Safety & Defense 8(2) (2022)
DOI: https://doi.org/10.37105/sd.179

Challenges for employing drones in the urban transport systems

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Received: 31 May 2022 | Revised: 02 June 2022
Accepted: 20 June 2022 | Available online: 15 December 2022

Abstract

Unmanned aerial vehicles, often referred to as drones, are increasingly used as an element of the transport system, including in urban areas. Despite the limitations, mainly related to the range and load capacity, it should be expected that in the near future, they will transport cargo and passengers as one of the elements of the urban transport system. The concept of Urban Air Mobility (UAM), which envisages the use of drones and other aircraft in urban airspace, meets this goal.
Literature analysis was used to identify and describe applications of drones in the urban transport systems and to articulate key challenges related to this issue as well.
The article presents generalizations regarding the use of drones in the urban transport system, including urban air mobility. It identifies the key challenges related to their implementation in urban areas. Typical applications of drones in urban airspace include passenger and cargo transportation and support for services and Intelligent Transportation System components. The main challenges relate to legal regulations, safety and security, air traffic management, environmental impact, infrastructure and social acceptance for implementing drones in the city's transport system.

Keywords: drones, cargo movement, passenger movement, urban air mobility, urban transport systems

1.Introduction

Unmanned aerial vehicles, commonly known as drones, have taken a place in the public consciousness for good. Although their initial development is directly related to military applications, currently, civilian use, including primarily commercial ones, shows this technology's real potential.

Initially, the limited range and payload of drones meant that they were best suited to tasks that were costly or impractical to perform with manned aircraft. Examples of such tasks include aerial photography or surveying and mapping. However, with the advancement of drone technology, the scope of their use has significantly increased. It is now clear that in the coming years, drones will play an increasing role in the transport system, including the transport of goods and passengers.

In this context, it should be emphasized that drones are no longer limited to small rotorcraft commonly used by photographers, tourists and hobbyists. The term "drone" is universally used in public spaces and is understood to mean an aircraft without an operator (pilot) on board. The basic technologies used in drones can be practically adapted to a conventional aircraft, and their size, weight, level of automation, design features and type of drive vary depending on the type of drone.

Drones have both benefits and risks. They are expected to improve security through automation (thus reducing the degree of human interaction and associated possible human error) and to bring economic benefits by reducing costs and improving labor productivity. However, drones also generate new threats and impact the external environment. Unsurprisingly, the advantages of drones are emphasized while at the same time often trying to understate or conceal threats and challenges related to their functioning in the social sphere. Mitigating these threats will be crucial to building societal acceptance, which will ultimately be a factor directly or indirectly affecting the future use of drones.

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Technological progress related to the development of new electric vehicles, automation and the increasing capabilities of unmanned aerial vehicles are determinants of changes that develop the concept of Urban Air Mobility (UAM). There is an opportunity, but at the same time a challenge for the development of air mobility in urban areas, including the transport of passengers and cargo. This concept, known as Advanced Air Mobility (AAM), focuses on emerging aviation markets and the use of aviation, including on-demand drones, in urban, suburban and rural areas. The UAM concept, which is part of the AAM, provides for a safe, sustainable, affordable and accessible air transport system for passenger mobility, goods and emergency delivery within the metropolitan area.

Due to the growing awareness of environmental protection and legal reduction of greenhouse gas emissions, the technologies used in drones also take into account these risks. There are more and more structures using electric drives that are minimally invasive to the natural environment. In the short term, such structures will be used in transport systems – for the transport of goods and people and as an enhancement to Intelligent Transport Systems.

The research aims to identify potential applications of drones in urban transport systems and to articulate key challenges that influence drones as an element of urban air mobility. Thus, the content of this article answers the main research question: what tasks can drones be used for, and what are the main challenges related to their implementation into the urban transport system. In order to answer the question, a quantitative analysis of literature has been used. Conclusions from the research have allowed us to identify the crucial task conducted by drones in the urban transport systems and key challenges related to the issue.

