Professorship of Mobility Policy
TUM School of Social Sciences and Technology
Technical University of Munich

Holistic Approach For The Market Introduction Of Advanced Air Mobility (AAM)

Market segmentation analysis for AAM use cases in Cape town, Dubai & Johannesburg

Arshdeep Singh

Katrin Lippoldt, M.Sc.

Prof. Dr. sc. ETH Zürich Allister Loder

Student ID: 03739914

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Supervised by Katrin Lippoldt, Allister Loder

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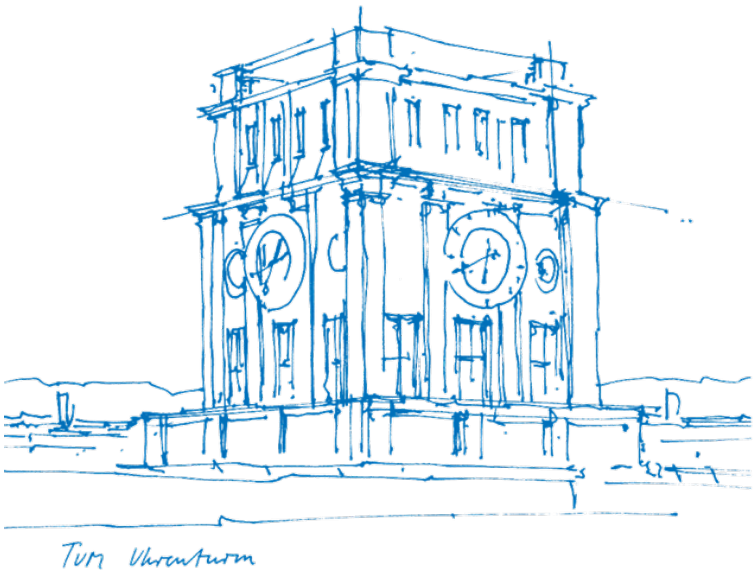

Erklärung

Ich versichere hiermit, dass ich die von mir eingereichte Abschlussarbeit selbstständig verfasst und keine anderen als die angegebenen Quellen und Hilfsmittel benutzt have.

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Contents

List of Figures

1 Introduction

Electric air vehicles worldwide have been developing for more than a decade now with millions of flight tests already conducted and many more to go in time to follow. These vehicles are quieter, more sustainable, and promise many things different from conventional aerial vehicles such as very short duration flights at higher speeds, low travel prices, and easily accessible in the vicinity of an Urban environment. In aviation, major revolutions have come about because of innovation in propulsion technology. We are now at the start of a new chapter – the age of electric propulsion. Future electric vertical take-off and landing vehicle (eVTOL) aircraft form a key part of this new era. Aircraft designs must be certified against compliance with specific regulations and this new generation of eVTOL aircraft will not be different in that regard. This latest age of electric aviation has the opportunity to look back and learn from the lessons of the past 100 years while embracing today's advancements in automation and digitization.

Advanced Air Mobility (AAM) has the potential to change the way we commute especially for short distances. AAM represents a transformative shift in transportation, aiming to make air travel more accessible, sustainable, and integrated into daily life. By leveraging cutting-edge technology and innovative aircraft designs, AAM has the potential to significantly improve urban mobility, reduce travel times, and provide new solutions for transportation challenges in cities like Cape Town, Johannesburg, and Dubai. In this research, we are choosing three cities Cape Town, Johannesburg, and Dubai for conducting market segmentation analysis and developing an approach for market entry of eVTOLs(electric vertical take-off and landing vehicles) because of their unique landscapes, economies, and infrastructure, which offer both opportunities and challenges for AAM. The hypothesis says that AAM has substantial potential to enter these markets across various segments addressing critical urban transportation challenges. Key questions that will be answered in this research are which market segments AAM can improve, how it can serve public and private transportation needs, and who the potential customers and use cases are for AAM in these cities.

This research will help find the key market areas and suggest promising business models, that can help to integrate AAM into the transportation systems of Cape Town, Johannesburg, and Dubai. This could lead to more sustainable, efficient, and innovative transportation solutions that improve urban mobility and quality of life in these cities. In the following sections, we will provide a deep analysis of the current state of transportation in the selected cities, asses their specific needs, and explore how use cases like Air taxis, Air Shuttles, Regional Connectivity, and Emergency Response Services create different opportunities for the integration of AAM into the existing transport infrastructure. The importance of the research lies in its potential to guide manufacturers, policymakers, and other interested parties in urban mobility in the

strategic implementation of AAM. By identifying key market segments and proposing a market entry strategy according to specific use cases the study will facilitate the successful integration of AAM into the the selected cities

2 General Literature Review

Traffic congestion in metropolises has been a pervasive challenge that casts a shadow over citizens' daily routines and physical well-beingNadrian *et al.* (2020). Recent discussions regarding the utilization of the third dimension in airspace have emerged, exploring alternative transportation modes capable of providing higher speed and punctual servicesWang and Qu (2023). As a result, there is a growing demand for mobility services, including passenger and freight transport, which leads to severe problems in larger cities, such as congestion and air pollutionBecker *et al.* (2020). A key challenge facing future urban mobility is to find an effective balance between economic sustainability, environmental regulations, and travellers' satisfactionCanitez (2019) While the future of urban mobility seems uncertain, several concepts are generated by new or improved technologies including autonomous vehicles (AVs), electric vehicles (EVs), and the integration of shared mobility servicesMiskolczi *et al.* (2021). Urban Air Mobility (UAM) one such concept operates within the low-altitude airspace of urban areas and transcends the densely packed road networks, which alleviates the challenge of roadway congestion Wang and Qu (2023), thus contributing to sustainable transport this basis, new concepts in aviation have also come forward which pave the way for innovations in Urban Mobility.

As a major transportation method, the aviation industry also follows the trend to reduce the emission of new generations of aircraft. Improvements in air-frame and engine technologies increase aircraft efficiency and reduce their emission. Aircraft electrification has become one of the most popular approaches to reduce aircraft emissionsKarpuk and Elham (2021). Electric aviation has become an important area of research following the rapid growth of the aviation industry, which directly corresponds to significant growth in aviation-related emissions. Despite the promising emission reduction potential of electric airplanes, several technological and regulatory challenges restrict the realization of this new regime of sustainable air transportAdu-Gyamfi and Good (2022). Benefits of all-electric aircraft include noise reductions 17 percent, a reduction in greenhouse emissions of 80 percent, operating cost, and pilot training cost reductions of 70 percentMoua *et al.* (2020)

As a major part of Advanced Air Mobility (AAM) represents a collaborative vision shared by NASA, regulatory agencies, and global industry leaders, aimed at establishing a robust and reliable air transportation ecosystem, which is expected to facilitate the safe and efficient movement of both people and cargo within urban, suburban, and regional environments .Kiesewetter *et al.* (2023) . Practitioners (e.g., Uber, Boeing, Joby Aviation, Airbus, Volocopter, Lilium, Ehang, Skydrive, and others) and researchers have been actively engaged in the activities to explore the feasibility of deploying UAM, addressing a broad perspective of issues involving demand forecasting, infrastructure development, flight route planning, pricing strategies, energy supply, safety control, and noise reductionCohen *et al.* (2021)

Espejo-Díaz *et al.* (2023a) Advanced air mobility vehicles could become an alternative means of transport to overcome traffic congestion in cities in the upcoming years. There has been enormous interest from companies and governments in recent years in developing such technologies and enabling markets for new air transportation services. Advanced air mobility (AAM) is an innovative concept that can enable new services for inter- or intra-city multi-modal transport, on-demand air passenger mobility, unmanned cargo delivery, rescue, and emergency operations. It is expected to bring ground-based mobility to low-altitude airspace to alleviate current challenges such as road congestion, carbon emissions, and inaccessibility in remote areasGuo *et al.* (2024).Essentially, air taxi services comprise a multimodal process. Alongside the flying segment, a complete UAM journey must encompass ground transportation, facilitating travel from the origin point to the departure vertiport and from the arrival vertiport to the final destinationRajendran and Zack (2019)

3 Advanced Air Mobility (AAM)

NASA defines AAM as safe, sustainable, affordable, and accessible aviation for transformational local and intra-regional missions. AAM is based on three main pillars as the basis to define its operations which are

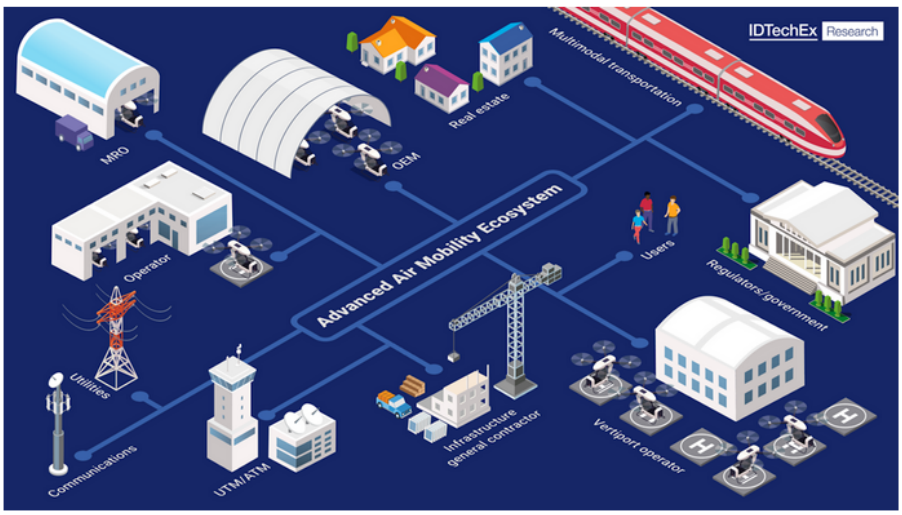
Sustainability: According to the European Environmental Agency (EAA) More than 17 percent of global aviation CO2 emissions could be addressed with lower carbon technologies such as green propulsion

Convenience: The promise of Urban air mobility that it gives concerning speed, noise, and infrastructural change, Also Door to door delivery with drones

Preservation of life:This will be achieved in case of combat advantage where it could help removal of war fighters from front line plus immediate support to front line persons. Emergency management is also one of the best use cases with respect to supply drones in remote ares or disaster management

Advanced air mobility according to Johnson and Silva (2022)is a growing dream in the aviation community of providing air mobility as an alternative for everyday transportation requirements described variously as On-Demand Mobility (ODM), Urban Air Mobility (UAM), Air Taxi Operations or Advanced Air Mobility (AAM).Dulia *et al.* (2021) defines AAM as an emerging transportation system that will enable the safe and efficient low altitude operations and applications of unmanned aircraft (e.g., passenger transportation and cargo delivery) in the national airspace. Garrow *et al.* (2022) believes that AAM is the reinvention of the idea of air travel. While the current commercial air transportation system is distinct from other modes of transportation because it has a monopoly on long-distance, high-speed journeys, AAM systems have been innovatively built to become an integrated part of a city or regional transportation system and, therefore, everyday life. AAM would work cohesively with ground-based modes as a segment of a customer's multi-modal journey to take advantage of high travel speeds and ground traffic avoidance as Figure 1 depicts. Advanced air mobility (AAM) is a broad concept enabling consumers access to on-demand air mobility, cargo and package delivery, healthcare applications, and emergency services through an integrated and connected multi-modal transportation network.Goyal and Cohen (2022).

