 The 26 pre-selected cities were then ranked in accordance with the following KPIs: number of food delivery app downloads per inhabitant, availability of Amazon delivery centres in the city and average congestion rate per city. A weighting factor was assigned to each KPI to indicate how significant that KPI's impact was on the overall ranking score (see Figure 66).

Figure 66: Target cities ranking process for the last-mile delivery use case

Ranking of cities based on further KPIs

KPI	Weighting
1 Number of food delivery app downloads per inhabitant	35%
2 Availability of amazon delivery centres in the city	35%
3 Average congestion per city	30%

City	Country	Ranking (100 = best suitability for UAM)	City	Country	Ranking (100 = best suitability for UAM)
Rotterdam		73,3	Aarhus		50
Hamburg		73,3	Nuremberg		50
Helsinki		69,2	Duisburg		50
Tallinn		69,2	Bremen		50
Bonn		69,2	Mannheim		50
Hanover		65,8	Münster (Westphalia)		50
Cologne		61,7	Brno		45,8
Dortmund		61,7	Bochum		42,5
Dresden		61,7	Wuppertal		42,5
Dusseldorf		61,7	Saragossa		42,5
Essen		61,7	Palma de Mallorca		38,3
Leipzig		61,7	Gothenburg		30,8
Bratislava		57,5			
Prague		50			
Murcia		50			

7.4.3 The top-ranking 15 cities were analysed in terms of the infrastructure available for UAM operations: availability of inner-city space for a heliport and availability of a river, motorway or corridor for noise avoidance (see Figure 67). All 15 cities passed the infrastructure assessment and were selected for the next step.

Figure 67: Cities infrastructure assessment for the last-mile delivery use case

Metropolitan area	Ranking from previous steps (100 = best suited)	Availability of innercity space for heliport	Availability of river, highway or corridor for noise avoidance
Rotterdam	73,3	✓	✓
Hamburg	73,3	✓	✓
Helsinki	69,2	✓	✓
Tallinn	69,2	✓	✓
Bonn	69,2	✓	✓
Hanover	65,8	✓	✓
Cologne	61,7	✓	✓
Dortmund	61,7	✓	✓
Dresden	61,7	✓	✓
Dusseldorf	61,7	✓	✓
Essen	61,7	✓	✓
Leipzig	61,7	✓	✓
Bratislava	57,5	✓	✓
Prague	50	✓	✓
Murcia	50	✓	✓

5. City viability for Medical supply delivery

Pre-selection for the medical supply delivery use case was based on the following metrics:

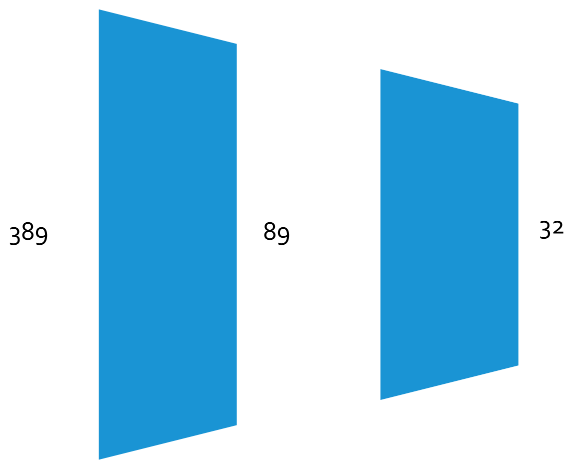
- **City population.** A high number of inhabitants is required as a signal for sufficient demand for potential operators.
- **Congestion rate.** A high congestion rate indicates the need for UAM medical supply services.

From a long list of 389 EU cities, 89 were identified as having a large population (over 300,000 citizens); from these 32 were further selected as cities with a high congestion rate (over 30 percent), as Figure 68 shows.

Figure 68: Target cities pre-selection process for the medical supply delivery use case

Selection criteria

Metrics	Cities population (Thousand)	Congestion rate (%)
# cities	>300	>30%
Rationale	High amount of inhabitants is required as a signal for sufficient demand towards potential operators	High congestion rate indicates a necessity for UAM medical supply services



Shortlist of cities

Belgium	Brussels
Czech Republic	Prague, Brno
France	Lyon, Marseille, Nice, Paris
Germany	Berlin, Hamburg, Munich, Nurnberg, Stuttgart
Hungary	Budapest
Italy	Genoa, Milan, Naples, Palermo, Rome
Bulgaria	Sofia
Poland	Cracow, Poznan, Szczecin, Warsaw, Wroslaw, Gdansk
Estonia	Tallinn
Greece	Athens, Thessaloniki
Ireland	Dublin
Lithuania	Vilnius
Portugal	Lisbon
Romania	Bucharest
Slovakia	Bratislava
Croatia	Zagreb

The ranking process for the 32 pre-selected cities was based on the following KPIs: number of hospitals per 1,000 inhabitants and average congestion rate. A weighting factor was assigned to each KPI to indicate how significant that KPI's impact was on the overall ranking score (see Figure 69). Cities with the lowest density of hospitals and highest congestion rate obtained the highest ranking.

Figure 69: Target cities ranking process for the medical supply delivery use case

Ranking of cities based on further KPIs

KPI		Weighting
1	Low number of hospitals per 1K inhabitants	50%
2	High average congestion rate	50%

City	Country	Ranking (100 = best suitability for UAM)
Cracow		100
Wroclaw		90
Bucharest		85
Warsaw		85
Poznan		85
Sofia		75
Budapest		75
Bratislava		75
Dublin		70
Prague		70
Vilnius		65
Hamburg		65
Berlin		65
Gdansk		65
Paris		60

The 15 top-ranking cities were analysed in terms of the infrastructure available for UAM operations: availability of inner-city space for a heliport and availability of a river, motorway or corridor for noise avoidance (see Figure 70). All 15 cities passed the infrastructure assessment and were selected for the next step.

Figure 70: Cities infrastructure assessment for the medical supply delivery use case

