SMART TRANSPORT FOR SMART CITIES: A FUTURISTIC SCENARIO AND A REALISTIC PROJECT

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ABSTRACT:

Smart transport for smart cities: our article presents an innovative and original idea in the field of urban air transport with a new type of manned drone. This scenario is analysed starting from some initial futuristic ideas up to the reality of the construction of such a vehicle. After a brief presentation of a list of manned aerial vehicles (manned drones) that reflects the efforts that have been realized until now, a number of parameters and specifications related to such aerial urban transport, are also pointed out. In addition, various emerging issues comprising legislation matters, infrastructure for landing and take-off in cities, navigation methods and other possible impacts on the urban transport, have also been presented shortly.

1. INTRODUCTION

The UAV (unmanned aerial vehicles) in our days have multiple roles and unlimited possibilities in various scientific, professional and military fields. Nevertheless, together and parallelly with their astonishing development, a new kind of UAV appeared a couple of years ago: the “passengers” drones or manned drones (other names also exist in relative bibliography, such as: personal aerial vehicles (Liu et al., 2017), vertical takeoff and landing aircraft (VTOLs) and flying cars (Kasliwal et al., 2019) and more). Those kinds of drones are capable of transporting passengers or cargo, flying like the UAV, and having the size of a small or bigger airplane. We can say that their real development starts when they made their appearance in science fiction movies (see paragraph 2). Our paper tackles a number of objectives presented in the following paragraphs: in paragraph two, we try to imagine a futuristic scenario concerning the smart transport in smart cities using passengers drones (making some references to relevant movies), paragraph three presents an exhaustive state of the art in the field of manned/passengers drones, paragraph four, summarizes the frame of the project SAV (Socrates Aerial Vehicle), paragraph five analyzes the futuristic scenario of the passengers drones (smart transport for smart cities) flying and landing in smart cities, and finally paragraph six summarizes the perspectives and conclusions of our ideas and objectives.

2. STATE OF THE ART IN AERIAL SMART TRANSPORT

The truth is that the smart aerial transport with drones, either in cities urban transport, intercity transport, or even in outer space, starts to appear in movies of science fiction simultaneously with the scientific research. In Avatar (Figure 1C) the manned military drones play a key role in the attack against the indigenes. In Oblivion, Tom Cruise surveys (Figure 1A), a vast area of destroyed earth using a passenger drone. Matt Damon in Elysium (Figure 1 B, C), fights against manned military drones, in a movie where the manned drones may also make inter-planet trips (between earth and moon). More other examples but not so well known can be found in the movie industry. The idea of having a car capable of flying, -especially in the cities-, has often been the objective of scientific research but without successful results from many points of view. May manned drones be the successful solution for this new kind of urban smart transport?

Manned drone's evolution has been extremely fast in the last three years. Countries and cities have already tested and continue to test new manned drone's models. For example, big taxi companies create/build drone terminals and/or buy specific building roofs to be used as drone's terminals. Uber announced the six prototypes of Uber Skyports at its second annual summit in Los Angeles this year and its latest aircraft designs. The ports are designed near popular city locations, such as concert halls and stadiums, where large crowds are likely to gather. Each port can handle more than 4,000 passengers per hour within a three-acre footprint, meeting other requirements such as providing charging stations for the eVTOLs and meeting noise and environmental requirements. (Eleanor Gibson |11 May 2018)

Figure 1. Im. A is from movie Oblivion (Oblivion, 2013), Im. B and D are from movie Elysium (Elysium, 2013), Im. C is a manned Aerial Vehicle in Avatar Movie (Avatar, 2009).

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We believe that the manned and unmanned (meaning here without pilot) drones for passengers and cargo transportation will be one of the central urban transport mean in the near future: a smart transport for smart cities! Until now in some cities (e.g. New York, Paris, London, Monaco, etc.) or some islands (Paros, Mykonos, Antiparos Santorini, Majorca,) the only aerial transport to be used a city / island despite its many limitations is the helicopter.

