EASA
European Union Aviation Safety Agency

Study on the societal acceptance of Urban Air Mobility in Europe

May 2021

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

Executive Summary

Urban Air Mobility (UAM), a new 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.

Citizens' and future UAM users' confidence and acceptance will be critical to success. The European Union Aviation Safety Agency (EASA) therefore carried out this comprehensive study on the societal acceptance of UAM operations, with the consulting firm McKinsey & Company, between November 2020 and April 2021.

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, revealing interesting insights – some unexpected. The survey results, very homogeneous across the EU, can be clustered into ten key take-aways:

1. EU citizens initially and spontaneously expressed a positive attitude towards and interest in UAM, seeing it as a new and attractive means of mobility, and a majority are 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 connecting remote areas, are better supported;
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 indicated that they want to limit their own exposure to safety, noise, security and environmental impact;
5. Safety concerns come first, but the study also showed that citizens trust the current aviation safety levels and would be reassured if these levels were applied to UAM;
6. Noise was the second main concern expressed; the study indicated that the level of annoyance versus acceptance would vary with the familiarity of the sound, the distance, duration and repetition of the sound;
7. UAM was seen as a good option to improve the local environmental footprint, through reduced urban traffic congestion and better local air quality, provided that it does not impact wildlife;
8. The results also demonstrated limited trust in the security and cybersecurity of UAM, which would require 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 felt directly affected by the deployment of UAM and want to engage and play an active role in its implementation.

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

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

Industry status and projection

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 OEM sector is rapidly evolving. More than 200 eVTOL designs and concepts are currently being investigated and developed worldwide. Europe is one of the leaders 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.

UAM vehicle types

In general, UAM aircraft designs for vertical take-off and landing (VTOL) can be categorised into three archetypes: Vectored thrust, Lift+Cruise, Wingless (multicopter), as can be seen in examples in Figure 1.

Figure 1: UAM vehicle types

	Vectored Thrust	**Lift + Cruise**	**Wingless (Multicopter)**
	Thrusters used for lift and cruise	Independent thrusters used for cruise as for lift	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

UAM ground infrastructure

Dedicated infrastructure is required for the initial operation of UAM passenger transport. 'Vertiports' that enable take-off and landing of air taxis, will probably appear in different sizes and numbers in different cities, depending on expected traffic volumes. Two important factors for determining vertiport locations will be ease of access, as well as electricity and infrastructure connection.

UAM high level societal benefits

The following benefits have been identified on the basis of market models, literature and expert interviews:

- The estimated market size of UAM in Europe, including R&D, vehicle manufacturing, operations and infrastructure construction could reach approximately EUR 4.2 billion in 2030[1];
- The estimated market size may create or sustain approximately 90,000 jobs in 2030;
- Local emissions by UAM, in the city environment could be almost zero if battery electric propulsion systems are used;
- One of the major benefits of UAM for users will be time savings: a city-to-airport transfer in Paris by air taxi could be 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.

1 Source: McKinsey Center for Future Mobility UAM Market Model (for further information see full report).

Survey results – 10 key findings

The survey contained three parts:

- A web-based quantitative survey, with 3,690 citizens across six European cities took place. Initially, a market analysis was conducted to identify European cities offering the conditions for the deployment of UAM in the next ten years. Six of them were selected from this list to conduct the survey (Hamburg, Paris, Barcelona, Milano, Budapest and the Oresund region);
- A qualitative survey was carried out, consisting of one-hour interviews with more than 40 stakeholders at local, national and European level;
- And a special noise perception survey with 20 participants was conducted.

The 10 key findings from the quantitative survey, the qualitative interviews and the noise test are presented below. For the detailed survey results, please refer to the full report at easa.europa.eu/UAM.

1. A positive initial attitude to UAM throughout the EU

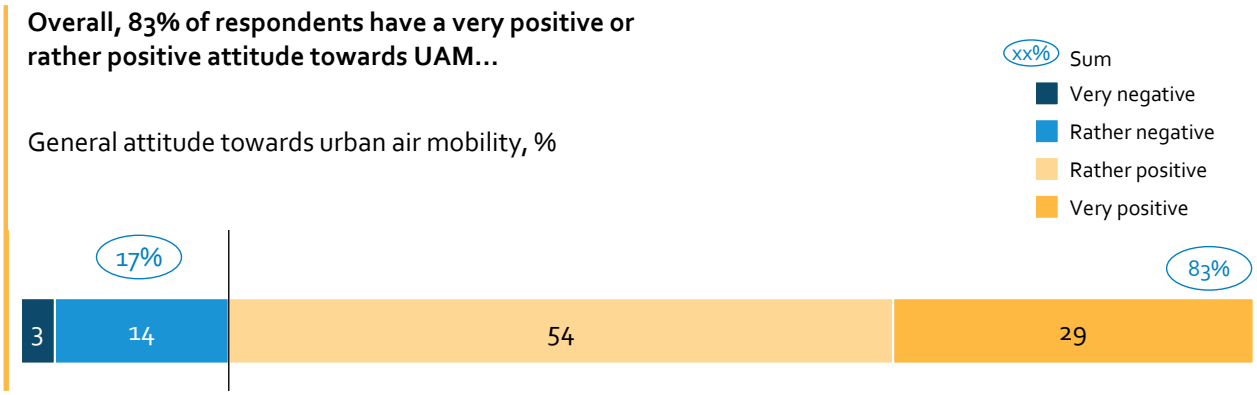
Homogeneous results

Unexpectedly, the results demonstrated **homogeneous replies:** a level playing field throughout Europe, with no major deviation between the respondents of the six cities, and no major deviations according to age, household composition or affinity to new technologies or other differentiating criteria.