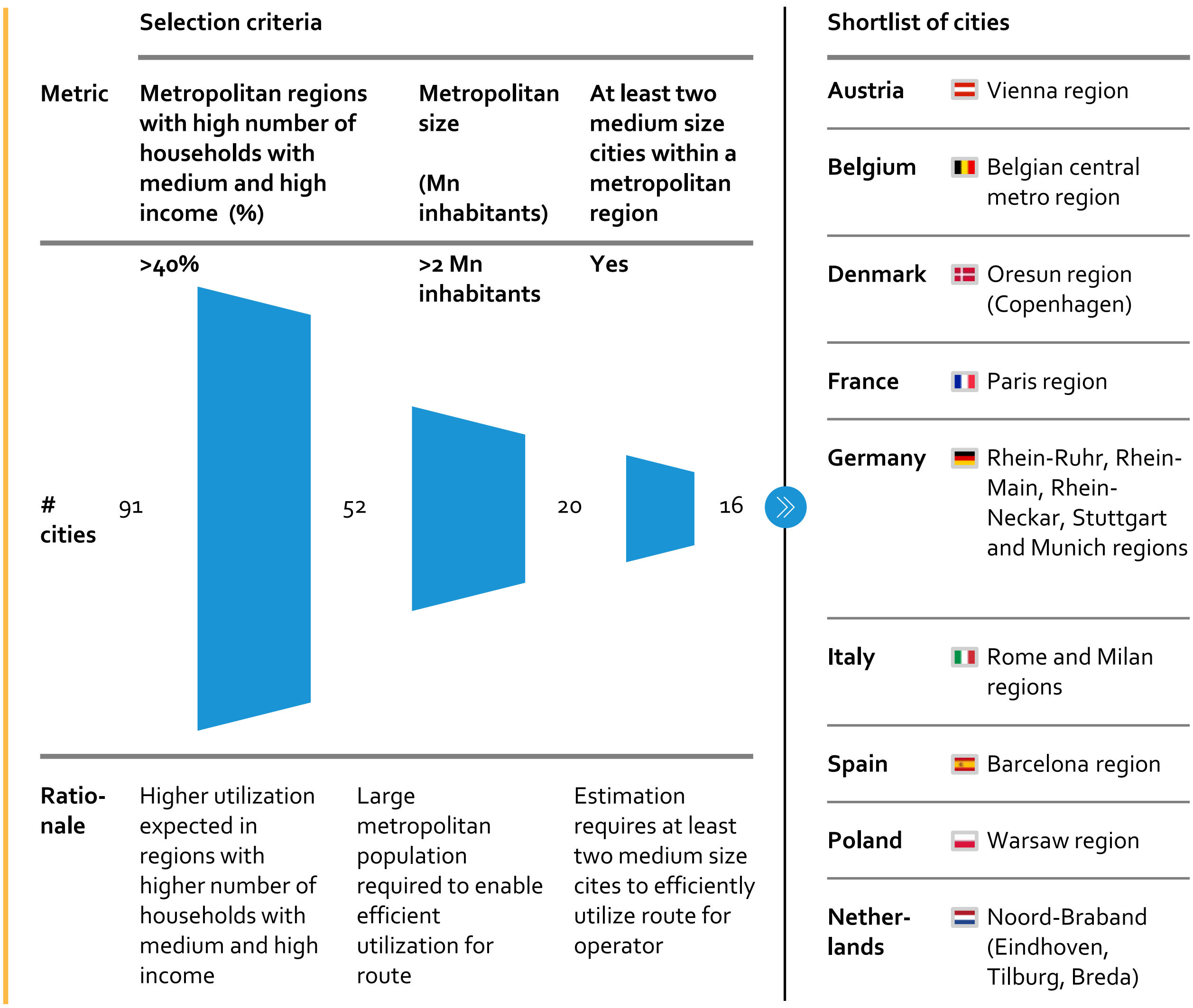
Metropolitan area	Ranking from previous steps (100 = best suited)	Availability of innercity space for heliport	Availability of river, highway or corridor for noise avoidance
Paris	83,3	✓	✓
Berlin	75	✓	✓
Hamburg	75	✓	✓
Lyon	66,7	✓	✓
Marseille	66,7	✓	✓
Nice	66,7	✓	✓
Genova	62,5	✓	✓
Prague	62,5	✓	✓
Budapest	62,5	✓	✓
Nurnberg	58,3	✓	✓
Stuttgart	58,3	✓	✓
Milano	45,8	✓	✓
Roma	45,8	✓	✓
Dublin	45,8	✓	✓
München	45,8	✓	✓

6. City viability for fixed metropolitan/regional network

Pre-selection for the metropolitan use case was based on the following metrics:

- **Number of medium- and high-income households.** Higher utilisation is expected in regions with a higher number of medium- and high-income households.
- **Metropolitan size.** The metropolitan/regional network would connect large and medium-size cities of a same region, within a single Member State or cross border; A large metropolitan/regional population is required to enable efficient route utilisation (i.e. minimum 2 million citizens).
- **Availability of at least two medium-size cities within a metropolitan area.** At least two medium-size cites are required to ensure sufficient route utilisation.

Figure 71: Target cities pre-selection process for the fixed metropolitan network use case



From 91 EU metropolitan areas, 52 were identified as having a high number of medium (over EUR 25,000) and high (over EUR 60,000) annual income households, and 20 of these were further selected as regions with a large population (over 2 million inhabitants). In the last step, 16 of these 20 metropolitan areas had at least two medium-size cities and were pre-selected (see Figure 71).

7.6.2 The 16 pre-selected metropolitan areas were ranked in accordance with the following KPIs: metropolitan size; distance between cities; time saved when travelling with UAM instead of the fastest alternative method (train, taxi, airport shuttle bus); GDP per capita; concentration of destination points within a metropolitan area; and suitable weather conditions (percentage of weather causes in total arrival delays, precipitation in mm per year). A weighting factor was assigned to each KPI to indicate how significant that KPI's impact was on the overall ranking score (see Figure 72).

Figure 72: Target cities ranking process for the metropolitan network use case

Ranking of cities based on further KPIs

KPI	Weighting
1 Metropolitan size	25%
2 Distance between the cities	25%
3 Time saving when traveling with UAM instead of fastest alternative source (train, taxi, airport shuttle bus)	25%
4 GDP per capita	10%
5 Concentration of destination points with one metropolitan region	10%
6 Suitable weather conditions (% of weather causes in total arrival delays, precipitation in mm per year)	5%

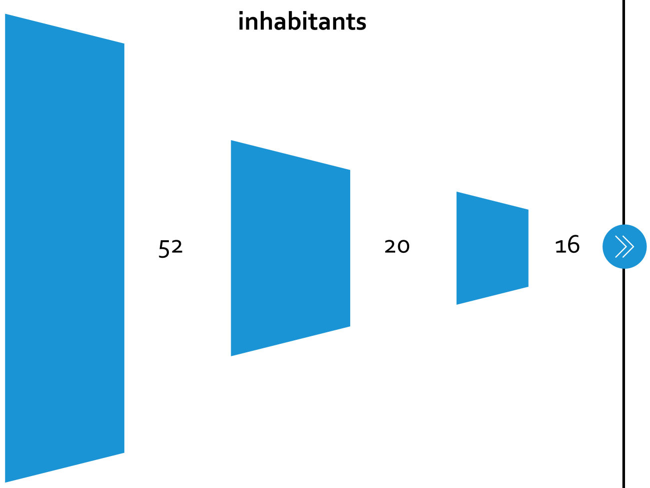
Metropolitan area	Example route	Ranking (100 = best suitability for UAM)
Belgian central metro	Brussels-Leuven	79.6
Rhein-Ruhr	Cologne-Bonn	79.2
Rome region	Rome-Ostia	78.8
Milan region	Milan-Monza	75.8
Barcelona region	Barcelona-Mataro	73.8
Rhein-Neckar	Mannheim-Heidelberg	73.8
Stuttgart region	Stuttgart-Reutlingen	72.5
Oresund	Copenhagen-Hillerod	68.3
Munich region	Munich-Heidelberg	62.9
Vienna regions	Vienna-Baden	59.2
Paris region	Paris-Chantilly	58.8
Rhein-Main	Frankfurt-Aschaffenburg	58.8

The 15 top-ranking cities were analysed in terms of the infrastructure available for UAM operations: availability of inner-city space for a heliport and availability of a river, motorway or corridor for noise avoidance; availability of mobility options for onward journeys (e-scooter, car-sharing etc.) (see Figure 73). All 15 metropolitan areas passed the infrastructure assessment and were selected for the next step.

