The operation of eVTOLs in the urban air mobility sector - use case & operator assessment

Marc Schoppmann

Dissertation written under the supervision of Professor Peter Rajsingh with the collaboration of industry expert André Pinho.

Dissertation submitted in partial fulfilment of requirements for the MSc in Management with Specialization in Strategy & Entrepreneurship, at the Universidade Católica Portuguesa, May 2022.

Abstract

Title: *The operation of eVTOLs in the urban air mobility sector - operator & use case assessment*

Author: Marc Schoppmann

Electric vertical takeoff and landing (eVTOL) technology enables a sustainable form of aviation for currently unserved connections. eVTOLs can reduce the carbon emissions of the aviation industry by replacing conventional helicopters and smaller aircrafts. In addition, traffic congestion in large cities can be decreased and travel times shortened. This thesis examines which use case is offered to the passengers. In addition, the prospective urban air mobility (UAM) market player that is expected to become a potential operator in the short term is summarized, alongside the value proposition (VP), key resources (KR), key activities (KA), and key partnerships (KP) of an eVTOL operator. The findings have been obtained through a qualitative research approach questioning 16 UAM experts, commercial as well as private aviation companies. The results reveal that eVTOL manufacturers are going to be the first market players to operate eVTOLs in the short to medium term. Commercial airlines are expected to step into the market in the long term. Interviews have additionally shown that airport shuttles will be the first served use case. The primary value proposition is saving time for the passengers. The primary key resource is human staff. The primary key activity is eVTOL maintenance. The primary key partnership is with the infrastructure provider and/or operator. Furthermore, this research adds value to the existing UAM literature on eVTOL operators, first commercially offered use cases as well as elements of an operator's business model.

Keywords: Urban air mobility, use case, airport shuttle, eVTOL, eVTOL manufacturer, eVTOL operator, business model

Sumario

Título: O funcionamento de eVTOLs no sector da mobilidade aérea urbana - avaliação de casos de operador e utilização

Autor: Marc Schoppmann

A tecnologia de decolagem e aterrissagem vertical elétrica (eVTOL) permite uma forma sustentável de aviação para conexões atualmente não atendidas. Os eVTOLs podem reduzir as emissões de carbono da indústria da aviação substituindo helicópteros convencionais e aeronaves menores. Além disso, o congestionamento do tráfego nas grandes cidades pode ser reduzido e os tempos de viagem reduzidos. Esta tese examina qual caso de uso é oferecido aos passageiros. Além disso, o potencial participante do mercado de mobilidade aérea urbana (UAM) que deve se tornar um operador potencial no curto prazo é resumido, juntamente com a proposta de valor (VP), recursos-chave (KR), atividades-chave (KA) e parcerias (KP) de um operador eVTOL. Os resultados foram obtidos por meio de uma abordagem de pesquisa qualitativa questionando 16 especialistas, empresas de aviação comercial e privada. Os resultados revelam que os fabricantes de eVTOL serão os primeiros players do mercado a operar eVTOLs no curto e médio prazo. Espera-se que as companhias aéreas comerciais entrem no mercado a longo prazo. As entrevistas também mostraram que os ônibus do aeroporto serão o primeiro caso de uso servido. A principal proposta de valor é economizar tempo para os passageiros. O recurso-chave primário é a equipe humana. A atividade de chave primária é a manutenção do eVTOL. A parceria de chave primária é com o provedor e/ou operador de infraestrutura. Além disso, esta pesquisa agrega valor à literatura UAM existente sobre operadoras eVTOL, primeiros casos de uso oferecidos comercialmente, bem como elementos do modelo de negócios de uma operadora.

Palavras-chave: Mobilidade aérea urbana, caso de utilização, transporte de aeroporto, fabricante de eVTOL, eVTOL, operador de eVTOL, modelo de negócio

Acknowledgments

First and foremost, I would like to thank my two supervisors, Professor Peter V. Rajsingh and André Pinho for their continuous supervision and support. During the entire writing period they were exceptionally responsive, flexible and always committed to help me with questions. In addition, I am especially thankful for enabling me to write about my topic of choice. They definitely helped me to navigate through the entire process and their feedback undoubtedly contributed and added great value to my thesis.