Figure 1: Depiction of general AAM ecosystem



As such, AAM is a broad term that covers an array of missions that may be performed in different types of aircraft flying between and over many different locations, including bringing

aviation capabilities to areas that are not currently served by aviation. AAM can encompass passenger transport, the movement of cargo goods, and aerial work missions. With AAM there are some other acronyms also which are often used. Some of them which are very common are: **UAM** (New transportation modes in urban environments like Air taxis and last mile cargo etc) **eVTOL** (The technology that makes UAM possible. Electric Vertical take off and Landing Vehicle.)More about this will be explained in section 3.3.1 **UAV** (The encompasses drones. Also UAS for Unmanned/Uncrewed Aerial System.) . The Main Objectives of AAM or the value it can provide include

- Improving transport efficiency to reduce travel times by providing a new way of travel contrary to traditional ground transportation, particularly helpful in case of congestion in Urban areas.
- Utilizing airspace for transportation will be very helpful in reducing urban road congestion leading to smoother and faster commutes
- With the use of an electric mode of transport AAM aims to reduce carbon emission, and noise pollution, hence emerging as a cleaner, quieter alternative mode of transportation in the Urban environment
- In case of emergency AAM can promise to offer a rapid application for services such as medical evacuation, disaster response, improving response items and potentially saving lives.
- Stimulate economic growth by creating new jobs in manufacturing, maintenance, operation, and infrastructure related to eVTOLs and supporting system
- One of the best transportation solutions for underserved and remote populations improving their access to various services, social activities, etc.
- Development of the AAM industry has paved the way for innovation not only in the aviation industry but also in related fields like advancements in autonomous systems, electric propulsion, and air traffic management

4 Key Components

4.1 Regulations

Electric Vertical Take-Off and Landing (eVTOL) are gaining momentum and regulatory bodies worldwide are involved in shaping standards for the safe integration, and operations into the existing urban transport infrastructure.

Federal Aviation Administration (FAA): FAA one of the first regulatory bodies around the world that laid the blueprint for introducing Advanced air mobility is playing a crucial role in the certification of eVTOLs and shaping the future of AAM. American regulatory body is evaluating these aircraft in three distinct categories: Type Certification: This involves assessing the design and safety of a specific eVTOL model Production Certification: Manufacturers must meet production standards to ensure consistent quality. Operational Authorization: Pilots and operators receive authorization to fly eVTOLs.

Regarding evaluations of operations, UAM(Urban Air Mobility) FAA states three evolutionary Stages in version 2.0 of the Urban Air Mobility (UAM) concept of operations document FAA (2023).

1. **Initial UAM Operations**: In this phase, current operations are supported by existing rules, procedures, and designated routes. As additional operations outside the current operational scope initiate changes need to be introduced to accommodate the additional demand and location of operations within the regulatory framework of the current Air Traffic Service (ATS) system.
2. **Midterm Operations**: The number and complexity of operations, along with aircraft capabilities and equipment, may increase beyond that effectively supported by leveraging current rules. To support such an increase, a UAM cooperative environment may need to be developed and implemented with new or modified procedures, an updated regulatory framework, and COPs. The UAM cooperative environment (i.e., UAM Corridor) is a performance-based airspace structure with defined parameters that are achievable by the participants. UAM Corridors would be known to airspace users and governed by a set of rules that prescribe access and operations. Where supporting infrastructure and support services meet participation requirements, UAM operations may be conducted. Operators whose aircraft meet performance and participation requirements may conduct operations within the UAM Corridor. Initially, the number of UAM Corridors may be low or

limited in use, but over time, additional UAM Corridors may be introduced as they may be utilized in airspace areas where traffic volume requires their establishment in the interest of safety and efficiency. The UAM Corridors may transit any applicable airspace classes

3. **Mature State Operations** :UAM operations continue to occur within UAM corridors.The Corridors may form a network to optimize paths to support an increasing number of vertiports. Remote piloting is very widely available. Additional increases in the tempo of midterm operations could require advances to the UAM environment and aircraft. To overcome the constraints, UAM operations may evolve into UAM mature state operations through advances in data sharing, DCB, UAM structure, and aircraft automation. Mature state operations may also include additional COPs accompanied by UAM-driven regulatory changes.

On May 3, 2023, the FAA released Version 2.0 of the Urban Air Mobility (UAM) Concept of Operations (ConOps) that describes the technical road map for enabling UAM, which is an urban-focused subset of AAM, from the near-term to far-term. The focus of this Implementation Plan, Version 1.0, is to document the work required to enable initial AAM operations in a variety of operational settings or “key sites” in the near term. Since we are researching the implementation of the services eVTOLs will provide in the Urban and regional airspace this document gives guidelines on how the operations will take place which will be helpful in the research

faa (2023)Innovate28 (I28) is an FAA effort that aims to combine AAM operations with OEMs and/or operators flying between various origins and destinations at one or more locations in the United States by 2028. I28 will use public-private partnerships to identify key locations and use cases of interest to AAM sector stakeholders, while also encouraging an all-hands-on-deck approach to ensure the essential measures are made to support these operations.

European Union Aviation Safety Agency (EASA): published rules for the operation of air taxis in cities, the first comprehensive proposal for such regulations to be issued worldwide. The proposed new regulatory framework is open to public consultation until September 30, 2022, and covers the technical domains of airworthiness, air operations, flight crew licensing, and rules of the air.

They complement existing EU regulatory material for operations of Unmanned Aircraft Systems (UAS), the unmanned traffic management system known in Europe as U-space, and the certification of aircraft capable of Vertical Take-Off and Landing (VTOL), as well as EASA guidance on the design of vertiports. EASA’s latest proposals will establish a harmonized set of regulations and rules at the EU level for this new mobility by air of people and cargo.

The overall objective is to foster the development of a new ecosystem for urban air mobility (UAM), to achieve the safe and secure integration of certified UAS and VTOL-capable aircraft operations in the EU, and to enable operators to safely operate VTOL-capable aircraft in the single European sky.

4.2 Operations

One of the key components of AAM is operation which includes types of air crafts and infrastructure that makes all the operation of advanced air mobility scenarios happen:

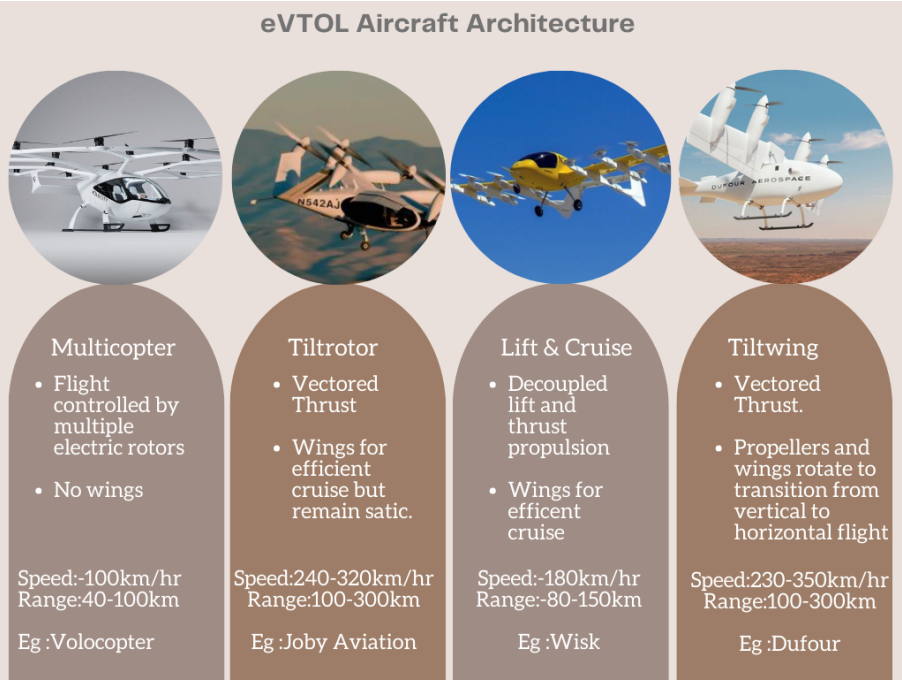
4.2.1 eVTOL Aircraft

There are a few modes of propulsion for vehicles in the AAM scenario called VTOLs or vertical take-off and landing vehicles but in this paper, we will only consider eVTOLs Electrical vertical landing and take-off vehicles (eVTOL) aircraft a type of air vehicle uses electric propulsion to complete its full set of operations from takeoff to landing thus providing enhanced efficiency, safety, and noise. These vehicles are mostly designed to operate in Urban environments to provide rapid transportation options that can bypass the congestion on the ground and provide a comparative time-saving advantage to the conventional or already in-use modes of transport in the urban environment. One of the main deciding factors behind the design of eVTOL is to provide environmentally sustainable air transportation options. Electric vertical takeoff and landing (eVTOL) technology is similar to that of a helicopter, allowing air taxis to lift and land vertically or maneuver at precise vertical angles between the buildings and other obstacles in metropolitan citiesYang *et al.* (2023). In the eVTOL market, there are four types of vehicle types Based on their design or aircraft architecture.

When we talk about the design and types of vehicles that will be used for AAM operations. Hundreds of aircraft prototypes have been introduced in recent times and out of those few were able to be flown and fewer have reached certification, commercial launch, or operations phase. Years leading up to 2024 saw some OEMs assembly of type-confronting eVTOL which is an important step towards achieving the certification required to begin the passenger operations. There are a variety of prototypes available in the scenario but we can narrow down these to a category of four different types of the basic structural design of that aircraft. Each design

corresponds to different speed and distance ranges. In Figure 2 you can see all four prominent designs of eVTOLs

Figure 2: eVTOL designs



Multicopter

Commonly used evtol designs a Multi-rotor helicopter is an aircraft whose lift is generated by four rotors. Control of such a craft is accomplished by varying the speeds of the four motors relative to each other. Multi-rotor crafts naturally demand a sophisticated control system to allow for balanced flight.Speed ranging from $100\,\mathrm{km\,h}$ to $120\,\mathrm{km\,h}$ and maximum distance travelled between two point averaging from $40\,\mathrm{km}$-$100\,\mathrm{km}$. One of the most popular evtol designs of this category is built by Volocopter named Volocity as shown in Fig 2.

Tiltrotor

A tilt rotor is an aircraft of a special kind, which possesses the characteristics of a helicopter and a fixed-wing airplane. Uses vectored thrust for flight and wings for efficient cruise but remains static. Tiltrotors are a type of aircraft configuration characterized by the ability to use the lifting rotors as propellers in forward flight by tilting them 90 degrees and obtaining lift from a wing. The general goal is to combine the VTOL capabilities of a helicopter with the forward flight speeds, efficiency, and range of an airplane Radotich (2022). Speed ranges from $240\,\mathrm{km\,h}$ to

$320\,\mathrm{km\,h}$ and the maximum distance traveled between two points averages from 100-300km. As shown in Fig 2 Aircraft from Joby Aviation falls under this category.

Lift & Cruise

The lift+cruise is the only aircraft discussed that does not have a true turbo shaft variation. Distributed electric propulsion is a requirement for the lift+cruise, therefore it was designed to have a turbo-electric hybrid and a fully electric version. The turbo-electric includes a turboshaft engine powering a generator to charge a battery that then distributes power to motors driving 8 lifting rotors and a pusher propeller. The aircraft has two distinct operating modes: helicopter and cruise. Speed ranges around 180km/hr and the maximum distance traveled between two points averages from 80-150km. Wisk manufactures aircraft with this design.

Tiltwing

This is a type of aircraft that can be rotated to a point vertically for takeoff and landing as seen in Fig 2. Tilt-wing eVTOLs are more efficient in cruise flight because they generate lift more efficiently than multi-rotors. Flight is done with vectored thrust, propellers and wings rotate to transition from vertical to horizontal flight. The average speed ranges from $250\,\mathrm{km\,h}$ and the average distance is between 100-300 kilometers. A Swiss manufacturer called Dufour is using this design concept.