Figure 73: Cities infrastructure assessment for the fixed metropolitan network use case

Selection criteria

Metric	Metropolitan regions with high number of households with medium and high income (%)	Metropolitan size (Mn inhabitants)	At least two medium size cities within a metropolitan region
	>40%	>2 Mn inhabitants	Yes
# cities: 91	52	20	16
Ratio-nale	Higher utilization expected in regions with higher number of households with medium and high income	Large metropolitan population required to enable efficient utilization for route	Estimation requires at least two medium size cites to efficiently utilize route for operator



Shortlist of cities

Austria	Vienna region
Belgium	Belgian central metro region
Denmark	Oresun region (Copenhagen)
France	Paris region
Germany	Rhein-Ruhr, Rhein-Main, Rhein-Neckar, Stuttgart and Munich regions
Italy	Rome and Milan regions
Spain	Barcelona region
Poland	Warsaw region
Nether-lands	Noord-Braband (Eindhoven, Tilburg, Breda)

Selection of the six cities or regions for the survey

The top 15 cities or regions across the discussed city selection use cases and the guiding principles were the basis for the selection of the six cities or regions, where the survey was to be conducted. The final selection of the survey cities was made during a meeting with the Executive Director of EASA and contained the cities of Barcelona, Budapest, Hamburg, Milan, and Paris, as well as the Øresund region between Denmark and Sweden.

Detailed information on questionnaire structure

The questionnaire was designed to assess, understand and measure the most important societal acceptance drivers for UAM, including perceived benefits and concerns and what it takes to increase societal acceptance. The questionnaire included 36 questions; the response time being estimated at twenty-five minutes.

Complementing the general attitude towards various use cases and the relative importance of them, two overarching use cases that are easy to imagine and self-explanatory for non-experts were identified in the quantitative survey to determine the levels of acceptance: the delivery of goods by drone and the transport of passengers by air taxi. An in-depth analysis was conducted to measure the relative acceptance levels of three key concerns, identified through the literature review: of safety, noise and visual annoyance in an urban environment, possibly tinted by cultural differences. Finally, the questionnaire addressed the general attitude and expectations of respondents towards regulatory authorities. For an English version of the questionnaire that was distributed online to the participants, please refer to the Appendix.

Part 1: Screener
Part 1 of the survey ensured that participants meet the predefined criteria (see the predefined quotas above). An informational video of 1 minute and 36 seconds was presented to ensure the participants' prior information as well as general and common understanding of UAM. The use cases shown in the video were passenger transport by air taxi, express delivery of food by drone, transport of emergency medical services to the scene of an accident, and delivery of medical supplies to a hospital. The selection aimed for a balanced representation of commercial and public service use cases, drone and passenger use cases, as well as use cases with a pilot on-board and remotely piloted. The vehicles depicted in the video were invented and did not correspond to any industrial product existing or in development. The objective was to give a general feeling and idea, rather than to reflect actual technical accuracy. The video concluded with the message that Urban Air Mobility is coming soon to Europe. The video did not include any sound other than music, as noise perception was evaluated in a separate survey.

Subsequently, this section checked whether participants fell into one of the pre-selected potential user groups, i.e. delivery of goods by drone and/or transport of passengers by air taxi.

Part 2: General attitude towards UAM
In a first step, participants' affinity to make use of new technologies was assessed. This was intended to help understand their attitude towards innovation. Participants were then asked to rank the usefulness of fourteen UAM use cases. In this way, the use cases considered the most important for the population could be identified. Participants were also given an overview of several conceivable use cases that go beyond those shown in the video.

In a second stage, participants were asked to evaluate the most important overarching perceived benefits and opportunities (not use-case specific) that UAM could entail. In addition, an open question invited them to name further positive aspects that did not appear in the survey and may not have been covered by the literature so far.

Part 3: Delivery by drone
To ensure participants did not mix responses for different types of vehicles (drones and air taxis), questions on drones were asked first, before questions on air taxis were asked separately in Part 4.

In a first step, participants' propensity to make use of current express delivery options was assessed. This was intended to help classify their views on the potential usefulness of express delivery options by drones. In a second step, they were asked to rank the most important perceived benefits of goods delivery by drones.

The core element of this section was the investigation into the public's concerns for this type of use-case. In general, questions were phrased in such a way to understand the relative importance of concerns among the population – whereas an absolute question such as 'How important is security to you?' would have led to a potential selection providing little to no insight ('Everything is important'). The concerns were measured through six groups of questions.

- The first question addressed participants' basic comfort level with the idea of unmanned air taxis. Air taxis pose a potential safety threat not only to the passengers using them, but also to pedestrians on the ground. As pedestrians will be affected by air taxis despite not necessarily choosing to use air taxis themselves, the hypothesis was that the perceived safety of pedestrians will have a significant impact on the societal acceptance of air taxi operations.
- In a second question, participants were asked to rank the most important concerns, in their view, regarding the operation of air taxis in an urban environment. This list of concerns was derived from the literature review.
- The third question was a deep dive into safety, noise and visual annoyance concerns using a conjoint analysis. The question aimed to determine which levels of these issues came within an acceptable range for a broad population.
- In the fourth question, environmental concerns were compared to determine their relative importance among the population.
- A sixth group of questions addressed affordability, privacy, job losses, allocation of inner-city space to take-off and landing stations, and security threats for local residents. These were intended to elicit the participants' expectations and fears, both rational and irrational.
- Lastly, participants were asked to rank the most important concerns, in their view, related to take-off and landing stations ('vertiports').

Part 4: Passenger transport (air taxi)

Part 4 was structured analogously to Part 3 and the same methodology and reasoning applied for most questions. Only in some points adjustments were made to fit the use case. In a first step, participants' travel habits were evaluated to assess their general propensity to fly.

- The first question was on how often they travel by aeroplane for personal or business reasons in a typical year.
- The second question asked them how they typically get to and from the airport. This was intended to help classify their openness to try out air taxis, specifically to airports.
- Next, they were asked to rank the most important perceived benefits of passenger transport by air taxi.
- The next set of questions were designed to measure concerns. First, participants were asked to rank different statements that people might make about air taxis. Four statements for ranking were given to identify the participants' basic comfort level with the idea of unmanned air taxis – for both passengers and pedestrians.

Air taxis pose a potential safety threat not only to the passengers using them, but also to pedestrians on the ground. As pedestrians will be affected by air taxis despite not necessarily choosing to use air taxis themselves, the hypothesis was that the perceived safety of pedestrians will have a significant impact on the societal acceptance of air taxi operations.

- With the fifth question, participants were asked to choose their most important concerns.
- After that, in the sixth question they were ask to rank the most important concerns, in their view, regarding the

operation of air taxis in an urban environment. This list of concerns was derived from the literature review.

- Participants were then asked to imagine themselves in three different situations in 2030, involving air taxis. Participants were then asked to choose their preferred option out of the alternatives.
- This was followed by rating given scenarios in terms of their acceptance.

After this, there was a deep dive into safety, noise and visual annoyance concerns using a conjoint analysis. The question aimed to determine which levels of these issues were deemed within an acceptable range for a broad population.