Figure 2. Im. A: (What Is eVTOL: Electric Vertical Take-off & Landing | Spartan, 2022), Im. B: (未来城市空中交通展望, 2022).

3. STATE OF THE ART IN MANNED PASSENGER DRONE

In the early 1990s, the use of unmanned aerial vehicles (UAVs) increased. Drone technology has advanced during the 2000s, including advancements in commercial uses such as delivery and passenger transportation. UAVs are now employed by civilians for data collecting and analysis, surveillance, research, and other purposes.

Recent studies discovered that the present trend is being driven by a definite expectation of economic gains, which is being accompanied by more broad expectations of societal and environmental benefits. More specifically, they discovered that the discussion is marked by the juxtaposition of quite concrete economic expectations with quite complex and diverse difficulties. This reflects the various technological peculiarities and possible repercussions of drones on both society and the environment that remain unknown. (Kellermann et al., 2022) (Müller et al., 2019) More over several surveys reveals essential designs considerations from the aspect of users like:

- The increased usage of passenger drones should not result in increased air traffic congestion.
- Participants desired a vehicle that could be used for secure parking both on land and in the air.
- The cabin environment should be able to remedy vertigo and claustrophobia.
- The aviation system should be designed so that there is minimal reliance on people for flight control, and the autonomous system should be capable of handling the majority of the operations without interruption.

To make passenger drones more affordable to the general public, system designers must develop a model that is not only cost-effective but also economically feasible. (Khosravi et al.,2021) (Rautray et al., 2020)

On January 6, 2016, during the international Consumer Electronics Show (CES) in Las Vegas, the first passenger drone was unveiled. The 184 was a one-passenger drone with four propellers that could fly for around 23 minutes at a peak speed of 63 mph, according to Ehang, a Chinese corporation located in Guangzhou.

Many new businesses have emerged since then, and nowadays some of them made the manned drones available to public for commercial use, also some aviation authorities started making the frame and the regulation for such aerial vehicles.

Ehang is a Chinese manufacturer that has produced a number of drones. The EHang 184 was the company's debut model, and it was designed as an eight-rotor, two-passenger drone. In 2021, Ehang introduced the VT-30 model, equipped with eight twin rotor wing blades. (EHang | UAM - Passenger Autonomous Aerial Vehicle (AAV), 2022)

- Herbert Weirather launches Drone Champions AG, which offers a virtual reality drone flying game. The company declared in February 2020 that they had created and manufactured the "Big Drone". Indoor testing was place in Germany before the drone was brought for its first outdoor flights in Vrsar, Croatia. (Big Drone - Drone Champions League, 2022)
- The SureFly is a two-seat hybrid manned air vehicle. Powered by a 200-hp gasoline generator, it can reach speeds of 110 km/h. It can lift a 180-kilogram payload and comes with a ballistic parachute, with a price tag of $200,000. (Inc., 2022)

Airbus has updated its CityAirbus project for use as an air taxi. New layout includes a fixed wing, V-tail, and eight electric propellers. It should be capable of transporting up to four passengers across 80 kilometers at 120 kilometers per hour. First flight is scheduled for 2023, with certification following in 2025. (CityAirbus NextGen, 2022)

- Jetson ONE has a top speed of 102km/h, 8 propellers and a flight time of 20 minutes. Jetson Aero a Swedish company finished their prototype in the spring of 2018. The production of 2022 and 2023 have already sold out and partially sold out. (Jetson, 2022)
- The Lilium Jet is a prototype electric vertical take-off and landing airplane. After 100 flights, it may be able to shift from vertical to horizontal flight. It has 280km/h max speed, 36 ducted fans, and a range of 250+ km. (Lilium Air Mobility - Lilium, 2022).
- The Volocopter 2X is a German two-seat multirotor electric aircraft with optional piloting. The airplane has a normal empty weight of 290 kilograms and a gross weight of 450 kilograms. It debuted at the 2017 AERO Friedrichshafen airshow. (Volocopter, 2022)