Besides that, I would like to thank my interview partners and UAM experts for their collaboration and their openness to talk to me even most of the time they were under time-pressure. You supported me greatly and allowed me to collect valuable insights into the urban air mobility industry with all its challenges and exciting facets. This enabled me to enrich my work and draw interesting conclusions.

I would also like to thank all my family and friends, who have helped and motivated me during the past four months with their opinions and openness to discuss anything thesis related. A special thank you to Zarah, for her mental support and words of encouragement.

Contents

List of Tables

List of Figures

Abbreviations

ATC	Air traffic control
ATM	Air traffic management
BMC	Business model canvas
eVTOL	electric vertical takeoff and landing
EC	European Commission
EASA	European Union Aviation Safety Agency
EU	European Union
FAA	Federal Aviation Administration
GHG	Greenhouse gases
KA	Key activities
KP	Key partnerships
KR	Key resources
OCC	Operations control center
OEM	Original equipment manufacturers
MRO	Maintenance, repair and overhaul
PBAC	Private/ business aviation companies
R&D	Research and Development
RQ	Research question
UN	United Nations
USD	US-Dollar
UAS	Unmanned aerial system
UTM	Unmanned traffic management
UAM	Urban air mobility
VP	Value proposition

1. Introduction

1.1 Problem statement

The United Nations (UN) projects that by 2030 about 60% of the world population will live in urban areas (Kellermann et al., 2020). This growth of urban populations will lead to increasingly congested infrastructure, which is already a worldwide issue. The cost of road congestion was estimated to be more than €110 billion per year in Europe (Ibañez Rivas & Christidis, 2012). Urban congestion not only leads to increased travel times for passengers, but also to a major increase in fuel consumption and resulting carbon emissions.

The transportation of passengers on the road causes the highest proportion of emissions in urban cities (European Commission, n.d.). One quarter of Europe's greenhouse gas (GHG) emissions are caused by the transport industry, with road transport as the largest emitter responsible for 72% of all transport related GHG emissions in 2019 (European Commission, n.d.; European Environment Agency, 2021).

The problem of road and traffic congestion as well as increasing carbon emissions have created a need for innovative mobility options. Mobility, in particular the transportation of people, has been a long-term challenge for urban authorities, especially the integration of sustainable urban mobility solutions as an alternative to existing ground fossil fuel-based transportation (Lyons, 2018).

The European commission has published a "strategy for low emission mobility" (European Commission, n.d.) that entails improving the efficiency of the transport system by using, for example, digital technologies and by promoting more initiatives to shift to lower emission transportation methods. Secondly, the commission declared its intention to improve the deployment of low emission energy alternatives for transportation. This includes using advanced biofuels, electricity, hydrogen, and renewable synthetic fuels as well as the removal of barriers to the electrification of transport. Thirdly, the commission wants to speed up the transition to employing low- and zero-emission vehicles (European Commission, n.d.).

Increased travel demands (Sun et al., 2021), airborne technology innovation, and autonomous technology advancements (NASA, 2018) have created additional incentives that promote urban air mobility concepts (NASA, 2018; Sun et al., 2021). Urban air mobility (UAM) is facilitated through using electric vertical landing and taking off (eVTOL) vehicles, referred to as eVTOLs.

eVTOLs are passenger-transporting drones that could be used as a safe, sustainable, and convenient urban mobility solution by utilizing the airspace (Michelmann et al., 2020). The investment of USD 907 million into UAM startups in the first half of 2020 showed that the concept of urban air mobility is backed by the market. In 2019, there were over 1,000 test flights of eVTOL aircrafts and, in March 2020, there were at least twelve eVTOL manufacturers reported as being in the process to obtain certification from the U.S. Federal Aviation Administration (FAA) (Dietrich & Wulff, 2020).

1.2 Academic & managerial relevance

Research on the concept of urban air mobility already exists, and the managerial and practical integration of eVTOLs into existing airspace is currently being prepared. Existing academic research has covered different eVTOL architectures, mathematical models for the placement of landing sites, demand estimations, UAM challenges and barriers, and the public's acceptance and adoption.

However, Michelmann et al. (2020) point out that future research should include laying out the key operational concepts and processes. Straubinger et al. (2021) added that meaningful UAM business models do not exist and should be built. This entails that the operators, which are responsible for the execution of efficient and safe operations, including their business models, have not been researched thoroughly. Multiple different market players who could facilitate the service exist, but insights from the market through experts are missing. In addition, the analysis of eVTOL use cases is lacking. The literature has proposed different possible scenarios, however, did not indicate which use case would be the first one to be operationalized.