4.2.2 Infrastructure

One of the key components in AAM planning is the infrastructure development of vertiports that provide air taxis designated facilities fulfilling take-off, landing, parking, charging, and maintenance functionalitiesBrunelli *et al.* (2023)

Vertiports The term “vertiport” is commonly used to describe the takeoff and landing locations for Urban Air Mobility (UAM) operations. Others also use the term heliport, helistop, or vertistop. In general, a vertiport consists of one or more designated takeoff and landing areas, or vertipads, and zero or more designated parking spaces. Parking spaces are areas that can be used for charging a vehicle and loading or unloading passengers, and that can only support one vehicle at any given time.Guerreiro *et al.* (2020)

Vertiports come in three categories: Vertistops, vertiports, and Vertihubs, each designed to accommodate varying levels of traffic and services. Generally speaking, Vertistops as the smallest of the three. They will provide shelter from the elements and up to two Vertipads. They are likely to be without energy systems initially, but as prices become more attractive, inductive charging platforms will enable quick top-offs during boarding and deboarding. Think of them as urban commuter on-and-off spots, such as public transportation bus stops or metro stops on a busy line.Holden and Goel (2016)

Vertiports will host two to five vertipads, a medium-sized terminal, and a range of energy options, including electricity, hydrogen, and sustainable fuels. They can provide some amenities in the terminals and full-scale staff and security. Finally, Vertihubs are the largest of the trio. They are designed to accommodate greater traffic with five to ten vertipads, multiple terminals, and a comprehensive energy infrastructure. Dedicated infrastructure is required for the initial operation of UAM passenger transport. 'Vertiports' will probably be in different sizes and numbers in different cities, depending on expected traffic volumes. The largest vertiports in a city will be the fewest in number, and the smallest ones will be the most numerous. Zhao and Feng (2024)proposed a method different method to identify the optimal vertiport locations considering the integration of UAM in multimodal transportation networks. Differing from existing studies, the vertiport locations are determined as part of the multimodal transportation networks, connecting existing mobility hubs, i.e., airports, train stations, and metro transfer stations.

4.2.3 Urban Air Mobility (UAM)

Urban Air Mobility (UAM) Lascara *et al.* (2019)is an industry term used to describe a system that enables on-demand, highly automated, passenger- or cargo-carrying air transportation services. The industry vision involves leveraging new vehicle designs and system technologies, developing new airspace management constructs and operational procedures, and embracing the sharing and services economy to enable a new transportation service network.

Aircraft manufacturers and service providers expect to use electric vertical takeoff and landing (eVTOL) technologies to enable runway-independent operations and small-size advantage. They also expect to operate with very high degrees of automation, up to and including fully self-piloted aircraft1 Most operators envision an on-demand service, enabling growth up to 100s or 1,000s of simultaneous operations around a metropolitan area at altitudes up to 5,000 feet

and speeds up to 278 kilometers per hour. These aircraft would carry cargo or 1-5 passengers on short-range trips (e.g. less than 100 km) Lascara *et al.* (2018)

UAM consists of an array of aircraft which are different based on the type of design, type of propulsion (electric, hybrid, hydrogen, Fuel cell), and ecosystem for safe, affordable, sustainable, and accessible air transport system for commuter mobility, goods transport, emergency services, within the city OR intercity. For operations involved in the UAM scenario, there is either a demand service model or a fixed demand model. Like Patterson *et al.* (2018) proposed some very come operational models which are either on-demand service or fixed demand service or both of them together

1. **Private service** model in which an aircraft serves a single party or individual for the required period. Examples of this operational model include private vehicle ownership, fractional ownership, and rental. Such a model is similar to how most general aviation aircraft are operated today this model is also on-demand based.
2. The **Air Taxi** model is a truly on-demand service in which a single user or a single group of users reserve an entire aircraft for a flight and determine the flight's origin, destination, and timing.
3. The **Air Pooling** model is a largely on-demand service where multiple individual users are aggregated ("pooled") into a single vehicle for flights. Flight departure times and/or origin-destination pairs may be set by a single user with other users fitting into that schedule, or the operator may adjust all users' desired schedules to enable aggregation of passengers.
4. In **Semi-Scheduled Commuter** model, aircraft departure times and/or locations are modified from a baseline schedule based on the preferences of consumers. For example, an aircraft may be scheduled to depart between 8 am and 10 am each day on a particular route, but the actual departure time will be modified day-to-day based on an aggregation of customers' stated preferences/availability.
5. The **Scheduled Commuter** model provides a near-on-demand service by offering frequent flights along the same route(s) in a regularly scheduled service.

More about these will be discussed in section 5 when we discuss use cases examples.

4.2.4 Cargo

The emergence of Advanced Air mobility has led to vast research and development of new opportunities and innovation in various types of use cases. One such use case is Urban Air mobility to transport cargo in and around metropolitan cities, Cargo operations with UAM are more likely to be Mid-mile delivery MMD initially but once the aircraft is technically advanced it would go a longer distance. Many papers that investigate AAM cargo delivery focus on the use of small Unmanned Aerial Systems (UAS) for Last Mile Delivery (LMD), the segment of delivery between the final warehouse or distribution center and the final destination.

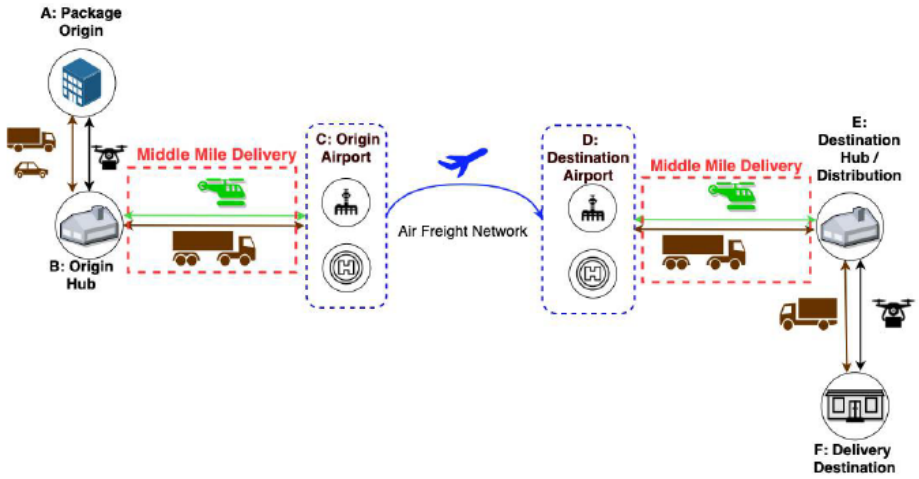
Unlike Unmanned Aerial Systems (UAS), UAM will likely be used for Middle-Mile Delivery (MMD), which refers to the segment of the logistics chain between nodes within an operator's network, such as between distribution centers, warehouses, or fulfillment centers. Several industry ventures exist for future UAM-enabled MMD operationsGunady *et al.* (2022). UPS recently announced an order of up to 150 eVTOL aircraft from Beta Technologies' with up to a 2000 lb cargo payload as part of the Flight Forward campaign UPS flight forward adds new aircraft (2021).

This campaign is aimed at augmenting the current logistics infrastructure reducing air network emissions, and highlighting the possible heterogeneity of future AAM mission fleets. In one paper on UAM MMD operations, it was notionally studied the usage of UAM in USA eVTOL aircraft for delivery from a fulfillment center to various aerodromes in the San Francisco Bay Area German *et al.* (2018). The package demand model is presented in the paper. relied on estimations from the literature regarding Amazon orders to study demand for UAM cargo delivery. This paper studies future UAM MMD operations by modeling real MMD operations of major logistics carriers with quantified package demand models in the Chicago Metropolitan region.

This paper presented a methodology and computational framework for quantitatively studying future UAM cargo operations, specifically Mile Delivery (MMD). Through the use of SoS techniques, components of the UAM were identified and modeled in a computational tool. Demand for UAM MMD operations was explored, and a demand generation framework was presented for case studies of FedEx operations in the Chicago Metropolitan area. A route-effective cost metric was introduced, which is used to identify routes in MMD that prove feasible for UAM operations. They found that UAM trips begin to be utilized when the package VoT(value of time) is around 98 dollars in the Chicago network. Additionally, it identified that UAM demand in cargo MMD operations is a function of more than just VoT, rather, specific characteristics

of routes significantly influence the computational framework's choice to allocate UAM trips. Future work will expand on this research, exploring the traveling salesman problem for more accurate UAM MMD operations considering multi-leg trips rather than assuming deadhead on each mission. In this research, we will only focus on UAM passenger transportGunady *et al.* (2022)

Figure 3: Representation used to model an operator supply chain The MMD Gunady *et al.* (2022)



4.2.5 Autonomous

Autonomous Electric Vertical Take-off and Landing (eVTOL) Transport Aircraft are a wide category of unpiloted, electrically powered aircraft to transport goods or organisms. They may fall under the Cargo Air Vehicle (CAV) or Passenger Air Vehicle (PAV) categories. The aircraft have relatively small footprints and are well-suited for navigation in urban environments. They are currently in development by various companies ranging from traditional aerospace companies (Airbus and Boeing) to new competitors from different backgrounds (Amazon to Rolls-Royce) and are widely believed to have a huge impact on the future of mobility. While individual components of the technology are well developed, the focus here is the assembly and integration of autonomy, which requires increased efficiency, increased reliability, improved infrastructure, and significant cost reductions from the current state.roadmaps.mit.edu (2023)

proposed a nuanced six-level autonomy framework for eVTOLs, categorized by the extent of human-technology collaboration. This taxonomy spans from level 0, indicating no automation, to level 5, signifying full automation with swarm capabilities.The delineation of these levels is as followsWei *et al.* (2024) :

Level 0 (No Automation): The eVTOLs like the Terrafugia Transition operate entirely under human control, where pilots are responsible for all flight aspects: navigation, system monitoring, take-off, in-flight maneuvers, and landing. Scenarios: Ideal for training, flights where manual control is preferred, early-stage eVTOL models, etc.

– Level 1 (Assisted Automation): The eVTOL (e.g., the EHang 184) has systems assisting in certain tasks, with the pilot primarily in control. Automated assistance is involved like stability control, altitude holding, or basic navigation. Scenarios: Crucial for pilot decision-making; offers assistance in routine tasks; varies with weather conditions.

– Level 2 (Enhanced Automation): The eVTOL like Volocopter 2X performs major flight operations automatically under specific conditions but requires pilot supervision. Autopilot is capable of take-off, cruising, and landing on predefined routes. Scenarios: Suitable for commercial operations on established routes; requires pilot readiness for control.

– Level 3 (High Automation): The eVTOL (e.g., Joby Aviation S4) autonomously handles all flight aspects in most typical scenarios. For such eVTOLs, advanced navigation, obstacle avoidance, and real-time decision-making are achieved during flight. Scenarios: Ideal for long-distance commercial flights; complex urban environments pending regulatory approval.

– Level 4 (Full Automation): The eVTOL like Lilium Jet is fully autonomous and requires no pilot. Advanced perception and decision-making systems for complete situational awareness and autonomous emergency handling. Scenarios: Future scenarios with operation in smart cities and advanced air traffic management systems.

– Level 5 (Swarm Automation): Large-scale deployment of eVTOLs with full autonomous intelligence and interoperability. Networked eVTOLs operate collaboratively, with advanced machine learning systems enabling adaptive responses to a wide array of scenarios. Scenarios: Extensive urban and intercity operations, integrated with city infrastructure, offering on-demand mobility services without human intervention.

5 In-depth analysis on the Advanced Air Mobility ecosystem

This section will aim to conduct an in-depth analysis focusing on the Advanced air mobility ecosystem, modes of operations, market-entry, and scope of growth in the future. The design part of the study consists of Three major parts Key factors under market segmentation analysis, Business use cases considered for the operation of eVTOLs, and scenario analysis explaining which scenario concerning operations of the EVTOLs is best suitable for a particular use case. For conducting the analysis we are considering South Africa and Dubai both markets are very different in terms of economy, political work-frame, and technology acceptance. In both regions, there is a huge potential for developing a strong customer base for AAM services. Also, huge market potential but a lack of substantial and promising research concerning advanced air Mobility makes these two options more suitable for consideration.

5.1 Market Segmentation Analysis

Market segmentation analysis is a strategic approach used by businesses to divide a diverse heterogeneous market into homogeneous segments or subcategories according to various criteria, e.g. demographic, geographic, psychographic, and behavioral. The goal of market segmentation analysis is to identify particular clusters of customers or consumers of potential with the same kind of needs, preferences, and attributes.

In the thesis, market segmentation analysis is the fundamental ground for discovering heterogeneous market conditions. It thus suggests those specific chances of entering and penetrating the target market. By systematically analyzing the potential customers or users into segments, the thesis aims to systematically analyze and categorize potential customers or users into segments based on the considered use cases, assumptions, and scenarios, the thesis aims to:

Identify Target Segments: Determine those market segments in South Africa and Dubai that relate so much to air mobility including all business and personal use cases.