Initial perception

Overall, the perception of UAM was positive: most of the respondents (83 percent) felt (very or rather) positive about the introduction of UAM overall. 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 (see Figure 2).

Figure 2: Vast majority of respondents were positive on UAM



Readiness to use UAM

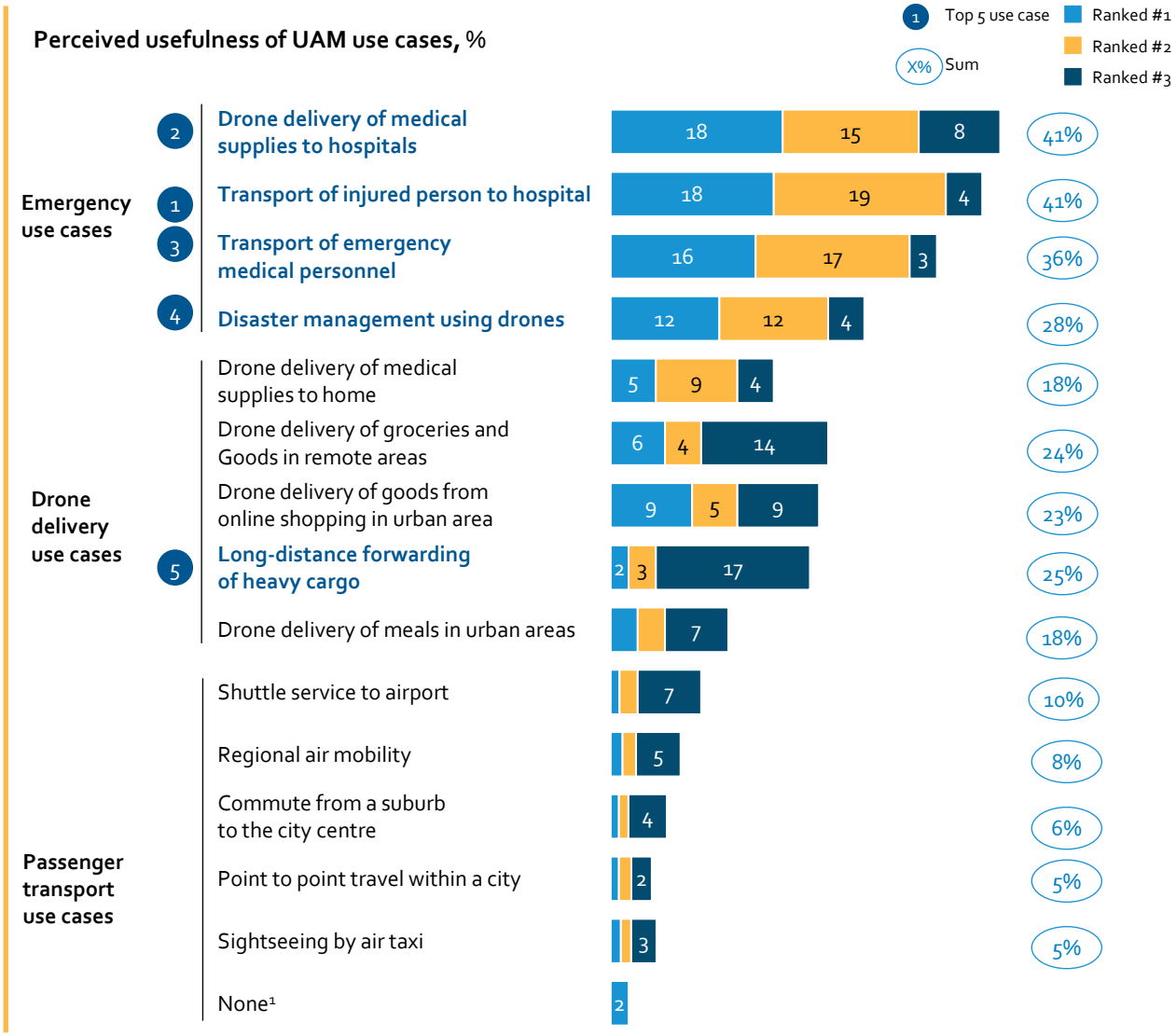
The results also show that a **large share of the population would also be interested to use UAM services:** 64 percent of the respondents would be interested in using drone delivery and 49 percent would be interested in using an air taxi. 43 percent would be interested in using both, 71 percent are likely to make use of at least one service.

The qualitative interviews confirmed that UAM is seen as an exciting innovative development, 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.

2. Strong support for use cases in the public interest

As illustrated in Figure 3, use cases related to **medical and/or emergency transport** were often selected as most valuable. This indicates that use cases that are in general public interest, notably in the health and safety domains, would be better accepted than those fulfilling private and individual needs, such as sightseeing. Respondents confirmed however, that medical/emergency should meet the same safety or security standards as other use cases.