- Next, environmental concerns were compared to determine their relative importance among the population.
- Separate questions on affordability, privacy, job losses, allocation of inner-city space to take-off and landing stations, and security threats for local residents were designed to elicit the participants' expectations and fears, both rational and irrational.
- Another question on vertiports helped to understand how pleased participants would feel to have a take-off station close by.
- Lastly, participants are asked to rank their most important concerns related to take-off and landing stations.

Part 5: Regulators and their role

As the study was commissioned by EASA, for future regulatory work, participants' attitudes towards European, national, regional or local authorities deserved special focus.

- Therefore, the survey polled participants' trust levels in the aforementioned authorities to adopt regulations and to handle the risks associated with UAM.

Part 6: Further understanding of security and environmental aspects

In order to find out more on environmental and cybersecurity concerns, the survey also polled participants' trust levels in the security and cyber security of drones and air taxis.

- First, participants were asked to what extent they trust that advanced aircraft flying in an urban environment will be technologically secure and armed against threats from hackers.
- Secondly, participants were asked whether and to what extent their trust level would increase with measures and regulations to manage cyber security risks. They were asked to compare authorities.
- Furthermore, the desirability of an ecolabel for UAM was assessed. This question was visually illustrated by a sample ecolabel.

Part 7: Additional demographic questions

Before the end of the survey, a few additional demographic questions were asked, such as the number of people living in the participant's household, their level of education, total gross household income and current occupation in order to be able to assess potential differences in the respondents' groups.

Methodological basis of survey question types

Different types of questions are suitable for different objectives and the choice of question type should be guided by the aim of the question. Multiple-selection, rating as well as forced-ranking questions were used. In the following, the rationales behind each are described briefly.

Multiple-select questions

Multiple-select questions allow survey participants to choose one or more answers from a set of provided options. The order of the options may be randomised to avoid bias, as survey respondents have a tendency to choose options positioned higher on the list. The advantage of this question type is that it gives participants the freedom to select several options and not feel restricted in their answers. Question A4 (see next Appendix section) is an example of this question type, when participants are asked to pick their top three personal benefits related to UAM.

For example, it is suitable for enquiring about participants' motivations for an attitude or decision. When evaluating the survey responses, the relative frequency of mentions of each option can be compared and their importance assessed.

A slight restriction can be imposed by introducing an upper limit on the number of choices that participants may select. This forces participants to prioritise. The number of mentions of an answer among the top three, for example, can thus be evaluated.

A special case is single-punch questions, where only one answer can be selected. These are suitable for asking about extremes (e.g. 'What is your top priority?') or when options are mutually exclusive (yes or no).

Rating questions

Rating questions allow participants to weigh answers or statements via grades or numerical scales. They are often used when participants are asked about their level of approval or acceptance.

The grades can be transferred into a numerical evaluation via a Likert scale, which allows, for example, the comparison of approval rates for different statements or population batches such as age or gender groups.

An example of this question type is Question B6 (see next Appendix section). Here, the level of comfort with different drop-off locations for drone parcel delivery is queried to ultimately understand which option leads to the highest possible approval rate across the population.

Forced-ranking questions

Forced ranking questions enable participants to compare items and to rank them according to their preference. Again, the items may be randomised to avoid bias for higher-positioned answers.

The advantage of this question type is that participants consciously sort the items and indicate each item's relative personal importance; whereas in multiple-select questions, items are either important or unimportant, and in rating questions, items can be assigned the same absolute grade. Therefore, this type of question helps make relative differences visible, providing critical insights into participants' individual preferences and the preferences of the panel overall. In this way, within a set of important issues, the most important ones can be identified. An example of this question type is Question B9 (see next Appendix section), where the aim is to get to know the most critical environmental concerns for respondents among an overall set of key environmental concerns.

A special approach was taken in Questions B4 to B5 (see next Appendix section). Since forced-ranking questions are only suitable for a limited number of items (six to seven items is considered the upper bound, as the process becomes confusing beyond that), a combination of multiple-select questions followed by forced-ranking questions was chosen In this way, participants had the opportunity to pre-select the concerns that they considered most important, before being asked to give a relative assessment for this subset. This way, the important concerns are separated from the unimportant ones, and the especially important ones are then ranked.

A similar approach was taken in Questions A2 to A3 (see next Appendix section). First, participants are asked to select the most useful use cases, in their view, in each of the following categories: delivery, medical emergency transport and passenger transport. In order to make the usefulness comparable across the categories, the top two from each category are transferred to Question A3 and are then subject to forced ranking. In this way, the most useful use cases are identified, and conclusions can be drawn about the categories that are perceived as fundamentally useful.

Detailed information on methodology of quantitative survey question types and questionnaire

Different types of questions are suitable for different objectives and the choice of question type should be guided by the aim of the question. Multiple-selection, rating as well as forced-ranking questions were used. For more details on the question types used, see Appendix.

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A1. Affinity to new technologies

A1. Frequency of usage of new technologies, such as mobility services

In a typical year, how often do you use the following technologies and services? Please consider a typical year, for instance 2019, before the Covid-19 pandemic started. Please select one answer in each row.

Technology or service	Never used and not interested	Have not used yet, but would consider it	A few times a year	6 to 10 times a year	Once a month	Every 2 weeks	Every week or more often
1. Car rental, e.g. Sixt, Europcar, Avis	○	○	○	○	○	○	○
2. Ride hailing, i.e. ordering a car similar to a cab via a mobile app, such as Free Now, Uber, Bolt, it Taxi, Uber, Cabify, Moove, Viggo[1]	○	○	○	○	○	○	○
3. Car sharing, e.g. Share Now, Miles, Cambio, getaround, Ubeeqo, enjoy, letsgo, GreenMobility, GreenGo, MOL Limo[1]	○	○	○	○	○	○	○
4. Ride sharing (i.e. sharing a taxi or similar with other people taking a similar route), e.g. UberPool, Moia[1]	○	○	○	○	○	○	○
5. (E-)bikes, (e-)scooters or electric kick scooters from sharing providers, such as Lime, Tier, emmy, Cityscoot, Dott, GoVolt, Bird, Vaimoo, MOL bubi, ogre&co[1]	○	○	○	○	○	○	○
6. Online booking or booking via app of mobility tickets, e.g. for trains, flights, buses, other public transport	○	○	○	○	○	○	○
7. Video conferencing, e.g. Zoom, Microsoft Teams, Skype	○	○	○	○	○	○	○
8. Drones, e.g. for photos, videos or recreation	○	○	○	○	○	○	○
9. Flat fee or subscription model for the delivery of online orders (of groceries, consumer electronics, apparel, etc.), such as Amazon Prime, OTTO UP, Zalando Plus, Cdiscount à volonté, Fnac+, PcComponentes Premium[1]	○	○	○	○	○	○	○

1. Only relevant providers in respective cities are shown

B1. Express delivery

B1. Frequency of usage of express delivery services

In a typical year, how often do you shop online for yourself or your family (such as for food, beverages, daily supplies, consumer electronics, fashion and apparel) and use express delivery for your purchases? Please consider a typical year, for instance, 2019, before the Covid-19 pandemic started.