4. THE SOCRATES LAB - UNIWA PROJECT (SAV – SOCRATES AERIAL VEHICLE PROJECT) FOR A MANNED PASSENGERS DRONE

Since 2019, the University of West Attica, in the center for long life Education, has been operating the first public and academic program Remote Pilots / Drones Pilots School, according to the European frame, legislation, and instructions. The school named “DOMINATE” (https://dominate.uniwa.gr/) which is an acronym for “DrOne MissIon desigN And daTa procEss”, besides the basic Remote Pilots Europeans Licences A1-A3/ A2, offers specific education programs for the use of drones for cartography, environmental protection, infrastructure inspection, agriculture, etc. Special training is also offered concerning the night flights, the Extended Visual Line of Sight flights (EVLOS), the Beyond Visual Line of Sight flights (BVLOS) (Figure 3), the flights for aerial works, the flights with fix wings drones etc. In parallel and with close collaboration with the National Service for Civil Aviation, we develop specific education programs for drones in the frame of the new regulations of EASA (European union Aviation Safety Agency) Mobility. Due to the fact that in this school teach University professors from different University departments (Mechanology, Informatics, Geoinformatics, etc.) the DOMINATE school became a center for innovative research ideas and projects development quickly. In a few words, this is how the SAV project idea has born. In the beginning, after testing a large number of drone models, we decided to be based on the Mavic Air 2 model of DJI Company in order to develop our manned AV (Figure 4a). The basic reasons for this choice were the stability of this model, during strong winds and the user friendly navigation functions.

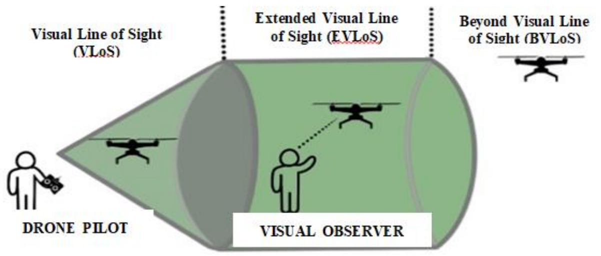

Figure 3. VLOS, BVLOS, EVLOS visual representation.

At the very beginning, the idea of the prototype realization included carbon fiber as the basic material, for bucket seats for passengers and pilots and aluminum for the rest of the prototype. In a second phase and after the construction of the model and the successful flight, structural elements of the frame could be adjusted, such as the motor shafts, the arms, etc. (Figure 4b).

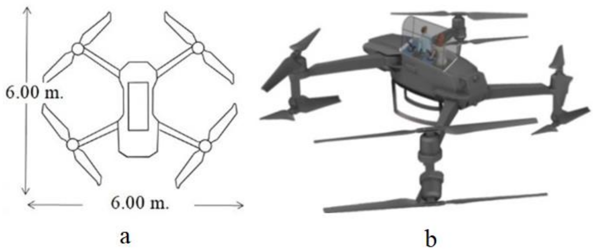

Figure 4. a. The first SAV project idea. b. First basic model mainframe.

Nevertheless, the initial ideas for developing a new type of aerial vehicle with the primary aim of serving transport in the city have changed. The new ideas are based on a similar aircraft that appeared mainly experimentally in the last five years, while only one in 2021 went into commercial production. Its flight is based on the flight mode of the UAV quadcopters, a flight completely different from that of both the plane and the helicopter. As we have already mentioned, several such efforts have been successful, either by very small and newly established companies or by large and well-known companies in the aviation industry. So the key question that arises from the beginning of such a venture is this: Why to such a vehicle? In our opinion, the most precise reasons that answer the above question are the following:

The flight of such an aircraft is very easy, and the training needed by anyone is considered almost analogous to the training of a car (provided that he is not afraid of heights). The possibility of automated and pre-scheduled flights also makes things even simpler.