This thesis aims to contribute to the existing literature on UAM by providing an analysis that focuses on the managerial implementation of an eVTOL transportation service. This research is three-split into an analysis of the first operational use case, the market player becoming the eVTOL operator, and the infrastructure and offer area of the business model for an operator. The analysis of the first use case lays the foundation for the academic and managerial analysis to grasp the different scenarios. The examination of the first market player operating eVTOLs supports the realization of operations and the understanding of how operations will look. In addition, because the service cannot be offered to passengers without the operator, the third part of the analysis focuses on specific parts of the business model canvas to gain insights on the design and process of operations. This research therefore provides insights on operational aspects of UAM, which is currently disorganized (Sun et al., 2021) and provides a needed analysis of parts of a commercially resilient operating model for operators (Baur et al., 2018).

1.3 Research question and outline

This research aims to assess the developments of the eVTOL operations. This includes the different use cases that will attract passengers and promote an intention to buy. This entails analyzing which entity will operate the service and aims to understand what the operator's main resources, partnerships, and activities are likely to be to provide a safe, sustainable, and convenient air transportation service.

The focus of this research study is to analyze which use case the eVTOL technology is going to serve in the short to medium term and what kind of market player will act as an operator, resulting in three research questions:

RQ1: *Which use case of eVTOLs will prevail with the operator in the short to medium term?*
RQ2: *What kind of market player or UAM stakeholder is bound to operate eVTOLs?*
RQ3: *What are the value propositions and key resources, activities, and partnerships for an eVTOL operator?*

Following the introduction, the second chapter consists of the literature review, where knowledge about the UAM market, the eVTOL technology, the different use cases, and the operator of eVTOLs is collected. The third chapter explains the qualitative research design as well as the primary and secondary data collection. The fourth chapter follows with a descriptive analysis of the results, concluding with a frequency analysis. The discussion in chapter five compares the results with the literature and provides answers to the research questions. Chapter six presents the required digital enablers to achieve operations, the limitations of the research, and the opportunities for future research.

2. Literature review

This chapter will review the existing literature on UAM. It will start with the theory on emerging technology and emerging industries to lay the foundation. It then provides a review of existing literature on the concept of UAM with its definition, expected market size, and challenges. The following chapters explore the technology of eVTOLs, use cases, and potential operators. The literature review ends with introducing the Business Model Canvas by Osterwalder and Pigneur, which will be the underlying theoretical framework for the analysis.

2.1 Emerging technology & industries

The emergence of new technologies, the disappearance of old ones, and the change of weight of economic activities and their interaction are considered the main engines of economic growth via structural changes in industries (Pyka & Saviotti, 2011). Emerging technologies are perceived to have the ability to change the status quo (Alexander et al., 2012; Cozzens et al., 2010; Day & Schoemaker, 2000; Martin, 1995). Corrocher et al. (2003, p.4) said in their findings, "The emergence of new technology is conceptualized (…) as an evolutionary process of technical, institutional and social change" and has "the potential to create a new industry or transform an existing one" (Day & Schoemaker, 2000, p.30).

The initial stage, the co-evolutionary stage, and growth stage are the three stages of the process of a new emerging industry (Gustafsson et al., 2016). In the initial stage, the existing market, technological system, or industry is challenged (Van de Ven & Garud, 1989), but change and development of the new industry have not yet significantly progressed (Gustafsson et al., 2016). The triggers most associated with the initial stage are scientific and technological development (e.g., invention, innovation, or technology) (Malerba & Orsenigo, 1996; Phaal et al., 2011), which compete with existing products or services (Hargadon & Douglas, 2001; Mezias & Kuperman, 2001; Munir & Phillips, 2002; Van de Ven & Garud, 1993). Disruptive innovations either originate in low-end or new-market footholds (Christensen et al., 2015). In the case of new-market footholds, disruptors create a new market where none existed before (Christensen et al., 2015). Multiple market categories and industry identities emerge (Gustafsson et al., 2016) while entrepreneurial opportunities, arising entrepreneurial activities, and new company establishments are increasing (Mezias & Kuperman, 2001; Sine & Lee, 2009).