Never used and not interested	Have not used yet, but would consider it	A few times a year	6 to 10 times a year	Once a month	Every 2 weeks	Every week or more often
○	○	○	○	○	○	○

C1 & C2. Flight habits

C1. Frequency of travelling by aeroplane

In a typical year, how often do you travel by aeroplane for personal or business reasons? Please consider a typical year, for instance 2019, before the Covid-19 pandemic started. Please select one answer.

Not at all	1-2 times a year	3-5 times a year	6-10 times a year	Every month or more often
○	○	○	○	○

C2. Mode of transport to airport

When travelling by aeroplane, how do you typically get to and from the airport from your home and vice versa? Please select all that apply.

- ☐ By foot, own (e-)bike, or own (e-)scooter
- ☐ By (e-)bike or (e-)scooter from a sharing provider, such as Lime, Tier, emmy, CityScoot, Dott, GoVolt, Bird, Vaimoo, MOL bubi, ogre&co[1]
- ☐ Private vehicle, such as a car or motorbike
- ☐ Taxi or equivalent provider, such as Free Now, Uber, Bolt, it Taxi, Cabify, Moove, Viggo[1]
- ☐ Carsharing, such as Share Now, Miles, Cambio, getaround, Ubeeqo, enjoy, letsgo, GreenMobility, MOL Limo, GreenGo[1]
- ☐ Ridesharing, such as Uber Pool or Moia or other local rideshare option[1]
- ☐ Public transport, such as bus, metro, or train
- ☐ Other, please specify: ______________________________

1. Only relevant providers in respective cities are shown

S5. General attitude towards urban air mobility

S5. Rating of perception from very negative to very positive

What would be your overall perception if urban air mobility solutions (such as those shown in the video[1]) were to be introduced in your city? Please select one answer.

negative	rather negative	rather positive	very positive
○	○	○	○

1. To inform participants about urban air mobility, a video of length 1:34 minutes was shown prior to this question, showcasing the use cases passenger transport by air taxi (pointing out to the existence of manned and unmanned VTOLs), parcel delivery via drone (more precisely, instant food delivery), transport of emergency medical personnel to site of an accident, and delivery of medical supply to a hospital

S6.S7. Likelihood to try out urban air mobility services

S6. Likelihood to try out drone delivery

How likely are you to make use of delivery of goods by drone (i.e., delivery of parcels from an online shopping platform to a nearby delivery hub, your garden or private property or a publicly accessible area), if it were offered in your city? Please assume that delivery by drone would cost about double today's standard shipping fees and ensured guaranteed delivery within 2 hours from the time you place your order.

negative	rather negative	rather positive	very positive
○	○	○	○

S7. Likelihood to try out air taxis

How likely would you be to use an air taxi (i.e., a flying vehicle that transports passengers from A to B) for a 25-50% higher price than current road passenger transport options like conventional (road) taxis or Uber-like offerings, if you assume the trip could be made in half the time in the air taxi?

negative	rather negative	rather positive	very positive
○	○	○	○

A3.A2. Perceived usefulness of urban air mobility use cases, among and across categories

A2.a Ranking of use cases in category drone delivery

Which of the below delivery use cases would you consider the most useful? Please sort the following applications from 1 being 'most useful' to 4 being 'least useful' or select 'none of these are useful'.[1]

- ◇ Drone delivery of goods in an urban area, for instance, from my preferred online shopping portal or site
- ◇ Drone delivery of meals in an urban area, for instance, from my preferred restaurant or food delivery site
- ◇ Grocery and goods delivery to my home or workplace in areas with long travel times to the next shop (i.e., in the countryside or not well connected with public transport)
- ◇ Long-distance forwarding of heavy cargo, for instance, to places with little infrastructure such as islands or drilling rigs
- ☐ None of these are useful

A2.b Ranking of use cases in category medical emergency

Which of the below medical emergency use cases would you consider the most useful in an urban environment? Please sort the following applications from 1 being 'most useful' to 5 being 'least useful' or select 'none of these are useful'.[1]

- ◇ Drone delivery of medical supplies (such as blood donations, organs, medical equipment) to a hospital
- ◇ Drone delivery of medical supplies for personal need (such as pens for auto-injection of a vital substance, defibrillators and medications) from a central hub to a place not far from your home such as your own garden or a nearby park
- ◇ Disaster management using drones (such as drones with thermal cameras to evaluate fire incidents, drones equipped with firefighting foams and extinguisher bombs)
- ◇ Emergency medical service to transfer an injured person to a nearby hospital
- ◇ Emergency medical service to bring doctors or first aid personnel to the scene of an accident
- ☐ None of these are useful

A2.c Ranking of use cases in category passenger transport

Which of the below passenger transport use cases for urban air mobility would you consider the most useful? Please sort the following applications from 1 being 'most useful' to 5 being 'least useful' or select 'none of these are useful'.[1]

- ◇ Sightseeing by air in a city or region
- ◇ Air taxi, for instance, to get from the city centre to the local airport and vice versa
- ◇ Air taxi, for instance, to commute from a suburban area to the city centre
- ◇ Air taxi to travel from one point in the city to another
- ◇ Regional air mobility, for instance, from one city to another small city in the same region (like from Copenhagen to Malmö[2])
- ☐ None of these are useful

A3. Cross-category ranking of top 2 use cases from categories[3]

And which of the below use cases (that you previously selected as the most useful in their categories) are the most useful overall? Please sort the following applications from 'most useful' to 'least useful' or select 'none of these are useful'.[1]

- ◇ <If not none, #1 ranked option from A2.a is displayed>
- ◇ <If not none, #2 ranked option from A2.a is displayed>
- ◇ <If not none, #1 ranked option from A2.b is displayed>
- ◇ <If not none, #2 ranked option from A2.b is displayed>
- ◇ <If not none, #1 ranked option from A2.c is displayed>
- ◇ <If not none, #2 ranked option from A2.c is displayed>

[4]

1. Example of regional air mobility only shown in Öresund, as only supra-urban area where survey was conducted 2. Answers were shuffled to avoid biases towards options with higher position 3. If "None of these are useful" was selected in all three A2 questions, A3 is skipped 4. No "None" option in A3, as participant must have selected an option he conceived as useful in some A2 question, otherwise see 3.

B6. Level of comfort with drop-off locations for drone delivery

B6. Selection of level of comfort with drop-off locations for drone delivery

How comfortable would you be with the following modes of drone delivery for medium-sized parcels (max. 120 x 60 x 60 cm, up to 5 kg) at places near your home? Please select one answer in each row

	very uncomfortable	uncomfortable	somewhat uncomfortable	somewhat comfortable	comfortable	very comfortable
A. Over the walkway in front of my house or main door of my block of flats (publicly accessible)	○	○	○	○	○	○
B. In my garden or other private area (not publicly accessible)	○	○	○	○	○	○
C. On the roof of my house/block of flats or office	○	○	○	○	○	○
D. In a nearby park	○	○	○	○	○	○
E. Central delivery station in my neighbourhood, such as a petrol station, supermarket or a postal service station	○	○	○	○	○	○

A4 & A5. Benefits incurred by UAM

A4. Selection of up to 3 benefits incurred by UAM

What benefits and opportunities can the development of urban air mobility bring for the EU and EU citizens? Please select up to 3 answers.