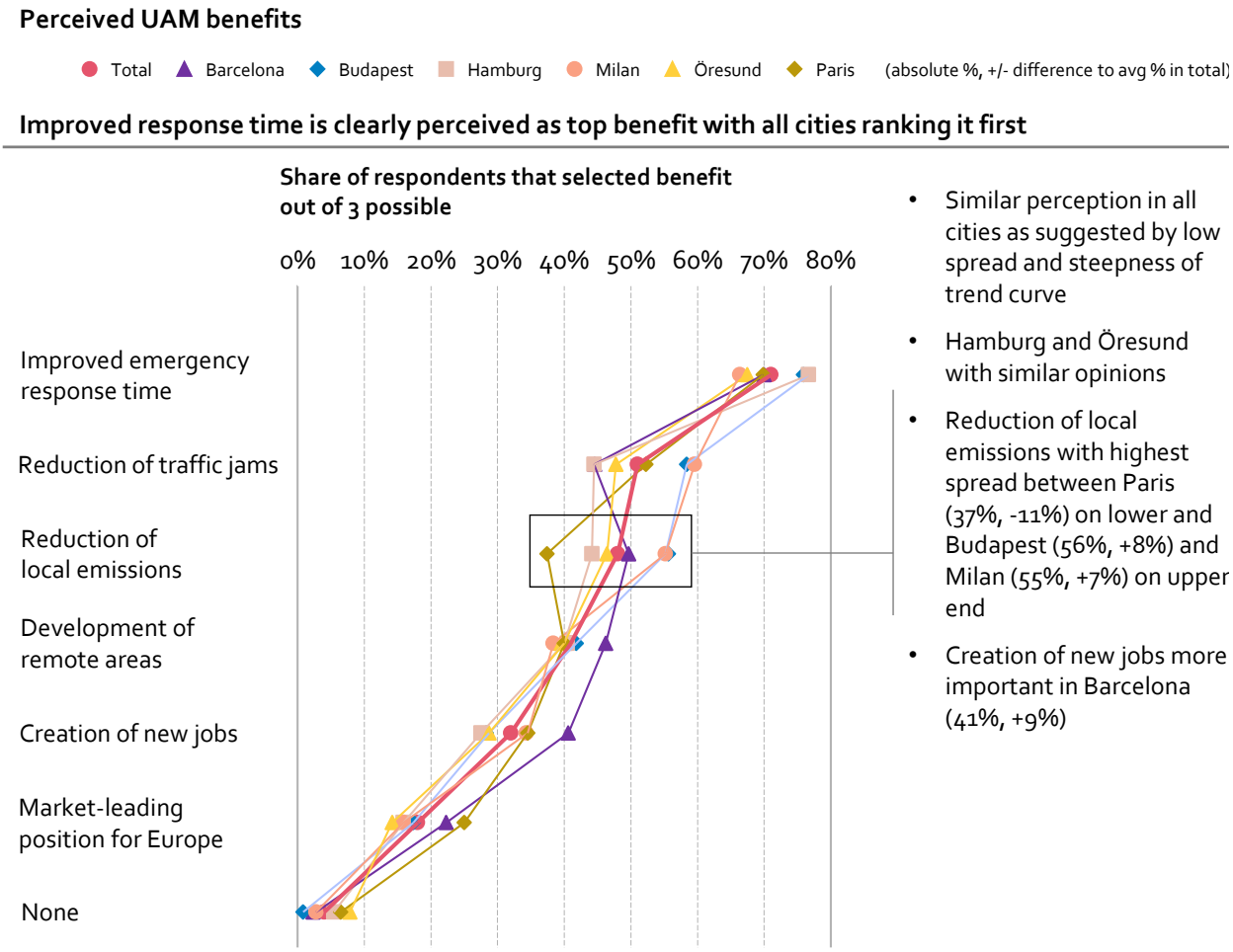
Figure 3: Emergency use cases are expected to be most useful



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

71 percent of participants expected an **improved response time** in case of an emergency as major benefit (see Figure 4). 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.