2. Potential applications of drones in the urban transport systems

Drones in a city's transportation system can be used for cargo and passenger transportation operations. Drones' potential should be used to ensure the economic development of the transport sector while minimizing any potential threats. The use of drones in urban airspace can include passenger and cargo transportation and other tasks that can benefit the entire urban transportation system.

2.1. The use of drones for cargo movement

Roland Berger, a consulting firm, identifies four main tasks for cargo drones (Baur & Hader, 2020). The type of payload and the degree of autonomy in performing tasks is the criterion of division. However, in all cases, the primary aim is to automate the transport of goods in order to provide faster, more flexible and cheaper services compared to traditional modes of transport.

The first group of tasks covers the automation of intralogistics (in factories and warehouses). Drones can be deployed to deliver individual goods directly to the production line or to assist with warehouse operations. For example, the car manufacturer Audi uses drones at the Ingolstadt plant to transport car parts necessary for the production process. The drone transports loads up to 2 kg while traveling at a speed of up to 8 kph (SSRN, 2021).

The second group of tasks includes delivering of medical cargo (often to remote locations). Drones can provide fast and reliable transport of essential medical goods, especially where the existing transport infrastructure (or lack thereof) does not allow for efficient delivery. For example, Zipline – a US company that designs, manufactures and operates delivery drones – has been providing medical services to 25 hospitals and clinics in Rwanda since 2014, primarily for supplying blood samples and blood products (SSRN, 2021). Such services have since spread to all of Africa and beyond, and their interest has increased during the Covid-19 pandemic. The delivery of medical equipment is closely related to the concept of first/last-mile parcel delivery because the payload and range of individual drones can be very similar.

The third group of tasks is first/last-mile parcel delivery (often around and in urban areas). Drones can significantly increase productivity and profitability (and thus cost savings) for logistics companies in first/last-mile parcel delivery operations. This part of the freight chain is often the most expensive and least efficient part of delivery, requiring significant manpower, vehicle counts and time, especially where poor traffic, bad roads or geography impede existing delivery methods. Delivery drones can also be combined with other new technologies such as unmanned vehicles. Driverless vehicles loaded with parcels can send out multiple delivery drones when they come close to the most efficient point from which they can complete their deliveries. Such a vehicle would serve as a base station for drones, providing charging and replacement of the load as needed (PwC, 2018).

The fourth group of tasks covers the transport of air cargo (over longer distances). Freight drones can allow goods to be transported more flexibly than by truck or train; they can also provide an efficient way to balance stock in different warehouses. For example, an American start-up Elroy Air is developing a drone that can carry up to 225 kg with a maximum range of 500 km (Elroy Air, 2021); Yates Electrospace Corp., based in the US, announced the creation of a new wide-body drone for cargo delivery with a payload of 567 kg (Air Cargo News, 2020); Natilus, a start-up from California, is developing a 60-meter drone with a payload of 100 tons (Jordan & Collins, 2019); and in May 2020, the Sabrewing Aircraft Company presented a drone with a lifting capacity of over 2000 kg (during take-off and landing from the runway) and a range of almost 2000 km (Harry, 2020; Hsu, 2020). However, there has been no commercial use of heavy-duty drones until now.

Parcel delivery is one of the most common use cases of drones in the transportation sector at the moment, especially for medical cargo transportation. Delivering goods faster to customers can also increase the competitiveness and network range. In addition to increasing supply chain efficiency by large companies, drones can give small businesses greater access to the on-demand supply market, reduce delivery times and increase access to goods, especially for time-sensitive products. This could encourage competition and increase economic growth (Müller et. al., 2019).