- [ ] Improved development of and access to remote areas (for instance, the countryside, regions outside of a metropolitan area)
- [ ] Creation of new jobs and growth opportunities for people in my country (for instance, manufacturing, research and development, pilot projects)
- [ ] Market-leading position of Europe in urban air mobility technology (such as drones, air taxis)
- [ ] Reduction of traffic jams
- [ ] Reduction of local emissions and pollution (most of the vehicles will have battery electric propulsion)
- [ ] Reduced response time for emergencies
- [ ] None of these are useful

A5. Further positive benefits mentioned by survey participants

What other benefits and opportunities can the development of urban air mobility bring for EU citizens? Please add up to 3 ideas in the below text boxes.[1,2]

- [ ] ______________________
- [ ] ______________________
- [ ] ______________________

1. Three free text fields were shown to survey participants
2. The evaluation of free text boxes in question A5. did not show other significant benefits; an example can be found in respective evaluation for Paris

B2. Benefits of drone delivery

B2. Selection of up to 3 benefits incurred by drone delivery

What benefits and opportunities can the development of urban air mobility bring for the EU and EU citizens? Please select up to 3 answers.

- ☐ Faster delivery
- ☐ Exact time window for delivery
- ☐ Higher reliability
- ☐ Fewer interactions with other people (i.e. for better hygiene standards, especially during/after the pandemic)
- ☐ Less-congested streets (i.e. due to fewer delivery vehicles parked on the street)
- ☐ Less-congested city centres due to fewer people out shopping
- ☐ Less pollution due to electric propulsion
- ☐ None of these are useful

C3. Benefits of air taxis

C3. Ranking of benefits incurred by passenger transport with air taxis

In your view, what are the main benefits of air taxis? Please sort the following benefits from the 1 being the 'most useful' to 7 or 8[1] being the 'least useful' or select 'none of these are useful'.

◇ Significant time saving for passengers

◇ Comfortable continuation of travel after arrival at an airport station to my personal accommodation

◇ Reduction of traffic jams

◇ Less noise for inner-city residents due to emergency medical services taking an aerial route

◇ Ability to connect and access remote areas (areas with current poor access to city centres)

◇ The feeling of behaving in a modern way, being an early adopter

◇ Creation of new jobs in running air taxi services

◇ Other, please specify: ____________________________[2]

☐ None of these are useful

1. Number of options is 8 if participants opts for filling the free text field
2. The evaluation of free text boxes did not show other significant benefits

B3. Level of comfort with unmanned delivery drones

B3. Perception of safety with unmanned delivery drones

Drones intended for the delivery of goods are remotely piloted aircraft systems with no pilots on board. Assume that they have an average wingspan of 3 metres, would fly at between 120 and 150 metres altitude, and are certified by competent authorities. Please rate how much you agree or disagree with the following statement.

	strongly disagree	disagree	somewhat disagree	somewhat agree	agree	strongly agree
As a pedestrian on the ground, I would feel safe with unmanned delivery drones potentially flying above me.	○	○	○	○	○	○

C4. Level of comfort with manned & unmanned air taxis for passengers & pedestrians

C4. Level of comfort with air taxis by level of autonomy (present versus absent) and degree of interaction (active versus passive)

Recent studies extend the prospect of aircraft soon transporting passengers, either with a pilot on board or with a remote pilot. You will now see several statements that people might make about such air taxis. Assuming that all of the aircraft are certified by competent authorities, please rate how much you agree or disagree with each statement for each type of air taxi.

	strongly disagree	disagree	somewhat disagree	somewhat agree	agree	strongly agree
I would be interested in trying out the following vehicles myself:						
A. Manned air taxi (meaning with a human pilot on board steering the aircraft)	○	○	○	○	○	○
B. Unmanned air taxi (meaning no human pilot is on board to steer the aircraft)	○	○	○	○	○	○
As a pedestrian (not as a passenger), I am okay with accept the fact that the following vehicles could fly above my head						
C. Manned air taxi (meaning with a human pilot on board steering the aircraft)	○	○	○	○	○	○
D. Unmanned air taxi (meaning no human pilot is on board to steer the aircraft)	○	○	○	○	○	○

B4.B5. Absolute and relative importance of general concerns in drone delivery use case

B4. Selection of up to 6 concerns

What are you most concerned about regarding drone delivery, both for the delivery of day-to-day goods as well as medical supplies? Please consider your own usage of such a service as well as other people using it (e.g. your family or neighbours), which may affect you as well. Please select up to 6 answers.[1]

- ☐ Noise pollution, such as loud and/or annoying sounds
- ☐ Visual pollution, such as annoying air traffic
- ☐ Safety concerns, such as drones crashing
- ☐ Concerns regarding local environment, such as air pollution, negative impact on bird life and insects, or decreasing biodiver sity in general
- ☐ Global environmental concerns, such as negative impact on climate change
- ☐ Job losses, for instance within local delivery companies
- ☐ Security threats, for instance, criminal organizations (for ransom), hacktivists, or terrorists hacking into the control system and hijacking or misdirecting drones
- ☐ Privacy concerns, for instance, a drone flying close to my window or over my property
- ☐ Affordability, i.e. the service being affordable only for rich or privileged people
- ☐ Other, please specify: _______________[2]
- ☐ None of these

B5. Ranking of previously selected concerns

Please sort your main concerns from 'most concerning' to 'least concerning'.[3]

- ◇ <Concern chosen in B4 is displayed, if at least 1 was chosen>
- ◇ <Concern chosen in B4 is displayed, if at least 2 were chosen>
- ◇ <Concern chosen in B4 is displayed, if at least 3 were chosen>
- ◇ <Concern chosen in B4 is displayed, if at least 4 were chosen>
- ◇ <Concern chosen in B4 is displayed, if at least 5 were chosen>
- ◇ <Concern chosen in B4 is displayed, if 6 were chosen>

1. Answers were shuffled to eliminate bias related to positioning
2. Evaluation did not lead to significant other concern.
3. Only options chosen in B4 prompted in B5; if "None of these" was chosen in B4, question B5 is skipped

C5.C6. Absolute and relative importance of general concerns in air taxi use case

C5. Selection of up to 6 concerns

What are you most concerned about with respect to air taxis? Please consider your own usage of such a service as well as other people using it (e.g. your family or neighbours), which may affect you as well. Please select up to 6 answers.[1]

- ☐ Noise pollution, such as loud and/or annoying sounds of flying aircraft
- ☐ Visual pollution, such as annoying air traffic
- ☐ Safety concerns, such as flying vehicles possibly crashing
- ☐ Concerns regarding the local environment, such as air pollution, negative impact on bird life and insects, or decreasing biodiversity in general
- ☐ Global environmental concerns, such as negative impact on climate change
- ☐ Job loss, for instance affecting taxi drivers
- ☐ Security threats, for instance, criminal organizations (for ransom), hacktivists, or terrorists hacking into the control system and hijacking or misdirecting the air taxi
- ☐ Privacy concerns, for instance, an air taxi flying close to my window or over my property
- ☐ Affordability, i.e. the service being affordable only for rich or privileged people
- ☐ Inner-city space occupation due to infrastructure requirements (take-off and landing stations)
- ☐ Additional traffic from/to take-off stations
- ☐ Noise related to the operation of take-off stations
- ☐ Downwash, i.e. downward wind generated by the rotors of air taxis when flying or in hover mode
- ☐ Squandering of public money to finance new infrastructure and air taxi technology, instead of improving existing public transport and infrastructure like roads and rail
- ☐ Flight shame (i.e. my social reputation would suffer as a result of using air taxis)
- ☐ Other, please specify: ________________[2]
- ☐ None of these