Figure 4: Improved response time is clearly perceived as top benefit

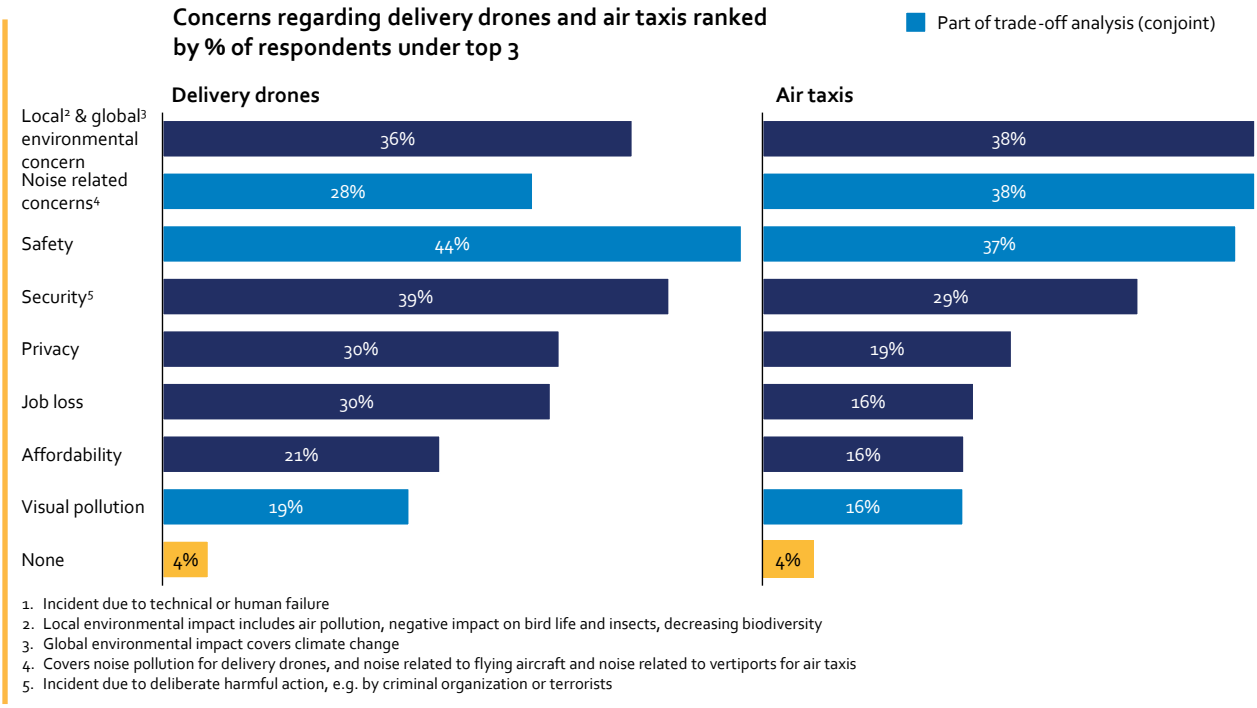


Source: EASA UAM societal acceptance survey questions A4. What benefits and opportunities can the development of urban air mobility bring for the EU and EU citizens? Please select up to 3 answers.

4. Top 3 concerns: safety, environment/ noise and security

Looking at expected concerns, the overall results indicate that **safety, security, and environmental issues** ranked on top for respondents. As can be seen in Figure 5, **noise** was also mentioned as a high concern, particularly for air taxis.

Figure 5: Respondents had similar concerns about delivery drones and air taxis



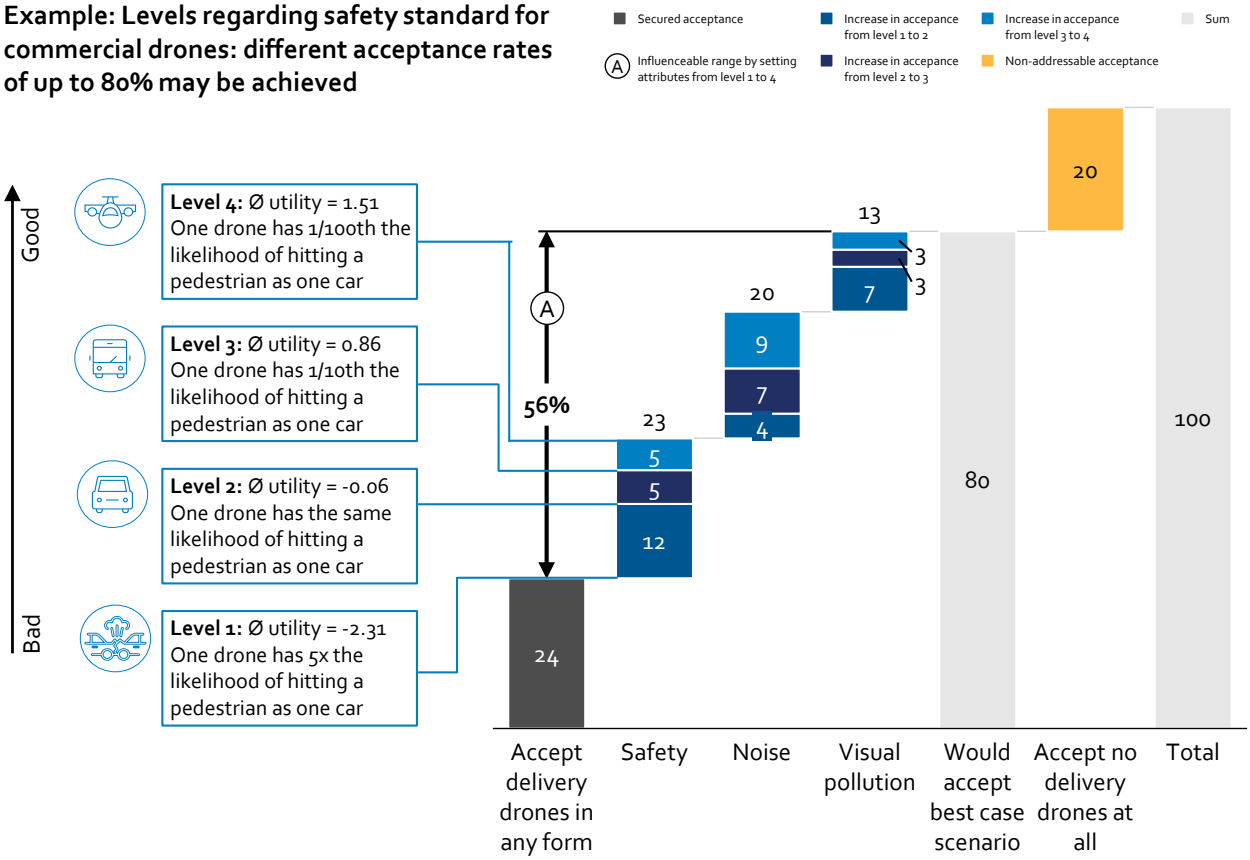
1. Incident due to technical or human failure
2. Local environmental impact includes air pollution, negative impact on bird life and insects, decreasing biodiversity
3. Global environmental impact covers climate change
4. Covers noise pollution for delivery drones, and noise related to flying aircraft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

5. Safety: existing aviation safety levels are the benchmark

The results from a simplified trade-off analysis on **delivery drones** indicated that citizens acceptance could be improved by 56 percent by implementing the highest levels for the safety, noise and visual pollution dimensions. 24 percent of participants indicated that they would accept delivery drones in any presented scenario (see Figure 6).