Tailor Strategies: Review a tailored marketing agenda, product, and service solutions concentrated on the specific requirements and preferences of the discovered segments. Optimize Resource Allocation: Allocate resources properly by concentrating on segments with the biggest likelihood of best in terms of adoption and income.

Enhance Market Entry Strategies: Approach market introduction strategies by determining the precise market segments(On-demand service, Pre-Paid), time of use, and vehicle ownership suitability for each segment taking into account their unique characteristics and preferences.

Maximize Market Penetration: Enable considered market introduction which involves segments that have the highest degree of adoption and acceptance of air mobility services.

Through the insertion of market segmentation analysis into the thesis, we are trying to explore an overall realistic picture of the market being composed of several divergent market segments whose specific needs must be met. This knowledge will help to formulate the market entry strategies and the strategies to increase the advanced air mobility adoption in South Africa and Dubai.

The reason for choosing South Africa and Dubai for this study is due to the lack of research-related market strategies in the field of aviation. Mellahi *et al.* (2011)The Middle East is a socio-cultural and political region without specific borders, characterized by a “diversity of ethnicity’s, languages, and religions”, as well as heterogeneous economic and political structures When we consider. Africa is also characterized by diverse economic, historical, and socio-political sub-regions Kamoche (2011). It comprises 59 countries and boasts the world’s highest GDP growth rateKamoche (2011); and its billion-plus inhabitants exceed Europe and the USA together and speak over 2,000 languages. Indeed, some argue that Africa is the land of the futureAdesida and Karuri-Sebina (2011). Despite being a “great promise as the last economic and industrial frontier” Kamoche (2011), similar to the Middle East,

In both regions when we consider electric aviation there is a lot of market potential in terms of the huge electric grid potential available in these places provided the electricity is generated from renewable sources of energy.Bokopane *et al.* (2019) confirms that the deployment of Electric vehicles in SA is only cost-effective with renewable energy-powered charging stations across the country If Africa’s solar potential is fully harnessed, it would have enough to power the entire continent. It is estimated that the solar photovoltaic potential of Africa is more than 660,000 Terawatt hours (TWh) of electricity a year compared to the current demand of 870 TWh per year IRENA (2020) in their research Ayetor *et al.* (2021) found out that an electric bus’s carbon dioxide savings could reach 39% even concerning the current national energy mix in SA. They concluded that, generally, in Africa, ICE bus emissions are 3.46 higher if electric vehicles are charged from their current national grid but 329 times higher if the national grid is substituted with solar charging. Other researchers, such as Collett *et al.* (2020), are also of the view that African countries should utilize a smart charging strategy as part of their approach to vehicle fleet electrification

5.2 Example: Cape Town

Cape town is the legislative capital of South Africa and largest city in the Western Cape province. As per recent data city's population approximately is 4.6 million.Contributes 11.1 percent approximately of South Africa's formal employment. Over the past 5 years recorded an average annual economic growth rate of 1.2 percent in comparison to the overall national economic growth which recorded 0.8 percent of growth.

The city has diverse economies, including finance, tourism, technology, and manufacturing play a significant role in employment generation. Its strategic location as a major port city facilitates trade and investment and attracts foreign direct investment (FDI) due to its skilled workforce, infrastructure, and business-friendly environment plus the current focus on dense and transit-oriented growth.

Daily Commuters use Public transport but the mode of transportation in daily commuters varies. Approximately up to 58 percent of commuters use private vehicles to reach their destinations. Roughly 22 percent prefer mini bus -taxis, which of course play a major role in the city's transportation system. Then 9 Percent use bus services like MyCiTi and GABS. Talking about road transport only close to 2 percent of commuters use trains which is due to drastic decline in people choosing to travel by train a decline of almost 95 percent from 2010 to 2022.

A city is primarily an urban area densely populated and concentrated in the city and suburbs. The rural areas are characterized mostly by natural landscapes, agriculture, and smaller communities. Cape Town International Airport serves as a Major hub for air travel in the region. The airport offers scheduled passenger services for the Cape Town metropolitan Area.

5.3 Example: Johannesburg

In Johannesburg, as per recent data the metro area population of the city is approximately 6.32 million. Located in the Gauteng province of South Africa is the largest single metropolitan contributor to the country's national economy. The city's municipality represents 9.24 percent of the South Africa's total population. Johannesburg's economy is diverse and variable thus making it a major hub for business, finance, and commercial activity with an average GDP growth of 2 percent over the past decade

Johannesburg has a large public transport system even though it is not accessible to reach a lot

of places and is not reliable. To upgrade the network services like Gautrain have become very popular. Gautrain is a rapid rail system that links the central city with major business districts like Sandton and Rosebank. It's considered the fastest and most reliable public transport system in Johannesburg.

Rea Vaya bus service is also one of the steadily developing bus transport networks which aims to link areas like Soweto and the western suburbs. Minibus taxis, Metered taxis and tuk-tuks are additional transport choices fro those who don't own a vehicle or rely on shared public or private transport.

O.R.Tambo International Airport (ORTIA) situated in Kempton Park in Johannesburg is Africa's second busiest airport with a capacity to handle up to 28 million passengers annually. ORTIA serves as the hub for South African Airways. It serves as the primary hub for both domestic and international travel. Its strategic position between Johannesburg and Pretoria makes it a vital gateway for air travel in the region

5.4 Example: Dubai

Dubai is economically diverse with key sectors including real estate, tourism, finance, and trade. make it one of the most vibrant and diverse economic hubs in the world. As of 2022 the population of the city was approximately 3.55 million.

Dubai's economy exemplifies diversification from tourism hubs to communication networks, city's economic landscape illustrates its depth and wide range of nature. Important business sectors include transportation and storage services like logistics hubs, cargo delivery, etc.GDP growth was approximately 3.3 percent in the year 2023. Dubai Municipality plays a very important role in urban planning, infrastructure development, and environmental management.

In 2023, more than 1.92 million people used to travel by public transport services daily. Dubai Metro is a popular mode of transport in the UAE region serving nearly 260 million commuters in 2023, Notably, Burjuman, and Union stations recorded the highest foot traffic, serving close to 10 million riders respectively.

Public buses and trams also cater to a considerable amount of commuters. Shared Mobility options (e-hailing, smart car rentals, Bus-On Demand) experienced significant growth. Traditional abras, water buses, water taxis, and the Dubai ferry maintained consistent ridership.

This reflects the growing preference for convenient and flexible travel alternatives paving the way for Evtols also. Taxis is also a continued popular choice for commuters in Dubai.

Dubai International Airport is one of the world's busiest airports in terms of international passenger traffic. Cargo operations make it the seventh busiest cargo airport globally. It handles cargo volumes including freight transported by Airbus A380 and Boeing 777. Dubai's strategic location, modern infrastructure, and efficient air transport services contribute to its continued importance and prominence in the global as well as local aviation industry

6 Use Cases

A vast array of use cases can be considered according to the market dynamics, demographics, infrastructure, and demands. We consider those basic use cases that are highly likely to be used while operating EVTOLs while considering the similarities and differences in African and Middle Eastern markets. These use cases are also comparative to other major markets of advanced air mobility like Europe, America, and Asia

6.1 Air Taxi

An air taxi is a small commercial aircraft or a helicopter used to travel from point A to B frequently either within fixed intervals of time or for on-demand purposes. Rajendran and Srinivas (2020) describes air taxis as Small and eVTOL aircraft that are expected to transport on-demand users in metropolitan cities, with an average capacity of four.Cohen *et al.* (2021) defines Air taxis as on-demand services where a single user or a single group reserves the entire aircraft and determines the origin, destination, and timing of the flight the passenger capacity ranges between 1 and 4. There is substantial research going on exploring the benefits of air taxis over road taxis in terms of time-saving, faster commuting, regional and remote connectivity, etc.

In one such study, a stimulation has been conducted efficiency of UAM Air taxis Versus Taxicabs Naser *et al.* (2021).Based on the simulation study conducted in Hamburg, Germany. It was found that there could be 50 percent time-saving possible while using an air taxi instead of a conventional one when considering only travel time. The simulation study compared UAM

connections with ground transport in a European metropolitan area, specifically downtown Hamburg. The study also revealed a route length saving of up to 16 percent for air taxis. The scenarios assumed direct connections between hubs, with conflict-free routing for the UAM system

Sun *et al.* (2018) In this paper the research focused on understanding the impact of on-demand air taxi services on existing transportation modes, such as car, railway, and traditional air transportation, by providing high-resolution estimations of travel time lower bounds between any points in the region of interest. The research identified interesting links for air taxi services in Europe, mainly found at Europe's periphery, with highly-populated cities serving as a service hub. These cities considered here are quite similar to those we use in our analysis, like Johannesburg, Cape Town, and Dubai in many different ways.

Firstly applying Market segmentation analysis to Cape Time. Air taxis are typically on-demand services that offer exclusive and demand-based direct flights to specific destinations and we do with regular taxis o currently. Considering the diverse economic and demographic structure of the city there are few target segments where air taxis can play a major role

- **Business Executives and Professionals**: Often in need to reach a place quickly and have tight schedules between various locations for meetings, and client engagements. When there are peak rush hours in the city and travel time is high due to congestion and less frequent transport, the Air taxi service will be a savior, especially for business executives and professionals. It servers a flexible travel option that allows them to maintain their tight schedule and maximize travel time significantly
  Example: Someone wants Century City Business Park from Cape Town CBD to attend meetings at corporate offices in different parts of the city. The Air taxi can help commuting quickly and avoid the traffic hustle. Another example could be international business Travellers have business meetings at the Stellenbosch site/they can take an Air taxi from the airport to the place directly cutting down on travel time significantly compared to car rides or other means of transport.
- **Millionaires**: High net worth individuals often require private, luxurious, and efficient transportation for various purposes, which could in travel to a private estate, site seeing, beaches, resorts or remote retreats, etc . Air Taxi commuting provides them easy, convenient, exclusive and time-saving options.
  Example: A wealthy individual wants to visit their private safari in the Kruger National Park. An air taxi can provide direct rapid transport from their residence like maybe in Campus Bay offering them a smooth and hassle-free travel experience without any need for any road transport or commercial flights Or a weekend getaway also makes an

individual take on an air taxi from the city center to a private island resort avoiding the need for boat transfers and ensuring a swift and exclusive journey

- **Film or Entertainment industry**: Film and entertainment industry often require quick and flexible transportation for a film crew, actors, equipment, etc to various shooting locations. Air taxis provide efficient and reliable transport which makes them a perfect option to reach their desired location on time.
  Example: A crew wants to travel from Cape Town city center to a remote filming location in Ceder-berg Mountains or from the studio to a venue for a film Premier Air taxi provides a direct, efficient, and time-saving option compared to road transportation options.

Johannesburg is a bustling metropolitan city and a major economic hub not only for South Africa but also for the whole of Africa which makes it a hotspot for the introduction of electric air taxi service. The city's high congestion and the vast distance between key locations make air taxis a valuable solution when time, convenience, and exclusivity are the priorities. Let's have a look at the Target segments there.