1. We believe that such aircraft, in combination with the corresponding low-cost infrastructure and the corresponding legal framework, will be the answer (or one of the best answers) to the problem of transport within cities and the numerous mega-cities in the near future. The proposed solution is far superior to any other. It goes without saying that combined solutions are usually the best answer to such complex problems as intercity transportation.
2. There are already successful efforts that confirm the feasibility of the project.
3. There is already know-how for all parts of the proposed aerial vehicle construction.
4. The cost is considered very low.
5. It is an ecological solution without the burden on environmental pollution (compared to aircraft use).

4.1 The problem and the solution

The basis for resolving the design and the flight capabilities of the proposed aircraft is, as already mentioned, the flight and the manner of flight of the smaller UAVs (quadcopters) as well as the successful efforts of such aircraft so far. Our efforts concerning the aerial vehicle passengers' number will be escalated as following for:

1. A human dummy model around 80 kg.
2. One passenger/pilot around 80 kg.
3. Two passengers with baggage (300kgr)
4. Four people with a maximum weight of 320 kg
5. Ten people with a maximum weight of 1000 kg

4.1.1 Basic Model's main proposed technical characteristics -SAV-B1: Regarding the two-seat quadcopter manned drone city flight vehicle. The technical characteristics are the following:

1. Max takeoff weight 1000 kg (empty with full equipment 700kg)
2. Min engine thrust (idle -MIN RPM) 150 kg & max thrust -lift (max RPM) 400kg per engine (total engines thrust 1600 kg)
3. Cruise speed 130 km/h
4. Landing limits max crosswind 80 km/h
5. Landing space: a circle with 6,00m diameter + 1,00m safety
6. Other dimensions: passenger's area 1,30 X 1,50 length (Figure 5)

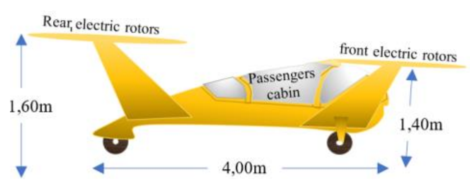

Figure 5. Basic model side view and physical dimensions.

7. The wheels can be replaced by a stable landing basis (like the helicopters) (Figure 6) (Figure 7)
8. Constructional Characteristics: A heavy-duty aluminum frame will be the only metallic part of the vehicle (Figure 8a)
9. The whole surface will be of carbon fiber with embedded elements of antennas – sensors – lighting led arrays and navigation aids

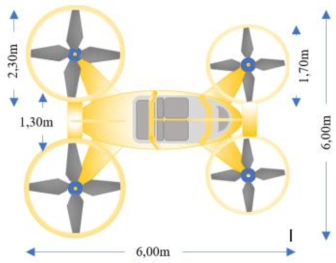

Figure 6. Basic model vertical view and physical dimensions.

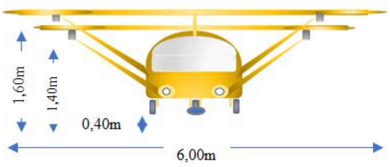

Figure 7. Basic model Front view and dimensions.

10. LOADS. In the front and rear of the main vehicle body will be the batteries position. In the front area a smart hybrid gas generator will be placed to provide electric energy in extreme requirements (failure of battery or charging purposes or extra power in heavy takeoff conditions). In the rear section a landing light with the tail single wheel will be positioned in the same area
11. Within the four rotors' pillars, fuel elastic tanks will be placed to feed by gravity the hybrid generator which will be supported with ram air during the flight for cooling purposes and cockpit air conditioning uses (heating the ram air) (Figure 8b)

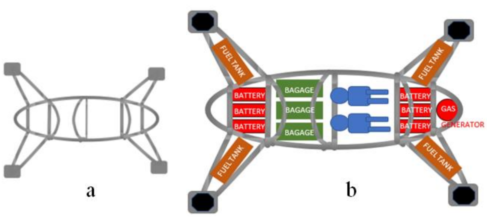

Figure 8. a. Basic model mainframe. b. Basic model fuel tanks battery and personnel allocation.