Figure 6: Trade-off analysis results for drones

Example: Levels regarding safety standard for commercial drones: different acceptance rates of up to 80% may be achieved



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

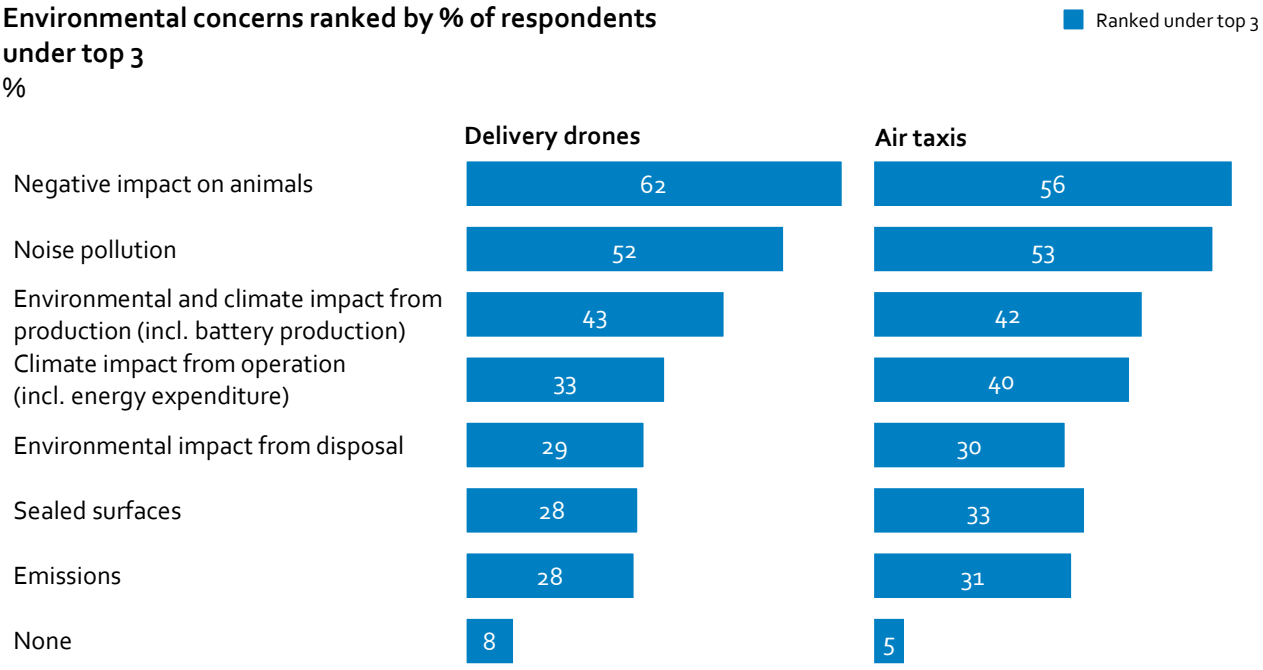
Source: EASA UAM societal acceptance survey questions B7. Put yourself in the year 2030: drones with about 3-metre wingspans, certified by competent authorities, are flying at altitudes of up to 150 metres. In the following section, you will be asked which scenario out of three alternatives is most acceptable 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.

The results from a similar simplified trade-off analysis **for air taxis** on the other hand showed that citizens acceptance could be improved by 49 percent by implementing the highest levels for the safety, noise and visual pollution dimensions. 33 percent of participants indicated that they would accept air taxis in any presented scenario.

6. Environment: priority is protection of wildlife

Environmental impact was one of the most significant concerns of citizens with respect to UAM. The primary concern within the environmental category was the risk of a **negative impact on animals** (see Figure 7). More than half of the respondents feared **noise pollution. Climate impact of the manufacturing and production** of aircraft and of the batteries ranks third.

Figure 7: 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'.

The survey results also made clear that a large majority (74 percent) of survey participants see advantages in introducing an eco-label for commercial Urban Air Mobility vehicles and operations to foster acceptance and buy-in on the environmental dimension.