- **Business Executives and Professionals**: Johannesburg is a city that is the center of numerous corporate headquarters, financial institutions, and industrial centers making it a prime location for business activities. Business executives can benefit from the flexibility of air taxis which offer an on-demand travel option that bypasses the road traffic. Example: Sandton CBD to Midrand Business Park, OR Tambo International Airport to Pretoria for a site or business meeting that supposedly will cut down on travel time significantly compared to car rides.
- **Tourists and High-End Travellers**: Johannesburg attracts a significant no of visitors who seek premium experiences. They can use air taxis to quickly transfer between airports, hotels, and key tourist attractions. This air taxi service allows them to visit more destinations in less time. Example: Sandton to a luxury Safari Lodge in the Kruger National Park, City center to a private island resort in Mozambique, City Center to Pilanesberg National Park

Dubai, a global hub for business, tourism, and luxury living presents unique opportunities for air taxi services. The city, 's rapid development, significant traffic congestion, and the affluent population make air taxis an attractive and practical solution for various needs.For Dubai, we have some new use cases because these are only relevant to the city considering its well-established and stable economic infrastructure

- **Business Executives and Professionals** City hosts several international corporations, financial institutions, and trade centers, making it a major business destination. This

again allows them to maintain their schedule, and maximize productivity.
Example: The air taxi can quickly transport them from DIFC to Jebel Ali Free Zone, avoiding traffic and ensuring punctuality. After landing at Dubai International Airport an executive can immediately take an air taxi to Abu Dhabi for a business meeting significantly reducing travel time compared to car ride

- **Government Officials and Dignitaries**: Dubai Hosts international summits, conferences, and state visits regularly. Government Officials and dignitaries use air taxis to travel swiftly between government buildings, conference venues, and hotels, ensuring they meet their timely schedule
  Example: A government official needs to attend a high-level meeting at Zabeel Palace after an international conference at the Dubai World Trade Center. An Air Taxi serves the purpose perfectly
- **Luxury Real Estate Clients**: Dubai's booming real estate market attracts clients looking to invest in luxury properties. These clients need to visit multiple properties quickly and conveniently, without the hassle of navigating traffic and coordinating ground transportation.
  Example: Business Bay to Palm Jumeirah for property viewings, Downtown to Dubai Hill Estate
- **Sports Enthusiasts**: Dubai hosts numerous international sporting events, attracting sports enthusiasts and participants from around the around the world. Efficient transportation is crucial for athletes, teams, and spectators to ensure timely arrival at venues and seamless event experiences. The service provides a reliable and convenient mode of transport that caters to the unique needs of the sports community.
  Example: Hotel in Jumeirah to Dubai Autodrome for a motorsport event. A group of sports enthusiasts attending a cricket match can travel from Dubai Marina to Dubai Sports City via air taxi, avoiding traffic and enhancing their overall experience

6.2 Market Entry Strategy - On-Demand Service as Air Taxi

On-demand services in advanced air mobility (AAM) provide flexible and immediate transportation solutions based on real-time requests from users. These services function similarly to ride-hailing apps, where customers can book flights as needed with short notice. The flexibility and dynamic routing capabilities of on-demand services allow flight paths to be adjusted in real time, making them ideal for urban environments with fluctuating travel needs. Examples include air taxis for point-to-point travel within a city and emergency response services that can be rapidly deployed to specific locations.

- Provide convenient and flexible air transportation on an on-demand basis, allowing users to book flights via a mobile app. The prime value proposition of on-demand air taxis is the convenience they offer. Users can use mobile apps much like other ride-sharing services. This reduces the hassle of long commutes, traffic jams, and the need to adhere to rigid schedules of traditional transportation methods.
- On-demand Air Taxis allow for flexible scheduling, Users can choose their departure times, locations, and destinations based on their needs and preferences, For regional travel, air taxis provide a quick and direct mode of transport between major urban centers and nearby regions.
- The mobile app should be designed for ease of use, featuring intuitive interfaces for booking, real-time tracking of air taxis, and options for customizing the flight experience (e.g., selecting preferred routes or additional services such as in-flight refreshments or specific seating arrangements).
- Implement dynamic pricing based on demand, time of day, and route popularity. The dynamic pricing model allows for flexibility in fare calculation, adjusting prices in real time based on various factors such as demand, time of the day, and route popularity. Prices increase during high-demand periods, such as rush hours, special events, or holidays, incentivizing users to book during less busy times if they are flexible with their schedules. Conversely, prices can decrease during low-demand periods, making air taxi services more accessible to a wider audience.
- Routes that are more frequently traveled or in high demand can have a higher price. the pricing can also vary depending on the time of the day, with peak hours attracting higher fares due to increased demand for quick and efficient transportation.

Implementing these points effectively will position on-demand air taxi services as a premium, yet flexible and accessible, mode of transportation in Dubai, catering to a diverse range of customers seeking efficient, convenient, and luxurious travel solutions.

6.3 Air Shuttle

The Airport Shuttle use case features shuttle services between the airport and selected locations such as the city center, central business districts, or other points of interest, which will be provided on a schedule. According to an analysis of Volocopter Boelens (2019), the vast majority of routes between airports and city centers worldwide are below 30 kilometers. Therefore, a transportation distance of 30 kilometers is mostly considered ideal for doing any analysis on this use case. As multirotors are better suited for short distances, these flights are

to be performed with a multirotor configuration at a speed of 100 to 150 km/h. As the airport shuttle connects two points of interest (e.g. airport and the city center), the demand for these predefined routes will be high.

Currently, the fastest-growing sector is the airport shuttle service. Since airport accessibility is a crucial factor in airport choice Choi and Park (2022), UAM is an emerging transport mode for fast travel between the airport and downtown Consulting (2018). Also, because airports are generally located far from cities, it is easy to acquire initial demand Shaheen *et al.* (2020).Choi and Park (2022)They conducted a study on the economic feasibility of airport shuttle service for urban air mobility (UAM) in Korea and presented findings and metrics that highlighted the competitive fare estimation, viability, and operational policies for economic feasibility, dynamic pricing strategies, and infrastructure cost - sharing. By estimating a price range of 96 to 108 USD for Air shuttle service to attract users from Seoul Station to Incheon International Airport (ICN) and comparing it with professional assessments. By estimating a competitive fare range and comparing it with industry assessments, the study confirms the feasibility of UAM services as Air Shuttles in attracting customers and converting existing transport use

Goyal *et al.* (2021) The Air Shuttle market involves the use of electric vertical take-off and landing (eVTOL) aircraft to provide on-demand passenger transportation services within urban areas, connecting airports or vertiports along fixed routes. Their analysis suggested that the air tax and air shuttle markets could capture a 0.5 percent mode share, with the potential to replace non -non-discretionary trips exceeding 45 minutes.Coppola *et al.* (2024)Aerial Airport Shuttle refers to Urban Air Mobility (UAM) services that connect city centers or their proximities to airports. These services provide travelers with access and egress air connections, allowing them to avoid uncertainties related to traffic congestion, delays, and other transport issues typically experienced with ground-based routes. Their study emphasized on the importance of aerial airport shuttles in providing efficient and reliable transportation options for travelers moving between city centers and airports, highlighting their potential financial sustainability and attractiveness compared to other UAM services like city-taxi.

Hitge and Vanderschuren (2015)The paper discussed the importance of transforming cities to prioritize public and non-motorized transport over car-centric systems to address issues like noise, pollution, congestion, and global warming. It focuses on the competitiveness of public transport compared to cars in Cape Town. Their study aimed to optimize access to opportunities for all city residents and improve public transport to compete with private cars. Their analysis revealed that public transport travel times are not competitive with private cars, highlighting the need for interventions to reduce public travel times. With regards to improving public transport in terms of all the concerns mentioned in the cited research Air shuttle is one

of the best solutions for the city. Air shuttles cater to larger groups of passengers who need reliable, regular transportation on a fixed schedule on a preferred or more important route. here's a detailed look at the key segments.

- **Commuters**: Individuals who travel regularly between their homes and workplaces most of the time are reliant on public transport and always on a tight schedule to reach their destination. In a city like Cape Town where congestion can be significant and long travel time on rail transport air shuttle offers a viable alternative. significantly reducing travel times and providing a more efficient and stress-free experience. By operating on fixed schedules, air shuttles provide predictability, allowing commuters to plan their day effectively.

  Example: Air shuttle on the route from Bellville to Cape Town CBD . This route would serve commuters living in the northern suburbs who work in the city center. The air shuttle would have multiple departures in the morning to accommodate varying start times in multiple returns in the evening. This service would significantly cut down the commute time compared to road travel or train travel. The route does not have any public transport option currently and with the car being the only way to commute it shows an average of 27 min for the journey but if we consider peak traffic hours in the morning such as 7 am to 9 am and then 5 pm to 7 pm it should increase by 10 to 12 considering the congestion in the city. Air shuttle on the path will reduce travel time to almost half and also shift major demand to the Ariel route when there are peak traffic hours in the city.
- **Airport Shuttle**: This segment is one of the most important and discussed target segments of the Air shuttle use case. According to a report by Berkeley Transportation Sustainability Research Center daily demand in the U.S. could be 82000 passengers served by 400 four to five-seat aircraft with an annual market value of 2.5 billion USD. If we consider this report as a base Airport shuttle will be a game changer in South Africa which is home to the top busiest airports in Africa concerning tourists visiting the country business professionals or sports etc. Shuttles are cost-effective for both Airports and passengers. The market share is predicted to be around 28.40 percent by 2024 for airport shuttles. is projected to observe around 7 percent compound annual growth rate (CAGR It's a financial metric used to measure the average annual growth rate of an investment or business over a specific period, assuming that the growth is compounded annually.) from 2024 to 2032 due to increase in passenger traffic.

  For example Cape Town International Airport to the city center. This route would allow tourists, business travelers, and also airport staff to reach the airport from the center of the city in a short period and vice versa. Aligned schedules with the flights will offer frequent services during peak travel times. A booking system that helps a traveler coming into the country book their journey in advance along with their flight to reach the city

center will be a very seamless experience for the commuters.

- **Sports Teams and Fans**: Sports teams and fans often require reliable and efficient transportation to training facilities, match venues and events Air shuttles can help them reach their destination on time without delays due to traffic, reduce logistical challenges and enhance their overall experience. Like a group transport for sports teams to training facilities and match venues or scheduled services for the fans attending games without disturbing the ground traffic or increasing travel time due to considerable changes in demand.
  Example: City Center to New Lands Stadium.This route serves fans attending matches at the stadium providing direct transport from Central Cape Town or could be that passenger reaches the international airport takes an air shuttle to the city center and takes the next one to the stadium saving at least half of his travel time if he had taken the journey by car or other public transport. Shuttles departure times should be synchronized with the start and end of the matches. If a game starts at 7 pm, the shuttle should start operating at 4 pm.By targeting sports teams and fans with reliable air shuttle services, operators can significantly enhance the sports experience in cape town

Johannesburg is a city where more than 800000 daily commuters rely on various modes of public transport. Around 66 percent of commuters rely on public transportation for their daily work trips, contributing to reduced private car volumes during peak hours. Air Shuttle will always be a good new use case in the transportation domain. A versatile fleet of evtols capable of making short-haul flights with quick turnaround will serve a great purpose for this use case. Central hubs at key locations in different parts of the city using a hub-spoke type of transportation model.

- **Airport Shuttle**: OR Tambo airport to Sandton central business district which has a distance of approximately 30 km. Reaching from one place to the other takes 45 to 60 mins by car or bus considering the increased travel time due to traffic and congestion. Air shuttle can reduce time travel time to 15 -20 minutes.
  Example An international business traveler arrives at OR Tambo International Airport for a series of high-stakes meetings in the city or daily airport staff who have to reach the airport at a fixed schedule. High-frequency shuttles during peak flight arrivals and departure times can help both passengers. Regular travelers also use the fixed-demand service and skip the road traffic of the city
- **Commuters**: The commuter air shuttle service operates on a fixed schedule with again frequent departures during peak hours. This regularity ensures that users can plan their day knowing they have a dependable means of transport.
  Example: The commuter air route from Midrand to Sandton CBD is designed to serve

the growing population of professionals who live in suburban areas like Midrand and work in Sandton. Since Sandton is also called the financial heart of the city it makes this location very important to have an air shuttle route. The route covers approximately 20 km and aims to alleviate the stress and time associated with the daily travelers made by the road who are always susceptible to huge traffic congestion. The target uses for this service would be employees of major corporations, factory workers, tech and finance workers, consultants, etc these are some of the individuals who require punctuality and efficiency in their daily transport

- **Sports Event Shuttle Service**: This service will operate with increased frequency on match days with the schedule aligned to the match start and ending time. This will help to reduce extra demand for the ground public transport which always gets crowded on match days. Additionally. by reducing the need for personnel and offering a direct route to the stadium, the service helps to alleviate traffic congestion and parking challenges around the venue

  Example: The sports Shuttle from Sandton to FNB Stadium will be tailored to cater to the transportation needs of sports teams, coaching staff, and fans, The route spans approximately 15 kilometers, providing a direct link between Johannesburg's primary business districts and one of its premier sports venue.