However, drone deliveries will also face a number of limitations. It is likely that drones will not be able to operate in unfavorable weather conditions, such as strong winds, ice or heavy rains. In some circumstances, they may also be less efficient than other means of cargo transport, e.g., when direct delivery by the drone to a household or to a specific address is impossible due to the lack of infrastructure for the drone and/or due to potential flight or landing restrictions. They may not be preferred by some clients as well (Saboor et. al., 2021). As a result of these limitations, it is likely that drones in the urban freight sector will be a complementary or optional mode of transport compared to more conventional types of cargo delivery.

2.2. The use of drones for passenger movement

It can be assumed that drones will also play an important role in future passenger transport. An entirely new segment of the industry has been emerging in the last few years, with companies from around the world competing in the development of passenger-carrying vertical take-off and landing drone designs. The largest aircraft manufacturers – including Airbus, Boeing and Embraer – are developing drones for transporting passengers (Wakefield, 2020). Many of these drones are expected to have a pilot on board early in the development of the concept of passenger transport in urban airspace. In the short term, passenger drones would be mainly used for short-distance travel (in and around but not limited to urban areas) where air or ground transport is unavailable (e.g., due to infrastructure constraints) or very expensive (given its labor intensity, fuel and capital intensity). Ultimately, drones can also be used for passenger travel over longer distances.

Carriers offering drone passenger services in urban areas can complement existing short-distance ground transport or develop their own unique proposal helping to extend existing networks or providing an alternative. The first studies show that active transport (walking and cycling) travel is unlikely to be replaced, while current private car users, car-sharing users or taxi users are more likely to consider drone transport services. Depending on the price level and type of service, some public transport rides may also be replaced (Fu et. al., 2019).

With further improvements to electric drives, the reliability of communication links, and certification processes for automation, it is possible that drones may eventually become capable of medium- and long-distance travel, competing with rail or selected airline business models. They could open up new intercity or interregional markets on routes currently in low demand and facilitate passenger transport across natural barriers such as lakes, rivers, mountains and bays. Hybrid and fossil fuel-powered drones are also under development.

2.3. Other applications of drones in urban areas

In addition to transport tasks, drones can also be used as an element of intelligent transport infrastructure or to perform support tasks in the transport system.

Transport, rail and road infrastructure components (bridges, overhead lines, alignments) must be regularly inspected, which is laborious, time-consuming and costly. By using high-definition cameras and automated image analysis systems, unmanned aerial vehicles can inspect transport infrastructure and collect the necessary data, which will later be useful in infrastructure maintenance works. On the other hand, in road transport, drones can be used for traffic monitoring, detecting traffic obstructions and transmitting necessary information to traffic management authorities. Given the ever-increasing mobility needs, the existing transport infrastructure needs to be optimized. This requires having very accurate micromovement data in a given area, which describes the interactions between individual vehicles and the infrastructure and between the vehicles themselves. The analysis of video recordings obtained thanks to drones may contribute to developing a map of connections, which will facilitate traffic management (Saboor et. al., 2021).

There is also potential for using drones to monitor and inspect infrastructure on coastal and inland waterways. The unmanned aerial vehicle can be used to inspect the condition of navigational aids and weirs, thus minimizing the need for time-consuming and costly vessel-based inspections. Drones can complement vessel traffic monitoring performed by manned aircraft using high-definition cameras to detect oil spills or by sampling emissions from maritime vessels (Outay et. al., 2020).

Drones can be used to inspect runways and taxiways in air transport. Image processing sensors can be used to detect objects that pose a threat to aircraft. They can also be used to deter birds in the airport area, significantly improving the safety of aircraft during take-off and landing. Drones can also conduct research flights related to the assessment of the aerodrome area, such as for terrain obstacle assessment in landing and take-off areas or for instrument landing systems. In aircraft inspection and maintenance, drones can assist in the visual inspection of hard-to-reach parts of the aircraft, for example, the top of the fuselage or the vertical and horizontal tail surfaces (Gupta et. al., 2021). They are also a widely used tool in aviation accident investigations, providing high-definition photos of the accident site.