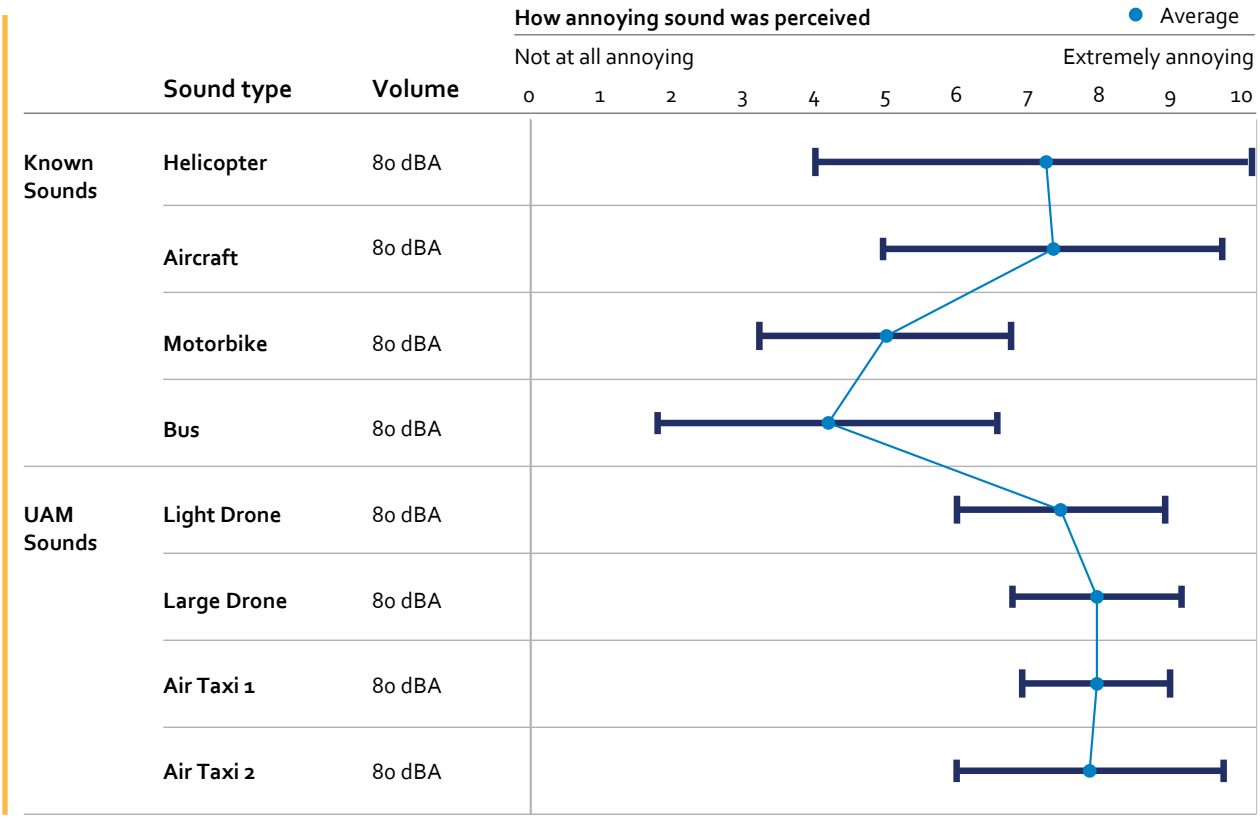
7. Noise: acceptable at level of familiar city sounds

In order to assess the noise acceptance of European citizens towards UAM vehicles, 20 participants took part in a detailed noise perception assessment.

The participants were exposed to several sounds of different vehicles in a professional 3D sound lab (ARUP mLAB). All vehicle sounds were played on top of a typical city background noise at ~55dBA. After each sound, the participants were asked to rank the annoyance level of the respective sound. The conditions were identical for each listener, so differences in responses were not due to any difference in the test methodology.

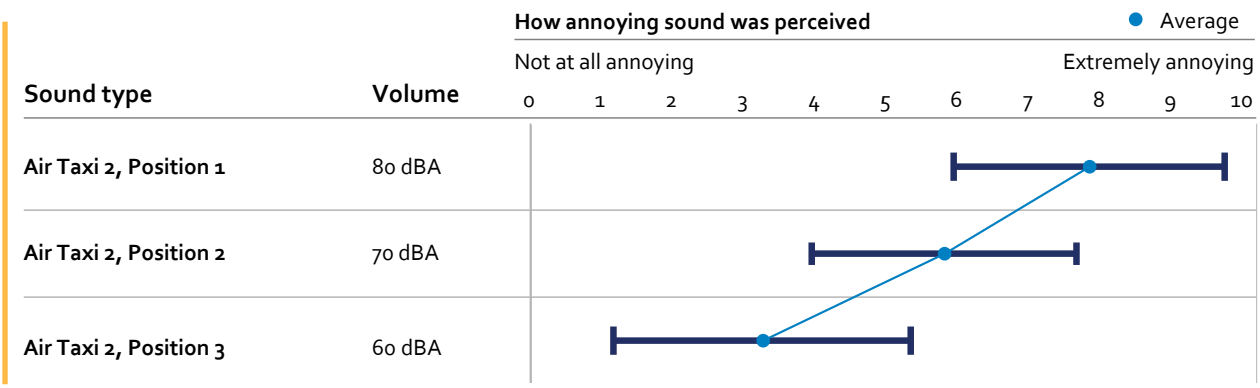
Although this is a small sample of results, the responses have been analysed statistically.

Figure 8: Result comparison between familiar sound and Urban Air Mobility vehicle sounds at same maximum noise level



The volume values presented in dBA units in Figure 8 above and Figure 9 below corresponded to the loudest instant in the sound sample, and did not capture the different noise durations. This aspect should be accounted for and softens the following conclusions.

Figure 9: Noise perception at different distances



Observations of sounds played at the same noise level:

- 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 taxi and the road vehicles;
- The air taxi and large drone scored the highest mean average result of 7.8. The synthesised air taxi at 80dBLAmax,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 the conclusion 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. Increased familiarity with such sound may lead to a greater acceptability in future. This consideration would benefit from further investigation through a larger set of tests.

Observations with respect to different distances:

- As expected, the synthesised UAM score drops with distance/sound level, both in terms of individual ratings and the mean average. The difference in responses between Position 2 and Position 3 is greater than the difference in rating between Positions 1 and 2;
- As would be 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.