12. The rotors' pillars frame will be covered by aerodynamic cover like the rest vehicle's body to minimize the drag during the flight
13. The main vehicle's body will be at the same philosophy, an aerodynamic wing shape producing extra lift during horizontal flight. (Figure 9a)
14. Extra electric power of 600 watt may be achieved during the day light period if a Photovoltaic Film is positioned on the vehicle's surface. (Figure 9b)

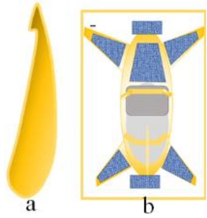

Figure 9. a. Main vehicle body aerodynamics. b. Top view with blue PhotoVoltaic Film on the surface of the vehicle.

15. Four autonomous electric engines will produce the lift with four blades each. The number of four blades is a matter of principle design and safety. Using four blades we have less length and less vibrations. In addition, in engine failure condition, the vehicle is falling (F1 vertical speed in-flight condition (D direction of falling flight) due to its aerodynamic shape (L3 is a total glide lift force) and the four engines' propeller influence (they cause vertical drag – falling resistance as L1 + L2) decreasing the falling speed. They behave like a parachuting fall. The main reason for the longer blades in the rear is a matter of aerodynamic behavior of the vehicle during an emergency falling flight. The rear blades will produce higher lift conditions (wind meal run), and the vehicle's nose will be lower. It will help the stability and the platform flight performance to have positive lift forces (Figure 10)

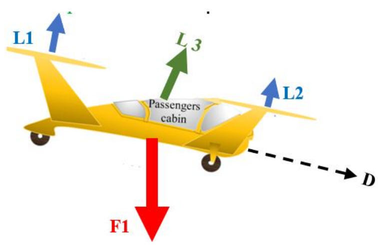

Figure 10.Forces acting on vehicle.

16. Rotor's philosophy. The four blades made by fiber – composite – aviation material will have the exact dimensions after finalizing the requests for lifting and cruising needs. The exact span, min at the end and max-width near the center will be calculated in accordance with the rpm engine performances (Figure 11a)
17. A circle fiber-made aerodynamic cover will provide extra safety conditions during takeoff or landing conditions protecting the blades and not only (Figure 11b)

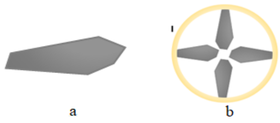

Figure 11. a. Blade schematic. b. Rotor safety cover.

4.1.2 The engine: The aircraft's flight (passenger's UAV) will be supported by electric motors of special construction, which will fully meet the design requirements. The U15XXL motor is a candidate for use in the proposed aircraft, which has 102Kg maximum thrust, maximum power of 28KW and is powered from 50 to 100 Volts. Also the operating temperature is 130^{o}C. The aircraft will need at least 8 such motors. It should be emphasized that in the above motor, the propeller is included. (Anon, Motor the safer propulsion system)

4.1.3 The batteries: Battery selection is vital for electric aircraft. Many of them are too heavy, but there is a clear safety issue even in those without a weight problem (risk of fire, explosion). There is also a big issue regarding their charging times. A hybrid electrical system has proven to be quite satisfactory for use in electric aircraft. In our case, however, and especially in the standard SAV aircraft, the appropriate batteries specially made for its weight and engines will be selected. (Anon, Drone battery customized solutions)

4.1.4 The drone navigation, controls and flight operation: The flight and the handling of the aircraft in general is based on the flight and the handling of the UAVs. There are, therefore two proposed solutions:

1. Two levers (controls) with the same functions as in a UAV.
2. A lever as in FPV (First Person View) UAV.

Both solutions have advantages and disadvantages.