The drones can also act as a temporary traffic sign informing, for example, about a change in speed limit or as a traffic indicator in a specific area. At the same time, it can collect the necessary data, the analysis of which with the use of machine learning will allow determining the behavior of transport users in relation to specific signs. This will enable the installation of permanent elements of the transport infrastructure in the future, taking into account the conclusions from the analyzes of data obtained by drones, which play the role of temporary road infrastructure.

Virtually all drones are capable of carrying warheads with optoelectronic devices installed, mainly cameras. In transport, they can be used to monitor the road situation in specific areas as a "flying eye." Examples of drones in this role may include tasks related to reaching the scene of an accident in the city and quickly analyzing the situation. In addition, drones can collect and analyze traffic information by creating congestion maps and thus direct an ambulance to the scene of the accident along the optimal route (Menouar et. al., 2017). Drones can also assist ambulances to the scene of an accident by flying in advance and by giving audible and visual signals to road users to create an "emergency corridor."

The police also use drones to enforce traffic violations. By working with ground police units, they can track traffic violations committed by road users, such as speeding or failure to follow road signs. They can also support the police in pursuit actions instead of helicopters by providing information about the pursued vehicle or limiting its mobility.

It should be emphasized that the above-mentioned uses of drones in the transport system do not show the full potential of their applications in and for the transport system.

3. Key challenges of implementation of drones in urban transport systems

It should be expected that the use of drones as part of the urban transport system will require overcoming many barriers in areas such as safety and security, legal regulations, air traffic management, environmental impact, noise, weather conditions, infrastructure, and user's safety and societal acceptance.

3.1. Regulatory issues and security

Despite the fact that drones have unique characteristics, they are still aircraft and will need to adapt to the existing aviation system to ensure continued safety and public acceptance. The aviation system has been established and improved over many decades based on specific regulations and standards that are set out in international conventions and reflected in national regulations and regulations and practices of operators around the world. Including drones into this system without decrementing the level of safety and security of the aviation system will be a big challenge for many years to come.

Legitimate safety concerns about urban air mobility users, other airspace users and outsiders represent a security challenge. Implementation activities will be strictly related to broadly understood aviation safety and security, which are based on legal regulations regarding aircraft, airworthiness, air operations (including crew requirements) or air space access. The most important issues in the area of the safety of UAM operations that require regulation, clarification or development of minimum standards are certification of organizations producing aircraft for the purposes of UAM; operational requirements and airworthiness of the aircraft; certification and licensing of pilots, flight crews, maintenance and other necessary personnel; infrastructure certification (Straubinger et. al., 2021). In addition, the safety operation in urban airspace will require the installation of appropriate navigational aids and air traffic management infrastructure and the development of air traffic rules, including airspace allocation.

The current legal regulations mainly apply to manned civil aviation, and those related to unmanned aerial vehicles do not regulate the use of drones in urban airspace in the transport of people and cargo. Meanwhile, the anticipated specificity of drones used at UAM may pose a challenge for the certification and authorization of the use of some innovative technologies and combinations of features that can be found in aircraft intended for use at UAM. Examples include new types of electric propulsion, new design solutions related to the vertical take-off and landing of an aircraft, autonomous hardware and software, optional piloting configurations and electricity storage (Cohen et. al., 2021).

Efforts are being made to identify and address regulatory and safety challenges for new UAM technologies such as (Cohen et. al., 2021):

a) electric propulsion and energy storage: there is a real need for further research on the challenges facing electric propulsion in aircraft, especially in urban airspace;
b) autonomy and advanced software: machine learning, complex computational algorithms, human-machine relations;

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c) remotely piloted and optionally piloted aircraft: the possibility of using the same designs in manned and unmanned versions, taking into account the physical safety of passengers and crew (pilot), operational procedures, air traffic management, cybersecurity and taking into account aircraft airworthiness.