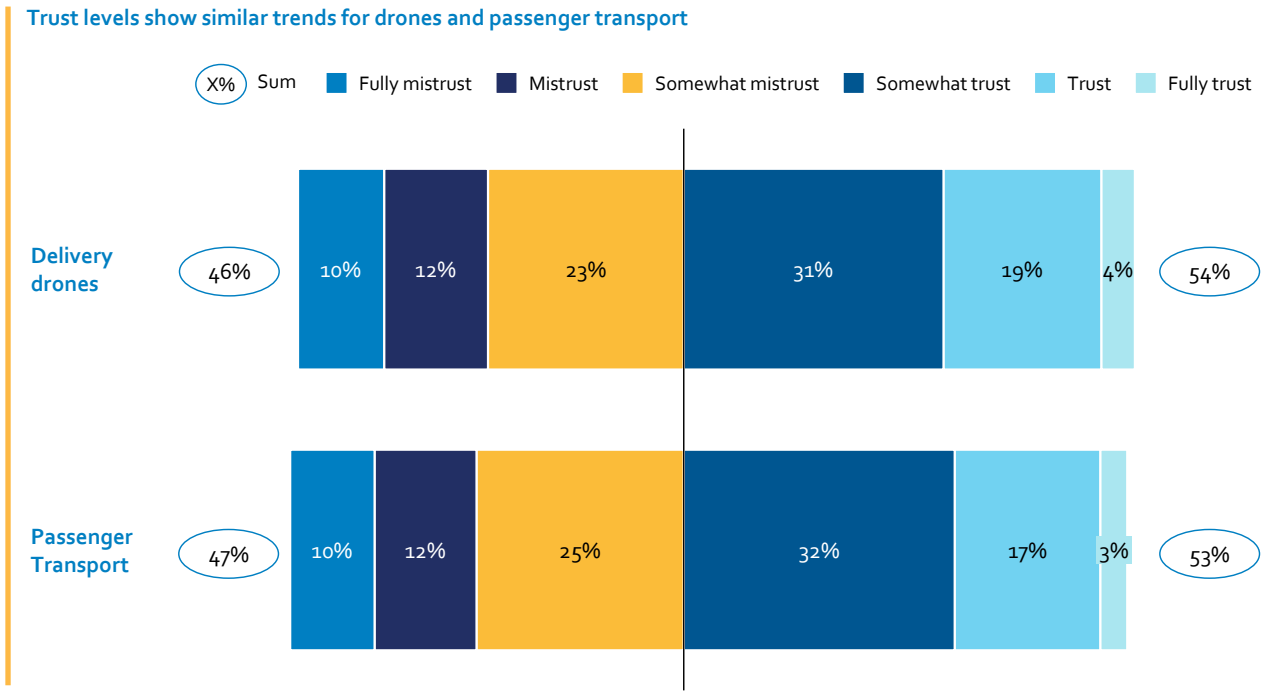
Sound character and response

In addition, the frequency spectrograms have been calculated and analysed for each sound source, to enable a preliminary insight on impact of certain frequencies on annoyance levels. There is generally a clear tonal component at around 3kHz for most drones/UAMs, 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.

8. Security: need to build confidence and trust in citizens

Security was the third highest concern of respondents. The level of trust for delivery drones as well as for air taxis is just above 50 percent and therefore could be improved (see Figure 10). A bit more than half of the respondents indicated that cybersecurity regulations would influence their trust in UAM vehicles.

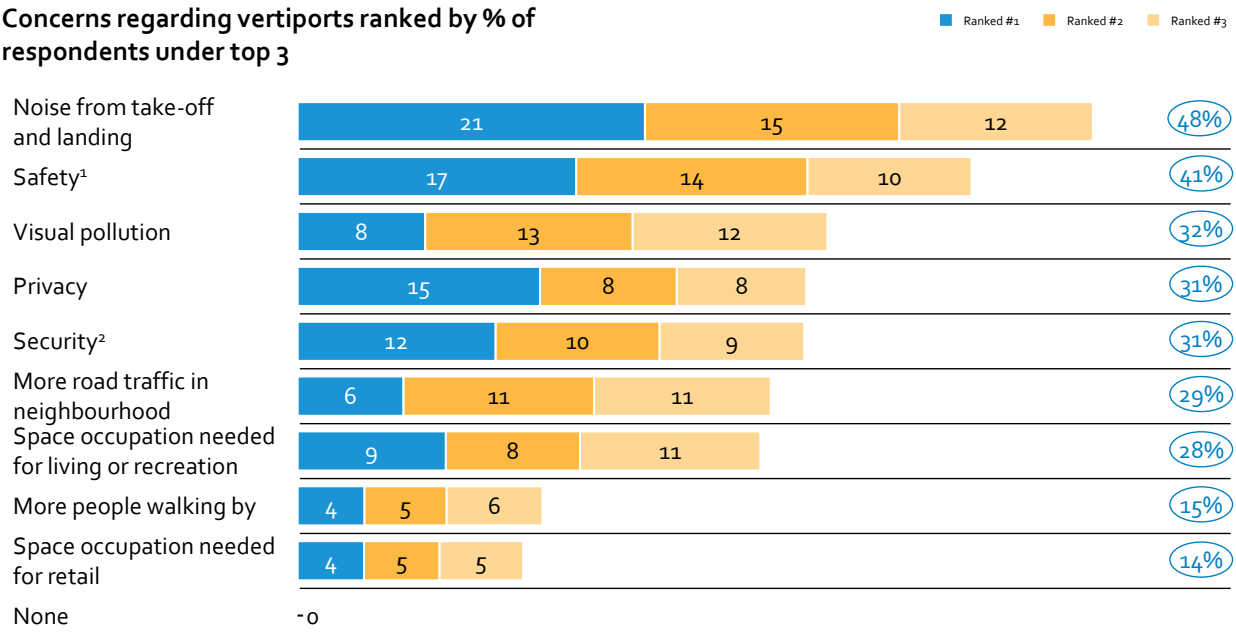
Figure 10: Trust levels in VTOL technology incl. security and cybersecurity are just above 50 percent