4.1.5 Control instruments: The operation and navigation screens of the aircraft must give the following indications (based on the indications of the respective UAV applications: Number of Satellites Online, Battery Level, Navigation Map, Ambient Temperature, Compass, Horizon Electronic Instrument, Speed Indicator, Sensor Status, Altitude Indicator. The aircraft's position on digital satellite maps will be shown, it will be possible to navigate and pre-plan the flight. The battery information screen must include near-real-time battery cell voltage temperature and cell status and static info like battery serial number and times that the battery had charged. In the transmission information screen, a near real-time graph will saw the pilot/user the channel's frequency spectrum and the stability of each one in case of remote management of the aerial vehicle. Also, for safety reasons, a screen with a setup of maximum altitude and RTH (Return to The Home) autopilot must be present and configured by the pilot/user before the flight.

4.1.6 Navigation controls and how to use them: Navigation will, in principle, be automated. The idea is to show/input the coordinates of the point of arrival and the flight to be done automatically as in the UAVs. The navigation functions will be the following:

1. Take-off landing (moving forward - left control)
2. Left-handed right-turn rotation (left-hand movement - right-left control)
3. Forward-reverse (left-rear left-hand drive)
4. Left Right Side (left-hand drive - left-hand control)
5. A combination of movements gives the expected result e.g., movement forward left control with simultaneous movement right control would lead to take-off with simultaneous movement of the vehicle forward (Figure 12)

4.1.7 Controller: The proposed controller for the manned aerial vehicle could be MP21283X Triple Redundant which consists of three complete autopilots, advanced voting logic and a carrier phase GPS. A triple-redundant system is made up of three similar systems. If one of the three systems fails, the other two will take over to provide a double redundancy arrangement.

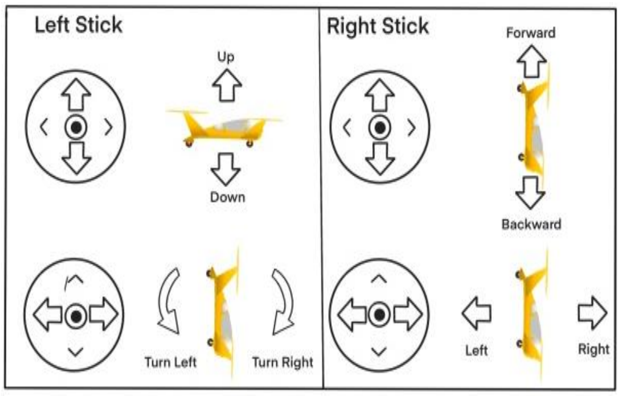

Figure 12. Joysticks combinations.

If one of the other two systems fails, the third system will take over. There is an additional system to oversee the three systems. Triple redundant systems are very tolerant of autopilot hardware failures. The redundancy board has several input/output ports. The board has two serial ports that can communicate with a ground control system using radio modems. This design prevents users from needing to work directly with bare circuit boards. The autopilots have no individual casing, which keeps the system's overall weight very low; however, the entire redundancy board is enclosed to protect the system. (www.micropilot.com, World leader in professional UAV autopilots: Product Page - MP2128 3X triple redundant autopilots).

4.2 Safety/Sensors

A basic precondition for the successful development of the vehicle both in the experimental stage and in its possible commercial success is the safety that it can offer to both the passengers and the possible victims and damages in case of a fall.

The installation of sensors is mandatory. The required sensors will be similar to commercial UAVs but with a special design to avoid collision with any obstacle in the flight path. For example, TF02-Pro 40m IP65 LiDAR sensor will be an ideal selection that combines low cost and high efficiency. Each of 5 sensors will be installed at the front-back-left-right of the air vehicle and at the bottom to maintain attitude hold.