Critical risks to the safety and security operations in urban airspace may include flights outside assigned airspace; flights close to people and/or urban infrastructure; aircraft failures (e.g., loss of GPS signal, engine failure, etc.); loss of drone control; cyber-attack; physical destruction of the drone. The possibility of unfavorable weather conditions, meteorological phenomena, human error, collision with birds, or intentional and unlawful interference by third parties should also be considered.

In summary, the challenges related to the multidisciplinary nature of UAM will require a number of procedural, operational and safety implementations to be able to perform air operations in urban airspace in the future.

3.2. Air traffic management

Currently, in most countries, drones operate at low altitudes in uncontrolled airspace without permission or in communication with air traffic control. However, in the future, it is expected that drones will regularly operate in other classes of airspace as they become larger and fly at higher altitudes, and there are likely to be more and more planes in the air. New Unmanned Traffic Management (UTM) systems will be needed to enable seamless communication between drones, other aircraft and air traffic control.

Drone operations are expected to be performed at relatively low altitudes and in a crowded urban environment. One of the main challenges will probably be to reconcile the UAM concept with commercial transport ecosystems operating in urban space and unmanned aerial vehicle operations performing other tasks. Commercial air carriers work with experienced pilots in controlled airspace where air traffic controllers are empowered to control air traffic. In recent years, unmanned aerial vehicles have generally operated in uncontrolled airspace based on specially created regulations. Drone flights in urban areas (in particular to/from large and medium-sized airports) are likely to be operated in both controlled and uncontrolled airspace, ensuring safe take-off, approach and landing together alongside drones that normally operate below 120 m. It is clear that the number of drones in urban airspace should be expanded gradually, first with a small number of low-complexity operations. As the operational pace increases, the creation of “UAM corridors” is foreseen where drones can exchange information with other corridor users to avoid hazardous situations, including collisions – without relying on air traffic control services (Gupta et. al., 2021). In the next stage, it will be possible to perform more operations in complex urban airspace, including those involving autonomous drones. This will require the development of new regulations, procedures and training. It will also be necessary to introduce service providers guaranteeing support for drone operations, including operational procedures, airspace management and availability, and information exchange between urban airspace users.

Communication between drones and commercial and general aviation aircraft should also be considered a challenge. It will be necessary to establish collision avoidance procedures, in particular between drones and commercial aircraft. Along with the increase in the number of operations, it will be necessary to adjust the operational procedures both in commercial aviation and UAM (Bauranov & Rakas, 2021). In order to maintain constant communication, investing in the urban sphere in 5G connectivity or other IT infrastructure guarantees adequate data exchange capacity is reasonable. Ultimately, it is planned to implement automated systems for monitoring drone systems.

UTM systems will be an essential part of the drone ecosystem (Zieliński & Marud, 2019). UTM enables de-conflicting air traffic and real-time identification of drones; they can also determine the most efficient route for a given flight based on take-off and destination, weather, actual air traffic, and a number of other factors. UTM will probably be an important tool for managing the impact of drones on the environment (allowing flight planning taking into account noise or visual disturbance) and ensuring equal access to take-off and landing sites in areas of high demand in the future. Regulators and policymakers worldwide will need to work closely with industry and other stakeholders to establish performance-based standards for UTM that must be interoperable and co-operate with existing air traffic control systems.

3.3. Environmental impact

Traditional aviation has a significant environmental impact, and a number of policies, standards and operating procedures have been developed to reduce its negative environmental impact. In contrast, relatively little attention has been given to the environmental impact of drones. The enormous variation in both the size and physical characteristics of drones and the environments in which they operate means that the mitigation measures that have been developed for traditional forms of aviation are unlikely to be sufficient to manage the environmental impact of drones, and this will pose a challenge.