Implementing an Air shuttle service in Dubai presents several advantages suitable to the unique characteristics and demands of the city. Unlike Cape Town and Johannesburg, Dubai is known for rapid urbanization, a higher number of international tourists, and a significant population of expats working in its rapidly growing business sector. Diverse sectors including finance trade, tourism, and real estate drive Dubai's economy. the high concentration of business activities in specific areas such as the DIFC(Dubai International Financial Center) and Business Bay needs reliable and efficient transport like air shuttles for business professionals

- **Airport Shuttle**: Airport shuttles will operate with high frequency to align with the peak arrival times at the Dubai International Airport, ensuring minimal wait times for passengers upon landing. On-demand options will also be available for those who require more flexibility but for those who want to reach the major hubs of the city air shuttle service at regular intervals will always be one of the best options.

  Example: The Airport Shuttle from Dubai International Airport to Downtown Dubai can be designed to serve the needs of a diverse range of travelers arriving in one of the world's busiest city. The route covers approximately 14km providing a direct and efficient connection between the place. The target segment includes business travelers, and international tourists seeking convenient access to popular attractions like Burj Khalifa and Dubai Mall. The service will also offer the convenience of direct routes to major

hotels and conference centers in the city.

- **Commuters**: The predictability of the service will allow them to plan their daily routines efficiently To enhance the convenience of the service subscription models such as monthly or yearly passes will help provide cost savings and simplify the booking process for regular commuters this will also help to integrate the service very smoothly in the existing public transportation sector.

  Example: The commuter service from Dubai Marina to Dubai International Financial Center(DIFC) is designed to serve the bustling community of professionals who live in the high-class residential area of Dubai Marina and work in DIFC, one of the city's primary business hubs. The route covers approximately 20 km and aims to significantly reduce travel times compared to road travel, which can be affected by heavy traffic during peak hours. The Target users for this service are corporate professionals, finance professionals, and legal firms. These individuals require a reliable, quick, and fast alternative to driving or using conventional public transportation systems.
- **To Man-made Islands**: Dubai known is for its innovative architecture and ambitious urban projects, including several man-made islands such as Palm Jumeirah and The World Islands. These islands offer luxurious residences, hotels, and leisure facilities but they also have unique transportation challenges due to their exclusive location and limited access by traditional transport means. Air shuttles can be a game changer in enhancing mobility and ease of travel to these islands.

  Example: The air shuttle service connects Dubai's mainland and key hubs like Dubai Marina Downtown Dubai or International Airport to various man-made islands. Some routes could include connecting from Dubai Marina to Palm Jumeirah, providing direct access to luxury resorts, residence and entertainment venues, or transport from Jumeirah beach to The World Islands, catering to high-end tourism and residential communities, or serving as a link between Dubai Creek or Dubai Festival to Deira Islands enhancing accessibility to upcoming residential and commercial developments.

6.4 Market Entry Strategy - Fixed Demand Service as Air Shuttle

Fixed-demand services in AAM operate on predetermined schedules and routes, similar to traditional public transportation systems. Designed to meet consistent and predictable travel needs, these services offer regular schedules and predefined routes between key locations such as business districts or tourist attractions. This predictability allows users to plan their travel, knowing exactly when and where flights will be available. Examples include air shuttles providing scheduled flights between major hubs and regional air mobility services connecting

cities or regions.

- Market Analysis and Demand profiling to understand unique demand profiles in each city like Johannesburg prioritizes business travel and commuting efficiency. Dubai prefers luxury tourism and island connectivity, while Cape Town focuses on tourism to scenic destinations like Table Mountains and the Cape Winelands
- Deploy a versatile fleet of eVTOL aircraft suitable for short-haul flights in urban environments, ensuring flexibility to different route demands and passenger capacities.
- Strategic partnerships with hotels, resorts, tourism boards, and corporate entities will help to offer integrated travel packages and exclusive services. Collaborations with local businesses will pave the way for seamless ground-to-air shuttle transfers and enhanced customer experiences.
- Planing scalability by monitoring demand trends, expanding route networks based on customer feedback and market analysis, and investing in technology-driven solutions provides operational efficiency and service expansion.
- Prioritizing customer satisfaction with personalized services such as concierge support, VIP lounge access, and onboard amenities. user-friendly booking platforms, real-time flight updates, and responsive customer service to ensure a seamless travel experience.

6.5 Regional Air Mobility

Regional Air Mobility provides a cost-effective solution to connect communities that have been under-served by current aviation norms while also providing needed relief to capacity-constrained aviation hubs. As this new generation of aircraft is developed, communities will welcome the benefits of utilizing their local airport infrastructure to provide a conduit for new opportunities in their region. RAM focuses on building upon existing airport infrastructure to transport people and goods using innovative aircraft that offers a huge improvement in efficiency, affordability, and community-friendly integration over existing regional transportation options.Antcliff *et al.* (2021)

Passenger transportation on small-capacity aircraft over short distances is referred to as commuter operations. High operating costs have historically impacted these services, resulting in operations that are only marginally profitable. The advent of novel electric propulsion technology has led to a notable advancement in aircraft operational efficiency, potentially yielding substantial financial and environmental benefits.Justin *et al.* (2022)The short-haul passenger transportation of tiny aircraft is referred to as regional air mobility. Low passenger

volumes, rivalry among transport options, and expensive operational expenses make these businesses difficult. However, there is hope for significant advancements in sustainability and operational efficiency due to the recent convergence of new technologies in electric propulsion and autonomy.

Short-distance air transportation in the region (RAM)Aircraft with ranges greater than $100\,\mathrm{km}$ but less than $300\,\mathrm{km}$. RAM (long-distance air mobility)Aircraft with a range of more than 300 kilometers but a capacity of 19 or fewer people. Next-generation RAM is appealing due to its ease of installation. It does not necessitate significant new development or landing technology, but rather the installation of charging or hydrogen refueling stations to current infrastructure. rolanberger (2022) Investments in the sector have already exceeded USD 2 billion, excluding the urban air mobility segment. However, additional expenditures are required to fully realize the potential of this new generation of transportation.rolanberger (2022)

Mckinsey (2022) RAM brings together new aviation technologies and existing small airport infrastructure into a transportation model that is more equitable, more economical, and more environmentally friendly for air travel over short distances, compared to today's status quo. If these changes materialize, the total addressable market (TAM) for small regional flights globally could be $75billionto$115 billion by 2035, representing 300 to 700 million passengers annually. We define RAM as the transportation of passengers and goods by air over about 150 to 800 kilometers on five- to 50-passenger aircraft (or the equivalent size for cargo), primarily using smaller regional airports.RAM is enabled by a broad range of modern technologies, such as green propulsion, digitization, and autonomy, which will reduce costs, boost reliability, and improve customer experience

RAM would connect Cape Town to neighboring cities and regions more efficiently. Instead of long drives, residents could opt for short flights, saving time and reducing road congestion. Access to remote areas, islands, and coastal regions would become easier, enhancing tourism and economic opportunities.

- **Last Mile Connectivity**: Regional air mobility can significantly enhance last mile connectivity.RAM using eVTOLs presents an innovative solution to enhance urban air mobility and efficiency, particularly for connecting residential areas with key business districts and transportation hubs in Cape Town
- **Regional Connectivity Hubs**: RAM can serve as a vital link between major urban centers and regional hubs
  Example: In the Western Cape region of South Africa enhancing regional connectivity between semi-rural areas like Somerset West and Stellenbosch presents a significant

opportunity for eVTOLs to come into the picture Stellenbosch, celebrated for its academic institutions and vineyard landscapes, are separated by approximately 20 kilometers of winding roads that often experience heavy traffic congestion. Introducing eVTOLs to connect Somerset West and Stellenbosch could transform this dynamic, offering a direct and efficient air route between the two destinations. The aerial journey can reduce the travel time to 15 minutes compared to 40 to 50 minutes with the conventional transportation mode.

- **Connecting remote places**; This use case can bridge a gap between the urban centers and remote areas which are often undeserved, help improve the Quality of life for the residents, and boost economic development in and around Cape Town
  Example: Connecting Cape Town to Cederberg Mountains. These mountains lie approximately 250 kilometers north of Cape Town, while the area is a popular destination for outdoor activities, adventure sports, and conservation projects its remote location makes it challenging to access. From Cape Town International Airport or Cape Town CBD to a vertiport in key attractions in the Cederber Mountains such as Sanddrif Campsite or wilderness area will take approximately 60 minutes of flight time compared to 3-4 hours by road

Introducing Regional Air mobility powered by eVTOLs in Johannesburg and its surrounding areas can help to uplift the economic demographics of the city and surrounding region. The can help them develop new remote economic hubs boosting localized economies besides enhancing connectivity across the region.

- **Connecting Remote places**: Implementing eVTOLs within remote places like Pilanesberg National Park demonstrates the transformative potential of regional air mobility. the initiative offers fast reliable and environmentally friendly travel options for tourists, researchers, and emergency responders.
  Example: The route between Johannesburg and Pilanesberg National Park is approximately 200 kilometers northwest of the city. The area is a well-renowned site for wildlife tours, research, and conservation projects. The road journey can take two to three hours often through congested and less-developed routes. Travel from a vertiport at Lanseria International Airport or Sandton CBD in Johannesburg to a vertiport within the national park will approximately cost 45 minutes of travel time this will help rapidly bypass the long road trip and boost remote connectivity.
- **Last Mile Connectivity**: Implementing eVTOLs for last-mile connectivity between Sandton and the Johannesburg CBD presents a viable solution to the challenges posed by road congestion and lengthy commutes. By offering a fast, efficient, and environmentally friendly transport option.

Example:TO commute from OR Tambo International Airport to Rosebank a vibrant district in Johannesburg that is a key commercial and retail hub with a thriving business environment. The best route between these areas would be from a Vertiport in Rosebank to OR Tambo International Airport. The ride would take 10 to 15 minutes approximately which otherwise takes one hour by car or the conventional means of transport

- **Regional Connectivity Hubs**: Connecting Johannesburg with regional hubs like Pretoria and Rustenburg. The distance between the city and Pretoria i approximately 55 km and Rustenburg is 110 km approximately.The current mode of travel causes long travel time to commute between these hubs. eVTOLS can be used in the scenarios in ways such as Example:A route from Johannesburg CBD or Sandton to Vertiports in Pretoria CBD or Hatfield a key business and educational hub. Travel time will take approximately 15 -20 minutes instead of 1-2 hours by car during the peak hours. Another route could be from Johannesburg CBD to Rustenburg CBD or Sun City a major tourism and conference hub with travel time around 30 to 40 minutes compared to 2-3 hours by car

Dubai's status as a global hub for business and tourism. eVTOLs can play a crucial role in addressing these needs by providing efficient, fast, and environmentally friendly last-mile connectivity.

- **Last Mile Connectivity**:Connecting Business Bay to Dubai Healthcare city.The typical ground commute between these areas can be congested during peak hours taking around 30 to 40 minutes by car due to traffic.
  Example: An eVTOL from a vertiport situated in Business Bay a prominent office tower to a vertiport within Dubai healthcare city, taking around 5-7 minutes. Healthcare professionals can travel between medical facilities and administrative offices. Implementing eVTOLs for last-mile connectivity between Business Bay and Dubai Healthcare City exemplifies a practical application of advanced urban mobility solutions in Dubai
- **Regional Connectivity Hubs**: Dubai Marina, a district known for its waterfront views and skyscrapers, is located approximately 35 kilometers (22 miles) southwest of Dubai World Central (Al Maktoum International Airport). This airport serves as a key aviation hub for cargo and passenger traffic, including flights by budget airlines and carriers operating long-haul routes. Regional air mobility services could establish a dedicated route connecting Dubai Marina to Dubai World Central, providing a swift and reliable aerial transport option.
  Example: Route from Dubai Marina to Dubai Central World. The ride will take approximately 20 to 25 minutes compared to one hour by road. This route is very well suited for cargo transport and logistic services between the two destinations. Which will help to boost the Supply chain efficiency of the region.