4.2.1 Spare engine/engines: In case of failure of an engine, immediate start of a second spare engine means that there will be 4 spares. A solution that increases the cost and it is unacceptable. Operation with eight motors/propellers presents the best chance for recovery when one motor or propeller fails; by spinning faster the two neighbors' motors, the drone can maintain level flight. (Zhang, 2018). This solution has already been implemented.

4.2.2 Parachute: In case of a complete failure of the engines, the automatic opening of the parachute(s) is activated.

4.2.3 Shock absorber: Application of shock absorbers that will absorb impact in case of failure and emergency or abrupt landing is a proposal we will investigate.

4.2.4 Safety arms: Roof safety arms/roll bars will provide additional safety in an emergency landing.

5. SMART CITIES FOR SMART TRANSPORT: A FUTURISTIC OR AN ACTUAL REAL SCENARIO?

5.1 Smart City Infrastructure for Urban Air Mobility

Sustainable Urban Mobility (SUM) is a top-ranked topic in all major Smart City projects. SUM includes initiatives for new mobility services and electric cars, as well as for Urban Air Mobility (UAM) (Urban Air Mobility (UAM) | Smart Cities Marketplace, 2022). Urban air mobility (UAM) and its associated technologies will transform the Smart City and its basic component, the Smart Home. New architectural designs, new structural components, special infrastructure and new IT infrastructure, will emerge, and, they will be required in a building that will support Urban air mobility (UAM). Several projects are currently running, such as NASA's High-Density Vertiplex for Advanced Air Mobility (Advanced Air Mobility (AAM), 2022), that focus on the development of technologies and infrastructure for UAM and will eventually impose a significant change in building design in the near future. Through the centuries, mobility and its corresponding means of transport imposed various designs, requirements, restrictions, or additions in the area of building manufacturing (Figure 13).

Figure 13. Adjusting building infrastructure to mobility needs through the centuries: From Stables and Docks to Car Parking and Verti-Ports.

The challenge for Smart-City/Smart-Building designers is to incorporate, early in their projects, the future need for UAM. The addition of Urban-Verti-Ports or Building-Verti-Ports to every new architectural design will become necessary.

Bigger and taller buildings will require large roof installations to house passenger UAVs and to provide one or more docking platforms. Large houses with large balconies, verandas, flat roofs, & terraces will ask for a landing pad/dock for their private/taxi UAV. Smaller houses with not enough space will be served by a shared installation, with the rest of the neighbors in the block. Apart passenger UAVs, all categories of buildings will also require, from the architect or civil engineer, the provision for smaller landing pads to serve the increasing delivery services of UAVs.

These new Urban-Verti-Ports designs should be cost-effective, rapidly deployable, and "compatible", i.e., vehicle-agnostic, ensuring open access for all vehicle operators. Of course, a number of issues will arise regarding the required building changes in infrastructure, the strength of roof/pavement, the allowed height in the area, the distance from other obstacles, buildings or electrical wires, etc.

On the other hand, the challenge for UAV designers is to build compatible vehicles in the sense of docking & infrastructure requirements.

Existing buildings will soon 'struggle' to find a place to install their Urban-Verti-Port. Construction companies will be asked to make roof upgrades, reinforcements, and additions to accommodate UAV docking stations. In addition, larger buildings with big flat roofs may rent their infrastructure for Urban-Verti-Ports.

In London, companies such as Skyports are already investing in roofs of apartment buildings to convert them into vertiports for landing and loading UAVs (Fairs, 2018).

The demand for "future-proof" buildings is expected to rise in the construction industry. New flats will come with a drone landing pad on the roof terrace, accommodating the development of contactless delivery, and correspondingly, new office or apartment buildings will come with Verti-Ports on their roofs accommodating the development of Urban Air Mobility (Figure 14).

Figure 14. Design plans for Urban-Verti-Ports: a) (left) on a terrace for small-delivery drones, b) (left) on a roof for larger-passenger UAVs, and, c) (down) on the balcony extensions of a building for private/personal vehicles.