The interest in the use of drones for transport in urban space is primarily due to the fact that they are to be unmanned aerial vehicles with electric drive, which is expected to reduce emissions (as opposed to gas-powered vehicles, small airplanes and helicopters). The results of studies in the United States show that a single-passenger electric vertical take-off and landing (eVTOL) aircraft (i.e., the pilot and no other passengers) emits 35% less greenhouse gases than a gas-powered vehicle with one passenger, but at the same time, it gives 28% more emissions than a battery electric vehicle with one passenger (Cohen et. al., 2021). At the same time, it should be remembered that the current technologies of electric drives do not guarantee the range of eVTOL competitive with other means of transport.

While most drones produce zero emissions, this does not mean they do not contribute to greenhouse gas emissions. All drones consume energy, and the amount of consumption depends on the design of the drone, its payload, the energy mix used to produce electricity, and the method of transferring electricity to the battery. The production and scrapping of drones at the end of their lifespan will also use energy and cause emissions. The net emissions of drones compared to traditional modes of transport will depend on the specific use case and local context (Kellermann, et. al., 2020). Drones can reduce emissions in some cases (such as carrying light packages in sparsely populated areas that would otherwise require a van). In other cases, drones can increase net emissions.

3.4. Noise

Noise is a key factor that can be a major obstacle to drone integration if not carefully managed. This is due not only to the actual noise generated by drones (often high-pitched, typically 20 to 70 decibels) but also to the way noise is perceived – for example, human awareness and acceptance of drones or the surrounding noise (Zieliński & Marud, 2019). In cities, the ambient noise levels of conventional vehicles can make drone noise less disruptive. On the other hand, proximity to residential areas and the growing interest in quieter electric vehicles can make drones more noticeable. Airplane and rotorcraft noise is a frequently mentioned problem in the vicinity of airports and heliports. The high noise level of rotorcraft is likely to limit the use of helicopters in urban areas in the near future. This problem is also considered in the context of societal acceptance of the use of aircraft in urban airspace. The assumption is that electrically powered aircraft are expected to generate half as much noise as a medium-sized truck and a quarter less than the smallest four-seat helicopter on the market (SSRN, 2021). As the UAM market develops, technologies will emerge that will alleviate the inconvenience associated with noise. On the other hand, the progressive electrification of ground transport systems makes them quieter, and the noise from the air becomes more bothersome for the community. In the context of UAM, it should be assumed that the noise standards will be more stringent than in the case of commercial aviation, especially in areas of urban congestion.

3.5. Atmospheric conditions

Weather can pose a number of critical safety and operational challenges for drones in a city. First, as an aircraft decreases in size, the safety risk and vulnerability of aircraft and passengers to weather hazards increase. Various weather conditions can occur, such as poor visibility, icing, crosswind, etc. In turn, performing low-altitude operations above urban areas can aggravate these problems. As a consequence, flight cancellations or delays may occur, but these are also phenomena in commercial aviation activities (Reiche et. al., 2021). It should be noted that aircraft operating in urban airspace will use a much greater number of technical devices to improve their safe operation compared to commercial aviation aircraft, which may have an impact on the quality of their operation in unfavorable weather conditions.

3.6. Infrastructure

Most drones are smaller than traditional aircraft. Their ability to take off and land vertically with high precision means they usually require less space. The physical infrastructure's specific characteristics will depend on the location and the nature of the destination (passenger transport or cargo hubs). In rural areas, the infrastructure for drones is likely to be relatively inexpensive. In densely built-up urban areas, suitable take-off and landing areas (especially for larger drones carrying passengers) are likely to be rare and require careful urban planning to comply with landscape planning regulations (Baur & Hader, 2020, November). In some cases, demand for landing sites in a given area may exceed supply, and in such cases, public funding or regulations may be needed to ensure fair and equal access to take-off and landing sites.