- **Connecting Remote Places**: Despite being a high-class urban city with a lot of investment in urbanization and real estate Dubai is surrounded by a vast desert landscape that poses challenges for traditional transportation and access to remote places.
  Example: Connecting Dubai to the Hajar Mountains located in the east of Dubai offering activities such as hiking and mountain biking but these remote areas are currently reached by road resulting in long travel times. One route for eVtols could be from Dubai International Airport or central Dubai to a vertiport near popular attractions in the Hajar Mountains such as Hatta or Jebel Jais Which can cut the travel time from 2-3 hours to 30-40 minutes.

Market Entry Strategy: It will be the same as both in the case of on-demand services like Air taxis Or Fixed demand services like Air shuttles.

6.6 Emergency Response service

Espejo-Díaz *et al.* (2023b)The latest advancements in electric vertical take-off and landing (eVTOL) vehicles indicate that soon this technology will be available in multiple fields. One potential application of this new technology is in emergency medical services. These vehicles will be able to reach emergency sites faster than ground ambulances at lower costs than traditional helicopters. So in the following years, eVTOL vehicles could be used for aeromedical transportation.

Szilágyi and Sziroczák (2022)The medical emergency response service is one of the electric vertical take-off and landing vehicles (eVTOLs) most promising field of application.By integrating eVTOL vehicles into the services. They could help to reduce emergency response times and hospital arrival times. They can have lower operating costs and a locally smaller environmental footprint than traditional helicopters, facilitating various applications. According to the analysis results, the percentage of the population receiving emergency care within 15 min can be increased from 85 percent to 99 percent. Szilágyi and Sziroczák (2022)This requires 30 eVTOL stations with about 40 vehicles, which have at least a 34 km service radius and are capable of 157 km/h cruise speed.

Doo (2022) Recent advancements in electric vertical takeoff and landing (eVTOL) aircraft have generated significant interest within and beyond the traditional aviation industry, and many new and novel applications have been identified and are under development. One promising application is rapid response during natural disasters, which can complement current capabilities to

help save lives and enhance post-disaster recovery.van der Zee (2023)The potential of electric aircraft for enhancing operations may be significant throughout various domains, including Emergency Medical Services (EMS). Their high speed, cost level, independence of ground infrastructure, and sustainability make them an interesting alternative for ground ambulances and helicopters. At the same time, implications of their use for EMS may be significant, in terms of large investments over a longer period, and considerable changes in EMS network and operations.

In Cape Town, the diverse geography includes remote areas where reaching through conventional means of transport takes a lot of time and in case of emergency, it becomes a challenge to reach that place faster. Using eVTOLs will revolutionize the city, 's emergency infrastructure by improving the speed and efficiency of medical, disaster, and rescue operations.

- **Medical Evacuations**: The Western Cape government's EMS system suffers from an ongoing ambulance shortage. Poor road conditions contribute to this issue. Ideally, the province should have 650 ambulances, but currently only 439 work. So we can already see a gap in the market where eVTOL Air Ambulance could be extremely helpful. Cape Town's diverse topography includes mountainous areas like Hout Bay. Ambulances often struggle to navigate difficult terrain, affecting response times.
  Example: An eVTOL air ambulance stationed at a central location like a vertiport in the city center or Groote Schuur Hospital can be immediately deployed in case of a medical emergency between Hout Bay and the hospital. the distance is approximately 15 km between the two places and can be covered in 5 to 7 minutes which is by far much less compared to time taken by conventional means of transport.
- **Disaster response**: Cape Town has been prone to heavy rainfall which led to floods in recent years. So to have a fast response through an eVTOL will always play a very important role towards disaster management in the city.
  Example: Consider a scenario where severe flooding occurs in Khayelitsha, a densely populated township in Cape Town. Traditional emergency response units face significant delays due to waterlogged roads and traffic congestion. In this scenario, eVTOLs stationed at a strategic location like Cape Town International Airport or local emergency response hubs can be quickly deployed. These eVTOLs can transport rescue teams, medical supplies, and emergency equipment directly to the affected areas. From the Airport to Khayelitsha, it will take 5 to 7 minutes to travel.
- **Firefight Support**: Cape Town faces a strong challenge when it comes to the risk of fire. During the summer, Cape Town recorded 7,190 vegetation fires, showing a 19 percent increase from the previous year. 851 informal residential fires and 699 formal residential fires. Cape Town's fire teams responded to over 13,000 incidents from October 2023

year to January 2024 making an increase of more than 10 percent from the previous year. Considering the intensity of the issue eVTOL is one of the must-have vehicles to emergency response in this scenario.
Example: Imagine a scenario where a wildfire breaks out in the Table Mountain National Park, an area known for its rugged terrain and dense vegetation. The fire rapidly spreads due to strong winds, threatening both the park and nearby residential areas.A gain in this case if eVTOL is stationed nearby like at the airport it can reach the location in 5 to 7 minutes and provide an initial overview and analyse the situation.

In Johannesburg, efficient emergency response is crucial due to the challenges posed by heavy traffic, delays navigating through congestion plus aging road infrastructure. By leveraging eVTOL technology, Johannesburg aims to optimize response times, improve situational awareness, and ultimately save lives in critical situations.

- **Medical Evacuations**: Rural response services often have to cover vast geographical regions, unlike urban areas. Ambulances must travel long distances to reach patients. This extended travel time can impact patient outcomes, especially in critical cases like heart attacks or strokes. Some rural communities are isolated, making it harder for response services to access them promptly.
  Example: An eVTOL air ambulance stationed at a central location like Charlotte Maxeke Johannesburg Academic Hospital is deployed immediately to an accident site bypassing the traffic.
- **Disaster Response**: Johannesburg is a city marked by spatial inequality. While affluent areas thrive, informal settlements and underserved neighborhoods face significant vulnerabilities. Rising temperatures and changing weather patterns lead to more frequent and severe disasters like droughts, floods, and wildfires. These pose significant challenges for disaster management. The integration of eVTOLs into Johannesburg's disaster response framework will represent a significant advancement in emergency management capabilities
  Example: Imagine a scenario where Johannesburg faces a sudden and severe flooding event due to heavy rainfall. Areas like Alexandra, experience widespread flooding In this scenario, eVTOLs stationed strategically at Johannesburg Emergency Management Services (EMS) hubs or Johannesburg International Airport can be swiftly deployed. They can reach flooded areas like Alexandra much faster than ground vehicles, providing critical support to residents stranded by rising waters
- **Firefight Support**: Lets directly go to the scenario
  Example: A fire breaks out in a high-rise building in Sandton, Johannesburg's financial district. The fire spreads rapidly, posing a significant threat to occupants and adjacent

structures. Firefighting eVTOLs equipped with water tanks, fire retardants, and specialized firefighting equipment are deployed from a nearby fire station. These eVTOLs can reach the fire site rapidly and provide aerial firefighting support.

Dubai's Emergency response service benefits from modern infrastructure, well-equipped ambulances, and advanced medical facilities. In comparison to other global cities, Dubai's investment in this infrastructure is commendable.

- **Medical Evacuation**:eVTOLs can significantly reduce response times by flying directly to the scene of an emergency.For critical cases like heart attacks or trauma, every minute matters. eVTOLs can quickly transport medical personnel and equipment.eVTOLs can also efficiently transfer patients between hospitals, especially when time-sensitive treatments (e.g., stroke care, organ transplants) are required
  Example: An eVTOL stationed at Dubai International Airport receives an emergency call. It takes off and reaches Dubai Marina in a matter of minutes, providing critical care to the patients on-site and transporting them directly to a specialized hospital like Rashid Hospital or Dubai Hospital.
- **Disaster response**: Strategically locating eVTOLs at key hubs such as airports and hospitals ensures rapid deployment across Dubai. Their ability to land in confined spaces or on rooftops allows them to reach patients in densely built-up areas like Dubai Marina, where traditional helicopters or ground vehicles may face logistical challenges.
  Example: Imagine a scenario where a resident in the Dubai Marina suffers a severe medical emergency An eVTOL stationed strategically at Dubai International Airport receives the emergency call. Within minutes of receiving the alert, the eVTOL takes off and heads directly to Dubai Marina. Due to its ability to fly above traffic and obstacles, the eVTOL reaches the scene within a short flight time, typically under 10 minutes. After stabilizing the patient on-site, the eVTOL swiftly transports them to a specialized hospital such as Rashid Hospital or Dubai Hospital, known for their advanced cardiac care facilities
- **Firefight Support**: Integrating eVTOLs into Dubai's firefighting infrastructure enhances the city's ability to respond swiftly and effectively to high-rise building fires. By leveraging advanced aerial technology and firefighting capabilities, Dubai not only improves firefighting efficiency and safety but also demonstrates its commitment to adopting innovative solutions for urban fire emergencies.
  Example: Imagine a scenario where a fire breaks out in a high-rise building located in Downtown Dubai, Upon receiving the emergency call, a firefighting eVTOL takes off from the Dubai International Airport Fire Station. It heads towards Downtown Dubai, covering approximately 15 kilometers to the fire location in just 5 to 7 minutes. This rapid response

time is critical in containing the fire and preventing its spread to adjacent buildings and areas.

Market Entry Strategy

- Establish partnerships with local government agencies, emergency services, and city planners. Collaborate to integrate eVTOLs into existing emergency response frameworks and develop operational protocols.
- Partner with hospitals, fire departments, and emergency medical services (EMS) to pilot eVTOL deployments for medical evacuations, firefighting support, and disaster response scenarios.
- Launch public awareness campaigns to educate communities about the benefits of eVTOLs in enhancing emergency response times and improving public safety.
- Identify strategic locations for eVTOL hubs, such as airports, fire stations, and medical centers, to optimize response times and operational efficiency.

7 Discussion

After a detailed Market segmentation analysis of all the use cases across the three cities we have seen in some cases one city is very much suited for a particular use case than the other one this gives us a chance to compare all three cities and discuss the strength and weaknesses dedicated to a particular use and draw results that could be helpful for the companies to decide which market to enter under a particular segment. To do this we are conducting a SWOT analysis based on the following factors

- Economic Landscape
- Market Demand
- Technological innovation
- Cultural and Demographic Factors
- Infrastructure Readiness
- Cultural and demographic factors
- Cost, Affordability, and Pricing

Figure 4: Factors and their effect on the cities

Factors/Cities	Dubai	Cape Town	Johannesburg
Market Demand	High due to tourism and business traffic	Moderate, strong tourism appeal	Moderate, business travel demand
Infrastructure Readiness	High with advanced urban planning	Moderate, ongoing development projects	Moderate, potential for development
Economic Landscape	High, strong economy and investment	Moderate, dependent on tourism fluctuations	Moderate, economic disparities
Technological Innovation	High, leading in smart city initiatives	Moderate, growing interest in technology	Moderate, increasing investment
Cost Affordability & Pricing	High income population, premium services	Varied affordability, tourism-driven	Economic disparities may limit adoption
Cultural & Demographic factors	Diverse population, global business hub	Rich cultural heritage, emphasis on tourism	Urban lifestyle, diverse demographics

Dubai consistently ranks highest across various factors crucial for advanced air mobility, including strong market potential, advanced infrastructure, economic strength, and a supportive regulatory environment. Its focus on technological innovation and diverse demographic appeal

further enhances its suitability. Cape Town follows with moderate scores, benefiting from tourism appeal, ongoing infrastructure development, and cultural heritage. Johannesburg ranks third, with moderate to low scores primarily due to economic disparities, regulatory challenges, and infrastructure readiness issues. Enhancing these factors is essential for improving its attractiveness for advanced air mobility solutions.

This SWOT analysis tables provide a clear overview of the factors influencing the implementation of air taxis, air shuttles, regional air mobility, and emergency response services in Dubai, Cape Town, and Johannesburg, focusing on strategic factors for stakeholders in the air mobility industry.