9. Ground infrastructure: must be integrated well

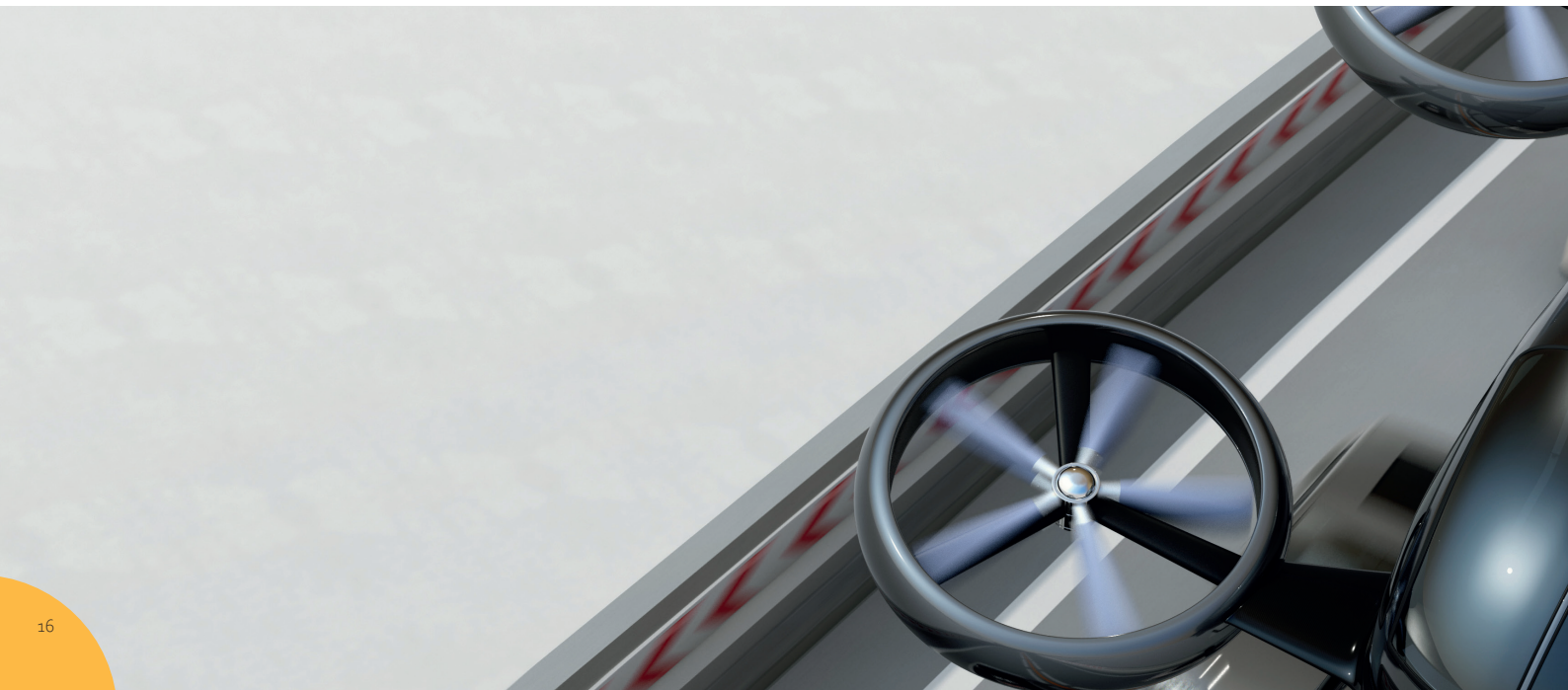
Overall, participants indicated that the closer to a private area that a drone can deliver, the more comfortable they would feel. For air taxis, it is assumed that they will need specific infrastructure on the ground to embark and disembark passengers, as well as to recharge their batteries, as their 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), survey participants were most concerned about **noise** from take-off and landing (48 percent) and safety (41 percent), as can be seen in Figure 11.

Figure 11: Concerns related to vertiports are mainly on noise and safety



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'.



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. As results in Figure 12 indicate, the participants' trust towards local, national, regional and European authorities comes with nearly the same proportion, with a slightly higher level of trust overall towards European regulatory authorities.

Figure 12: 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.

Overall, the study highlights 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.

Expectations and possible actions

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 towards and interest in UAM, they also expressed significant concerns. As a consequence, public acceptance, as a critical success factor of the future deployment of UAM, must be secured by a number of preventive actions. Some of them 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, but also for people on the ground ;
- Ensure birds and insects are not affected by the production of the aircraft and their operations;
- Ensure global environmental protection from a life-cycle point of view;
- 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 through timely, sufficient and transparent information and dialogue with 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.