Carrying out passenger and freight transport in urban airspace by drones will require extensive infrastructure such as a vertiport network, charging/fuel stations, communication and navigation networks and IT infrastructure. Air carriers, initially, will be able to use existing heliports. However, with the development of this type of communication in urban airspace, it will be necessary to adapt the existing infrastructure to the requirements of UAM with minimal modifications. The construction and development of dedicated infrastructure for UAM may be associated with many challenges, including opposition from local communities as well as the costs and problems of multimodal integration. Apart from the spatial layout of this type of infrastructure, the problem may be the provision of the UAM vehicle refueling network, charging, replacement and storage of batteries (Cohen et. al., 2021). The

Safety & Defense 8(2) (2022)
DOI: https://doi.org/10.37105/sd.179

provision of navigation infrastructure and air traffic control (including voice communication), ensuring the safe performance of tasks, seems to be of equal importance. UAM infrastructure must be resistant to disruptions, and the vulnerability to cyber-attacks should be minimized by ensuring proper cyber protection. The allocation of radio bands necessary for the drone ecosystem may be a problem in this context, which are limited resources necessary to ensure security.

3.7. Ensuring security of users

Ensuring security for UAM users – both physical and cyber – will be critical to maintaining an overall level of security and public trust. There are numerous concerns regarding the personal safety of passengers when booking, boarding and on board a drone from departure to arrival. Some of these concerns identified include hijacking, laser dazzling of the pilot and passengers during take-off and final approach, and violence against passengers, especially in the unmanned autonomous scenario (Straubinger et. al., 2021).

Advanced technologies such as biometrics, passenger assessment systems and traveler loyalty programs are tools that can be used to increase the personal safety of passengers on their rides. In addition, regulators, air carriers and ancillary service providers will put good practices and procedures in place to reduce the risk of safety incidents (Cohen et. al., 2021). Additionally, it will be necessary to ensure the physical safety of vertiports, drones, loading/refueling and other elements of the UAM infrastructure. Finally, the cybersecurity of all supporting information systems will be critical, including but not limited to ticketing/reservation systems, air traffic management, communication, navigation, surveillance and autonomous aircraft systems.

3.8. Societal acceptance

The lack of social acceptance of the UAM concept may be a significant challenge for its implementation. Key issues may relate to noise, potential air and ground pollutants, and intrusions of privacy, especially for flights over populated areas. The issue of social justice seems to be no less important – the use of drones in urban airspace may be perceived as a tool against congestion but available only to wealthy households (Fu et. al., 2019). Safety and security issues can also cause concern in the community. It will be necessary in this respect to conduct information campaigns explaining all the necessary problems related to UAM in a manner accessible to all potential beneficiaries. The problem of societal acceptance for urban air mobility has also been noticed in the EU, where the European Union Aviation Safety Agency has conducted studies in several European countries, which concluded that there is preliminary approval for this type of transport into urban spaces. At the same time, the respondents articulated many concerns related to the implementation of the UAM concept (EASA, 2021).

4. Conclusions

Undoubtedly, unmanned aerial vehicles will become an important element of the urban transport systems, increasing their capabilities and contributing to economic development. However, their complete implementation into the transport system requires meeting many challenges, including legal regulations, safety and security, infrastructure, and technology. Their use in urban airspace alongside manned aircraft as part of the UAM concept seems the right way, but the current technological limitations, mainly related to propulsion, environmental restrictions and social concerns, require the joint involvement of the private and state sectors in order to create favorable conditions for the development of the UAM and developing a transport system using drones. The usefulness of drones in the urban transport system has been proven during the ongoing COVID-19 pandemic, where unmanned aerial vehicles performed the tasks of monitoring and enforcing social distances and protective equipment, detecting viruses, delivering goods and necessary equipment and disinfecting public spaces. Thus, the potential of drones to be used in urban airspace cannot be overestimated. The main challenge related to the use of drones in the transport system, including urban airspace, is their integration with the currently functioning transport systems in such a way that it does not disturb the current *status quo*.

Declaration of interest
The author declares that he has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article

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