The co-evolutionary stage, characterized by reciprocal change between stakeholder firms, is associated with communication between actors about their activities in the new industry (Suarez

et al., 2014), a rising number of collaborations between firms (Burr, 2006; Van de Ven & Garud, 1994), increasing media coverage (Schultz et al., 2013), and "collective strategic actions and positionings of firms" (Gustafsson et al., 2016, p.31). The development of industry structures, business models, and value chains, as well as competition between different technologies, designs, value chains, and platforms are fundamental during the co-evolutionary stage (Gustafsson et al., 2016). Part of this stage is additionally the creation of cooperative technology organizations to set standards, which increasingly counteract existing and emerging uncertainties (Rosenkopf & Tushman, 1998). Established standards improve compatibilities and interoperability between companies to generate network effects at a later stage (Katz & Shapiro, 1986).

The growth stage happens when various processes and dynamics from the previous stage set in (Gustafsson et al., 2016) and when the industry grows and reaches maturity (Forbes & Kirsch, 2011). The emergence of a new industry can be in the form of a different sub-market or technological niche market within an existing industry (Geels, 2002; Jacobides, 2005). So-called irreversibilities happen, such as investments, building of knowledge, and technological and production commitments (Caves, 1984; van Merkerk & Robinson, 2006). These include exploitative alliance strategies, which involve acquisition of intellectual property and generation of manufacturing capacity (Gustafsson et al., 2016). The growth stage entails significant increases in sales (Agarwal & Bayus, 2004; Kapoor & Furr, 2014), improvement of product quality (Agarwal & Bayus, 2002), and clarification of competition (Munir & Phillips, 2002). New market players from related domains enter the new industry as a response to intensified competition for "institutionally defined resources" that became clear during the evolutionary stage (Leblebici et al., 1991, p.359).

2.2 Urban air mobility

The following chapter defines the concept of urban air mobility and displays expert estimations of the growth and development of the new urban air mobility market. Afterwards, the challenges for operation are divided into technological, ground infrastructure, regulatory and social.

2.2.1 Definition & market size

Urban air mobility (UAM) is an emerging concept of air transportation that enables different use cases for parcel delivery drones and passenger transportation (Michelmann et al., 2020). UAM enables "passenger transportation in the proximity of urban settlements using highly automated or fully autonomous passenger drones" (Michelmann et al., 2020, p.1). Drones,

called “air taxis” (Kellermann et al., 2020) or “air metros” (NASA, 2018), will in the near-term be operated by on-board pilots or in the long term, be remotely controlled by command-and-control centers (Reiche et al., 2018). The entirety of the mentioned UAM explanations is in the following used as the definition for the concept of UAM. Technological developments such as improvements in energy storage density and capacity (NextGen FAA, 2020), electric and distributed propulsion, aircraft design, and battery/engine technology have enabled the development of passenger carrying vehicles, called eVTOLs (Rothfeld et al., 2019; Sun et al., 2021).

SESAR 3 Joint Undertaking is an institutionalized European partnership between the private and public sector for “actively coordinating and concentrating research and development for safeguarding the future integration of drones into current airspace” (Kellermann & Fischer, 2020, p.108). SESAR 3 estimates the market value of passenger transport to be at least €2 billion by 2031 with the market taking-off in 2027 (SESAR Joint Undertaking, 2018). The European Commission (EC) estimates that commercial use of passenger drones will have an economic impact of €10 billion annually by 2035 and will further increase to €15 billion per year by 2050 (SESAR Joint Undertaking, 2016). In addition, the EC envisions creation of more than 100,000 direct jobs (SESAR Joint Undertaking, 2016). Similar to the EU, the US estimates 100,000 jobs over ten years (2015-2025) along with an additional 250,000-400,000 jobs in drone-related industries (Kellermann et al., 2020), amounting to an economic impact of USD82 billion (SESAR Joint Undertaking, 2018). A study conducted by NASA which included restrictions by infrastructure, willingness to pay, weather conditions, time of day, and capacity predicted a near-term demand in the US of 55,000 daily trips for air taxis and airport shuttles with 4,100 aircraft (Straubinger et al., 2020). The consulting company Roland Berger estimates that about 100,000 drones could be in use worldwide by the year 2050 (Baur Stephan et al., 2018). All of the above experts are united in their view that UAM will be a very substantial market in the medium to longer future.