5.2 Basic Verti-Box Docking Station Description

A number of automated drone hubs, for smaller UAVs, exists already in the market. They provide storage, recharging and readiness combined with automated landing/take off. When moving to a passenger UAV the scale of this docking station is changed.

On the one hand, for larger investments, the docking plans include special wide areas for large vertiports that will support the massive use of passenger UAVs. Smart Cities will soon incorporate such facilities, i.e., a combination of today's bus stops & airfields, as a new means of mass transportation. On the other hand, Smart Homeowners with enough roof space will require a smaller version of a vertiport, i.e., their own landing pad for docking and storing their private passenger UAV.

The proposed ideas for a passenger drone, presented in the earlier chapters, would not be complete without a proposal for its corresponding docking station/platform.

With our view focusing at the future of UAM, we propose a versatile container-landing hub the Verti-Box (Figure 15).

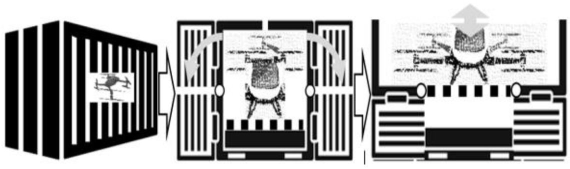

Figure 15. Passenger UAV transportation & deployment stages, using a standardized container box, which converts to a docking hub (Verti-Box).

The Basic properties the Verti-Box docking base are:

- Easy transportation. Using a standardized container box makes transportation very easy, by any available mean (trucks, trains, ships, airplanes, big helicopters, etc.), and practically everywhere on earth.
- Easy installation-deployment. Verti-Box has side and top opening. The UAV remains folded when closed. When the top opens, the landing surface is expanded, and the UAV is ready to unfold & fly.
- While docked or transferred, all weather protection for the UAV and its supporting equipment.
- Complete, safe and easy connectivity to mains & networks of a smart house.
- Overall: A safe & easy to functional docking hub that can be installed anywhere around, above, besides, or outside a smart house in a smart city.

The main functional requirements for the docking station are more or less the same as those for smaller hubs, i.e.:

- All-weather functionality (-50…+50^{o}C),
- Automatic open/close for takeoff/landing,
- Automatic Battery Recharging/Replacing,
- Unique Station Identification (apart from GPS, by using e.g., RFID, IP, QR, bar-code, etc.)
- Stable & secure connection to the Internet, 5G and IoT.
- Uninterruptible power supply and sufficient power storage,
- Compatibility with all-electric/computer/mobile networks
- All kinds of weather & proximity sensors to facilitate automatic & unmanned landing and correct positioning.
- Advanced scheduling capabilities for arrival/departure and recharging of multiple UAVs.

6. CONCLUSIONS PERSPECTIVES AND FUTURE CHALLENGES

An increasing number of megapolis will inevitably create a big problem for urban transport. The distances will be huge similar to inner-city trajectories, but with different, bigger and more complicated problems to solve. The problem will have no solution unless we use the third dimension of the mobility, the Air Mobility.

Similar efforts have already started and we believe that the solution for the future will be: smart transport for smart cities, air transport with passengers' drones. European Union already prepares the legal frame for Urban Mobility. (EASA issues world's first design specifications for vertiports | EASA, 2022)

Of course, a number of parameters must be analyzed and studied in order to make the use of urban aerial vehicles effective and safe, such as:

- the legislation frame of their use
- the safety matters
- the places of landing and takeoff in the cities
- the pilots/users' training
- the terrain stations for signal transmission in order to operate each aerial vehicle in an automated manner (e.g., using only the coordinates of the starting and ending points)
- the necessary data for a safe navigation
- the necessary infrastructure

In our contribution, we described the existing solutions, as we are looking forward to the future of urban mobility and we presented our efforts and proposals for the realization of such aerial vehicle. We had the ambition to present all the facets of the problem and their solutions showing the interconnectivity and interference between them.

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