C6. Ranking of previously selected concerns

Please sort your main concerns from 'most concerning' to 'least concerning'.[3,4]

- ◇ <Concern chosen in C5 is displayed, if at least 1 was chosen>
- ◇ <Concern chosen in C5 is displayed, if at least 2 were chosen>
- ◇ <Concern chosen in C5 is displayed, if at least 3 were chosen>
- ◇ <Concern chosen in C5 is displayed, if at least 4 were chosen>
- ◇ <Concern chosen in C5 is displayed, if at least 5 were chosen>
- ◇ <Concern chosen in C5 is displayed, if at least 6 were chosen>

1. Answers were shuffled to eliminate bias related to positioning 2. Evaluation did not lead to significant other concern 3. Only options chosen in B4 prompted in B5; if "None of these" was chosen in B4, question B5 is skipped
4. "Other" option in B5 contains text input from B4, if filled by participant

C11.C12. Concerns regarding take-off and landing stations

C11. Selection of up to 6 concerns

Assuming that a take-off and landing-station is close by (under 50 metres), what are you most concerned about? Please select up to 6 answers.[1]

- ☐ Noise originating from the take-off and landing manoeuvres of air taxis
- ☐ Increased number of people walking by
- ☐ Increased road traffic to and from the take-off and landing station
- ☐ Visual pollution, i.e. too many aerial vehicles in my field of view, for instance, when I look out of my window
- ☐ Breach of my privacy
- ☐ Increased security threats (such as terrorists hijacking an air taxi and letting it crash on purpose)
- ☐ Safety issues (fear of an increased number of air taxis crashing)
- ☐ Take-off stations taking up space needed for retail
- ☐ Take-off stations taking up space otherwise available for living or recreation, such as parks
- ☐ Other, please specify: ______________[2]
- ☐ None of these

C12. Ranking of previously selected concerns

Please sort your **main concerns** from 'most concerning' to 'least concerning'.[3,4]

- ◇ <Concern chosen in C11 is displayed, if at least 1 was chosen>
- ◇ <Concern chosen in C11 is displayed, if at least 2 were chosen>
- ◇ <Concern chosen in C11 is displayed, if at least 2 were chosen>
- ◇ <Concern chosen in C11 is displayed, if at least 2 were chosen>
- ◇ <Concern chosen in C11 is displayed, if at least 2 were chosen>
- ◇ <Concern chosen in C11 is displayed, if 6 were chosen>

1. Answers were shuffled to eliminate bias related to positioning 2. Evaluation did not lead to significant other concern 3. Only options chosen in C11 prompted in C12; if "None of these" was chosen in B4, question B5 is skipped
4. "Other" option in C12 contains text input from B4, if filled by participant

B9. Environmental concerns regarding delivery drones

B9. Ranking of 7 environmental concerns potentially incurred by delivery drones

What are your greatest concerns when it comes to the possible environmental consequences of drone delivery? Please sort the following answers from 1 being 'most concerning' to 7 being 'least concerning' or select 'none of these'.

- Air pollution
- Noise pollution, for example, regular exposure to elevated sound levels that potentially have adverse effects on humans or other living organisms
- Negative impact on bird life, insects and other flying animals
- High environmental and climate impact from drone operation, including power generation (e.g. electricity)
- High environmental and climate impact from the manufacturing of drones, including battery production
- High environmental impact from the disposal of drones
- Sealed surfaces, for example, covering soil with materials like concrete and stone, e.g. for take-off and landing pads, potentially reducing natural soil and ecosystem function in the area concerned

☐ None of these

C9. Environmental concerns regarding air taxis

C9. Ranking of 7 environmental concerns potentially incurred by air taxis

What are your greatest **concerns** when it comes to the possible **environmental consequences** of air taxis? Please sort the following answers from 1 being 'most concerning' to 7 being 'least concerning' or select 'none of these'.

◇ Air pollution

◇ Noise pollution, for example, regular exposure to elevated sound levels that potentially have adverse effects on humans or other living organisms

◇ Negative impact on bird life, insects and other flying animals

◇ High environmental and climate impact from air taxi operation, including power generation (e.g. electricity)

◇ High environmental and climate impact from the manufacturing of air taxis, including battery production

◇ High environmental impact from the disposal of air taxis

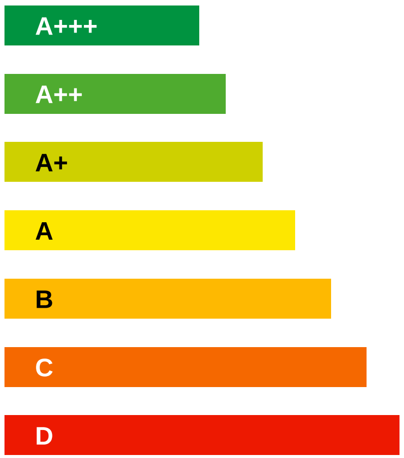
◇ Sealed surfaces, for example, covering soil with materials like concrete and stone, e.g. for take-off and landing pads, potentially reducing natural soil and ecosystem function in the area concerned

☐ None of these

D4. Introduction of an eco-label

D4. Opinion on certification of environmental impact of UAM

Should the environmental impact of urban air mobility operations be evaluated by the authorities and made public, e.g., via an eco-label such as the one shown below? Please select one answer.



Yes, certainly	May, not sure	No
○	○	○

B7.B8. Trading off concerns safety, noise and visual pollution regarding drone delivery

B7. Relative importance of attributes safety, noise and visual pollution in conjoint style question

Put yourself in the year 2030: drones with about 3-metre wingspans, certified by competent authorities, are flying at altitudes of up to 150 metres. In the following section, you will be asked which scenario out of three alternatives is most acceptable from your perspective. Please choose your most preferred option out of the three alternatives shown.[1]

Example choice card[2]	Alternative 1	Alternative 2	Alternative 3
Safety	One drone has the same likelihood of hitting a pedestrian as one car	One drone has 1/100th the likelihood of hitting a pedestrian as one car	One drone has 1/100th the likelihood of hitting a pedestrian as one car
Noise	One drone is as loud as a truck driving by at city speed (~82 dB, disturbing)	One drone is as loud as a bicycle riding by at city speed (~57 dB, barely noticeable)	One drone is as loud as a car driving by at city speed (~65 dB, noticeable)
Visual pollution	~10 drones per hour in one's field of view when walking down a street	20+ drones per hour in one's field of view when walking down a street	~5 drones per hour in one's field of view when walking down a street
	○	○	○

B8. Absolute acceptance of best case and worst case alternatives for delivery drone

Again, put yourself in the year 2030. How acceptable would you find the following scenarios for the future? Please rate each scenario based on the scale shown below.