Table 1: City Service Analysis

City	Service type	Strength	Weakness	Opportunities	Threats
Dubai	Air Taxi	High market potential Advanced infrastructure High-income population	High costs Market saturation	Tourism integration Environmental sustainability	Economic variability
	Air Shuttle	Developed urban infrastructure, Smart city initiatives, High-income population	High costs Dependency on public funding	Business travel solutions, Integration into a smart city	Economic variability
	Regional Air Mobility	Developed aviation infrastructure, Strong economic hub, Technological innovation	Economic disparities	Regional connectivity Technological innovation	Market Uncertainty
	Emergency Response	Rapid urban development, Cultural emphasis on safety, Strong economic hub	Dependency on public funding	Integration into smart city emergency services, Technological innovation in emergency response	Market saturation in emergency services

Dubai is the most suitable city for the implementation of Advanced Air Mobility(AAM) across all the use cases. the city,s city-developed infrastructure, strong government support for technological innovation, and strategic initiatives aimed at smart city integration created an ideal environment for AAM.Wiedemann *et al.* (2024)The UAE, especially Dubai, has been a pioneer in testing electric VTOL technologies for launching an air taxi service. To remain ahead of the economic development curve and be in a competitive position with other major business locations, Dubai aims to have 25 percent of vehicles autonomous as early as 2030, making drone delivery and flying air taxis a reality. Additionally, the city's advanced infrastructure, including planned vertiports and established regional connectivity, supports the efficient deployment of regional air mobility services. For emergency response, Dubai's strong connectivity and rapid technological advancements facilitate the provision of quick and reliable emergency services.

Table 2: City Service Analysis

City	Service type	Strength	Weakness	Opportunities	Threats
Cape Town	Air Taxi	Scenic tourism appeal, Ongoing infrastructure development, Rich cultural heritage	Limited infrastructure for aviation	Event transportation for high-profile gatherings, Scenic flights for tourism	Economic disparities affecting tourism
	Air Shuttle	Diverse geographical landscape, Hub for Business travel in Africa	Economic disparities in travel affordability	Integration with existing transport networks	Market fluctuations in the travel industry
	Regional Air Mobility	Technological innovation capabilities, Emphasis on regional connectivity	Regulatory challenges in aviation	Partnerships with local business, Tourists traveling to remote attractions	Integration into the existing network
	Emergency Response	Cultural emphasis on safety, Integration into a smart city	Lack of Public Funding	Poor Emergency response infrastructure, Need for improvement in these Services, Climate	Market saturation

Cape Town holds moderate suitability for AAM use cases, particularly excelling in areas

related to tourism and regional travel. The city's scenic landscape and high tourist appeal make it a promising market for air taxis, especially during peak tourist seasons. The city's potential for Municipal support and ongoing infrastructure development projects further enhance its prospects for air shuttle services, connecting key tourist destinations and urban centers. However, the challenges are due to seasonal tourism fluctuations and developing necessary infrastructure, which is needed to address to full use of the AAM potential. For regional air mobility, Cape Town's strategic location and growing interest in technological integration present significant opportunities. Emergency response services can benefit from the city's strategic location and scenic terrain.

Johannesburg's role as an economic hub also supports the implementation of air shuttle services or air taxis, particularly with growing interest in technology and new urban development opportunities. For regional air mobility, Johannesburg's strategic position and potential for new urban developments provide a solid foundation. Emergency response services in Johannesburg can leverage the city, 's regional connections and economic significance.

Table 3: City Service Analysis

City	Service type	Strength	Weakness	Opportunities	Threats
Johannesburg	Air Taxi	Economic hub, Business travel demand	Infrastructure reediness	Growing Interest in Technology	Economic Fluctuations
	Air Shuttle	Urban Lifestyle, Diverse Demographics	Economic Disparities	Need for a fast and reliable mode of Shared Transportation	Market Uncertainty
	Regional Air Mobility	Increasing investment in Regional Economic Scenario, Diverse Geography	Regulatory challenges	Remote tourist attraction, Spread out Geography of Remote Locations	Lack of Public Funding
	Emergency Response	Demand in urban sprawl Technological Innovations	Dependency on public funding	Cultural emphasis on safety Climate	Crime and safety concerns

Apart from this Members of Vertiport Alliance Africa (VAA) have agreed to support Advanced Air Mobility (AAM) and Urban Air Mobility (UAM) in South Africa. Altitude Angel is providing the Unmanned Traffic Management (UTM) system for the Alliance, and MeshTastic is providing messaging and independent aircraft tracking. This is to ensure aircraft can be tracked even

if 4G/5G and other internet systems are down. Each member will maintain nodes at their Vertiport and at least two others in their local area to build infrastructure, says the report. Data from group receivers will be sent to the Altitude Angel UTM. All these initiatives will help to boost AAM integration in South Africa.

Figures 6,7, and 8 show the potential location of vertiports according to use case analysis and the examples we considered and they also show an example of one prominent route in all three cities at 9.00 AM on Monday during peak traffic hours, there is always a lot of delays and normally where it takes to reach the destination 20 or 25 minutes, in this case, it takes 40 minutes to 1-hour showing the difference an eVTOL can make on these routes in terms of reducing the traffic stress in the roads plus reducing the commuting time of the passenger to almost half or even less in few cases bypassing the traffic.

Figure 5: Vertiports In Cape Town

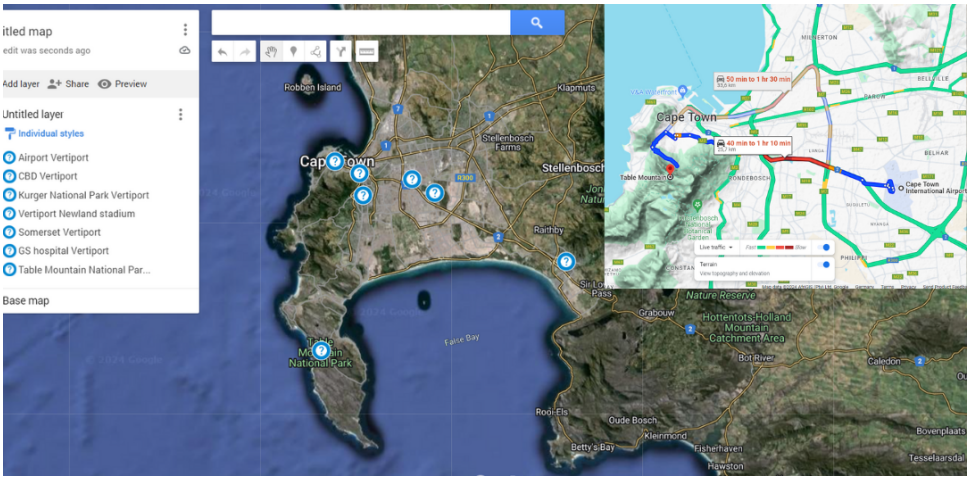


Figure 6: Vertiports In Johannesburg

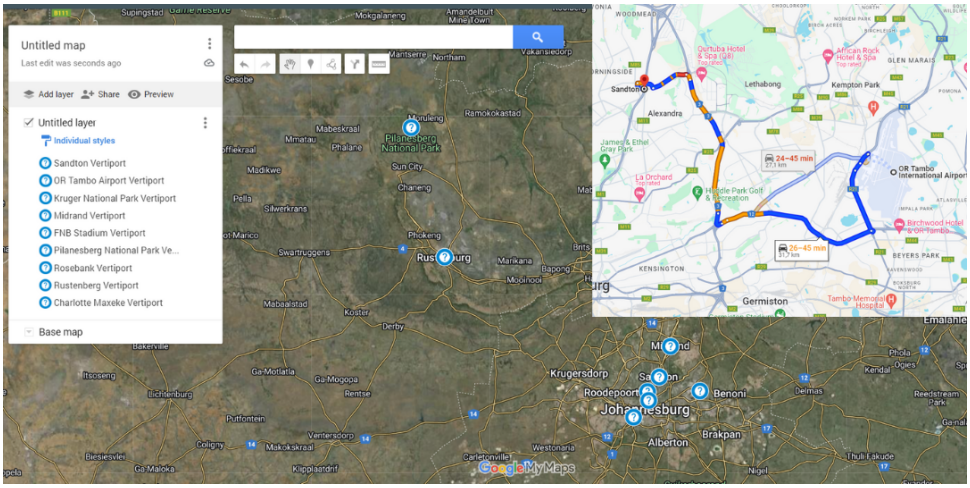
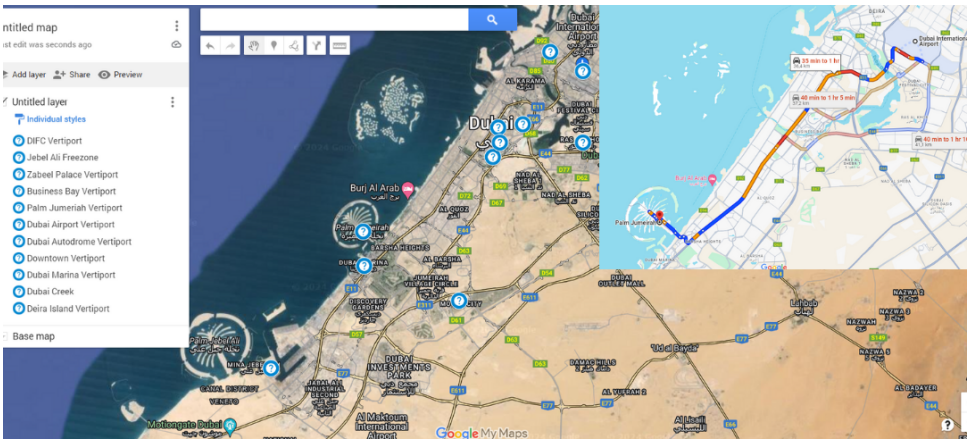


Figure 7: Vertiports in Dubai



8 Conclusion

Based on the detailed analysis and discussions of a holistic approach to provide a market entry strategy for Advanced Air Mobility use cases across the Three cities and dependent we saw a different type of examples of each use case based on the different cities. Every city has its unique characteristics and possesses different economic, cultural and graphic traits. Cape Town is one of the best suits among the three if you have to start a service of eVTOLs for businessmen and tourists Due to its famous coastline and beaches plus having nature reserves and forest land it is very attractive to tourists for all categories be it international, regional, researcher, etc.

In the same way, as we saw in our analysis, Dubai was best suited for all the use cases mainly due to its rich economic structure and reliable innovation projects which help easy integration

of new technologies. Johannesburg on the other has strong regional connectivity already existing which can lay a strong basis for the integration of AAM into the city but Johannesburg must address economic disparities, and infrastructure upgrades, to fully capitalize on AAM opportunities.

Summing up whole we can say Advanced Air Mobility is one of the fastest-growing sectors in the field of Urban and regional mobility providing various new options of commuting in our daily routine. These options promise efficient, fast, and seamless transport saving from congestion, long traffic jams, and long traveling times on short distances in rush hour, Urban Air Mobility will help to increase green spaces and reduce emissions using electric propulsion which will help cities, companies, and customer reach sustainability and environment-friendly goals faster. UAM also promotes the concepts of shared economy and shared mobility concepts, which are correlated and are important to achieving sustainable transportation in the future. I think eVTOLs have the potential to make a considerable difference in the whole concept of mobility transition and its effect on public transport if we look at the example of trains on how initially people were skeptical to adopt them as a new form of transportation but now it's the most trusted mode. So even though there are many doubts about EVTOLs now once they start their operation they could gain dominance as in the case of trains

In this analysis, we assumed climate, financial dynamics, political framework & environment, regulations, Technological infrastructure, public acceptance, and awareness as constant. Further research is possible considering the effect of these factors on the integration of AAM in the market. we had many limitations regarding the availability of specific numeric data for traffic demand and daily commute based on the use cases a further possibility for research is there based on this scheme with numeric data a transportation modeling problem can be developed for AAM using different use cases scenarios. Also, there is the possibility to use the proposed vertiport location in the analysis and compare routes based on factors (like total travel time from getting into the vertiport, boarding time, flight time, and reaching the destination), with a car route or other public transport and conclude how much time can be saved using eVTOLs that cars.

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