	Very unacceptable	Unacceptable	Somewhat unacceptable	Somewhat unacceptable	Acceptable	Very acceptable
A. Urban air mobility where 1) the chance of a delivery drone crashing onto a pedestrian is 1/100th that of a car hitting a pedestrian, 2) drones flying by have a similar noise level as bicycles passing by at city speed, and 3) one or two drones pass by per hour	○	○	○	○	○	○
B. Urban air mobility where 1) the chance of a delivery drone crashing onto a pedestrian is 5 times higher than that of a car hitting a pedestrian, 2) drones flying by have a similar noise level as a leaf blower, and 3) more than 20 drones pass by per hour	○	○	○	○	○	○

1. 8 trade-offs per participant to be made
2. Other possible levels for safety, noise ad visual pollution on following slides

C7.C8. Trading off concerns safety, noise and visual pollution regarding air taxis

C7. Relative importance of attributes safety, noise and visual pollution in conjoint style question

Put yourself in the year 2030: air taxis with wingspans of up to 12 metres, certified by competent authorities, are flying at altitudes of about 150 metres. In the following section, you will be asked which scenario out of three alternatives is most acceptable from your perspective. Please choose your most preferred option out of the three alternatives shown.[1]

Example choice card[2]	Alternative 1	Alternative 2	Alternative 3
Safety	An air taxi is as safe for passengers and pedestrians as a car (i.e., ~2 fatalities per billion passenger km)	An air taxi is as safe for passengers and pedestrians as a commercial aircraft (i.e., ~0.01 fatalities per billion passenger km)	An air taxi is as safe for passengers and pedestrians as a bus (i.e., ~0.05 fatalities per billion passenger km)
Noise	An air taxi is as loud as a car driving by at city speed (~65 dB, noticeable)	An air taxi is as loud as a bicycle driving by at city speed (~57 dB, barely noticeable)	An air taxi is as loud as a truck driving by at city speed (~82 dB, disturbing)
Visual pollution	~10 air taxis per hour in one's field of view when walking down a street	20+ air taxis per hour in one's field of view when walking down a street	~5 air taxis per hour in one's field of view when walking down a street
	○	○	○

C8. Absolute acceptance of best case and worst case alternatives for delivery drone

Again, put yourself in the year 2030. How acceptable would you find the following scenarios for the future? Please rate each scenario, based on the scale shown below.

	Very unacceptable	Unacceptable	Somewhat unacceptable	Somewhat unacceptable	Acceptable	Very acceptable
A. Urban air mobility where 1) the safety standard for air taxis is similar to the safety standard of commercial aircraft for passengers and pedestrians (highest safety standard), 2) air taxis flying by have a similar noise level as bicycles passing by at city speeds, and 3) one or two air taxis pass by per hour	○	○	○	○	○	○
B. Urban air mobility where 1) the risk posed by air taxis for passengers and pedestrians is comparable to that of motorcycles, 2) air taxis flying by have a similar noise level as leaf blowers, and 3) more than 20 air taxis pass by per hour	○	○	○	○	○	○

1. 8 trade-offs per participant to be made
2. Other possible levels for safety, noise ad visual pollution on following slides

B10. Negative assumptions about drone delivery

B10. Agreement with statements about drone delivery potentially leading to poor acceptance

To what extent do you agree with the following statements about drone delivery? Please rate how much you agree or disagree with each of the following statements

	Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree
A. I suspect that I would find extra fees for express delivery by drone much too expensive.	○	○	○	○	○	○
B. I would be afraid that drones could massively invade my privacy, for instance, by spying through my window and recording my personal life.	○	○	○	○	○	○
C. I would be afraid that the use of drones for the delivery of goods would significantly reduce the number of jobs, e.g. for parcel delivery personnel.	○	○	○	○	○	○
D. I would be afraid that the drones could be misused and become a security threat.	○	○	○	○	○	○

Source: EASA UAM social acceptance survey questions C5. What are you most concerned about with respect to air taxis? Please consider your own usage of such a service as well as other people using it (e.g. your family or neighbours), which may affect you as well. Please select up to 6 answers. C6. Please sort your main concerns from 'most concerning' to 'least concerning'

C10. Negative assumptions about air taxis & vertiports

C10. Agreement with statements about air taxis potentially leading to poor acceptance

To what extent do you agree with the following statements about aerial vehicles? Please rate how much you agree or disagree with each of the following statements.

	strongly disagree	disagree	somewhat disagree	somewhat agree	agree	strongly agree
A. I suspect that taking an air taxi is much too expensive for me personally.	○	○	○	○	○	○
B. I suspect that only rich people will be able to afford taking air taxis.	○	○	○	○	○	○
C. As a resident of the city, I would be afraid that air taxis or their passengers could massively invade my privacy when flying over my house/flat, for instance, by spying through my window and recording my personal life.	○	○	○	○	○	○
D. I am afraid that the introduction of air taxis significantly reduces the number of jobs, affecting, for instance, taxi drivers.	○	○	○	○	○	○

C10. Negative assumptions about air taxis & vertiports

C10. Agreement with statements about vertiports potentially leading to poor acceptance

To what extent do you agree with the following statements about aerial vehicles? Please rate how much you agree or disagree with each of the following statements.

	strongly disagree	disagree	somewhat disagree	somewhat agree	agree	strongly agree
E. Take-off and landing stations for air taxis operated by only one provider (comparable to airports for a single airline or docks for a single ferry line) would hamper competition and are therefore extremely unfair from a societal perspective.	◯	◯	◯	◯	◯	◯
F. I consider the allocation of inner-city space for take-off and landing stations of aerial vehicles as completely unfair or unnecessary.	◯	◯	◯	◯	◯	◯
G. I would feel comfortable living close to a take-off station for aerial vehicles, for instance, within a range of 50 metres.	◯	◯	◯	◯	◯	◯

D2. Trust in VTOL security

D2. Level of trust in security systems of drones and air taxis

To what extent do you trust that advanced aircraft flying in an urban environment will be technologically secure and armed against threats from hackers (such as criminal organisations, hacktivists or terrorists) in the following cases? Please select one answer per row.

Security	**Fully mistrust**	**Mistrust**	**Somewhat mistrust**	**Somewhat trust**	**Trust**	**Fully trust**
A. Drones (such as delivery drones)	○	○	○	○	○	○
B. Air taxis	○	○	○	○	○	○

D1. Trust in regulatory authorities

D1. Level of trust in regulatory authorities by level by area of influence

To what extent do you trust the following authorities to handle the risks and adopt regulations needed to manage urban air mobility (including safety, noise control, environmental protection, security, cybersecurity, etc.)? Please select one answer per row.

Security	Fully mistrust	Mistrust	Somewhat mistrust	Somewhat trust	Trust	Fully trust
A. European authorities	○	○	○	○	○	○
B. National authorities	○	○	○	○	○	○
C. Regional or local authorities	○	○	○	○	○	○

D3. Impact of regulation on trust

D3. Direction and dimension of impact from regulatory measures on trust levels

Would your trust increase if the following regulators were to develop regulations to manage cybersecurity risks (certification and operation of aerial vehicles)? Please select one answer per row.

Trust	Decrease a lot	Decrease slightly	Stay the same	Increase slightly	Increase	Increase a lot
A. European authorities	○	○	○	○	○	○
B. National authorities	○	○	○	○	○	○
C. Regional or local authorities	○	○	○	○	○	○

Appendix 3
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