2.2.2 Challenges for UAM operation

The commercial realization of UAM faces challenges that need to be tackled by different stakeholders to enable a safe and convenient environment (Straubinger et al., 2021). Challenges are clustered into technological, ground infrastructure, regulatory, and societal acceptance categories.

Challenges for UAM operation			
Technological	**Infrastructure**	**Regulatory**	**Societal acceptance**
Creation of Unmanned Aerial System Traffic Management (UTM)	Development and design of vertiports	Airworthiness certification (aircraft design, manufacturing, failure response and maintenance)	Risks to safety & security
Development, deployment and use of precise navigation applications	Placement of vertiports	Requirements and certification for operators	Concern of actual time saving
Securing of air traffic interaction and communication	Convenient customer service (e.g. security checks, bathrooms)	Regulatory framework for operators	Noise disturbance
Improvements in battery technology (e.g. storage, density and weight)	Maintenance, repair and overhaul infrastructure		Social acceptance for usage
Reduction of noise	Energy supply to recharge eVTOLs		

Figure 1: Challenges for the realization of UAM operations (Author's own illustration)

2.2.2.1 Technological challenges

A long-term technological issue concerns creating unmanned traffic management (UTM) when pilots are no longer flying eVTOLs. The UTM "provides airspace integration requirements, enabling safe low-altitude operations. UTM entails services such as airspace design, corridors, dynamic geofencing, weather avoidance, and route planning" (Shaheen et al., 2020, p.119). Geister (2017) adds the provision of terrain and obstacle maps, contingency management, separation management, and emergency and conflict management to the tasks of an UTM system. UTM is responsible for ensuring efficient and effective operations by providing necessary data to operators for strategic decisions (SESAR Joint Undertaking, 2018; Shaheen et al., 2020).

Another technological challenge for drones is the development, deployment, and use of precise navigation applications to prevent interference with commercial, manned, and unmanned aviation (Geister, 2017; Straubinger et al., 2021). In addition, the automation of navigation and communication in crowded, small airspaces and in various weather conditions is another challenge (Straubinger et al., 2021). Furthermore, a well-functioning air traffic interaction regime and communication with the Air Traffic Control (ATC) are crucial for the deployment of the urban air mobility concept (Hansman & Vascik, 2016; Reiche et al., 2018; Straubinger et al., 2021).

Due to high research and development (R&D) costs, the UAM sector is further dependent on improvements in battery technology by the automotive sector (Ploetner et al., 2020). The storage capacity and energy density of batteries presently limits flight duration and range of

eVTOLs (Straubinger et al., 2021). Battery weight and charging times are additional technological difficulties (Reiche et al., 2018).

Another technical challenge is reducing noise by adjusting the speed of blades, number of rotors, specific design of rotors, and corresponding shielding mechanisms (Straubinger et al., 2021).

2.2.2.2 Ground infrastructure challenges

Development and planning of suitable take-off and landing spots, called "vertiports" (Rothfeld et al., 2019), are essential for the operation of passenger drones (Baur et al., 2018; Hansman & Vascik, 2016; Nikitas et al., 2020). Various studies have been conducted to determine ideal locations of vertiports in, for example, Los Angeles and San Francisco (Daskilewicz et al., 2018), Munich (Ploetner et al., 2020), the metropolitan area of Seoul (Lim & Hwang, 2019), and other locations. Additional infrastructure is required to offer customer services (e.g., food and beverages, bathrooms) (Straubinger et al., 2021) and facilities in which to operate security checks (Ploetner et al., 2020; Straubinger et al., 2021). UAM infrastructure for maintenance after completed flights is necessary to ensure successful and safe operations (Baur et al., 2018; Straubinger et al., 2021). An additional challenge is securing a sufficient energy supply to recharge drones in between flights (Baur et al., 2018; Straubinger et al., 2021).

2.2.2.3 Regulatory challenges

Another challenge to operate urban air mobility is to have appropriate regulations for airworthiness certifications to address safety issues pertaining to aircraft design, manufacturing, performance, failure response, and maintenance (Reiche et al., 2018). Straubinger et al. (2020) point out that requirements and certifications for operators have not yet been fully developed. A regulatory framework for aircraft operation is a precursor for launching initial services (Straubinger et al., 2020).

2.2.2.4 Social challenges

Social challenges can be divided into societal acceptance and user adoption. The dilemma surrounding societal acceptance is whether more people will be influenced by possible negative perceptions rather than taking their cues from early adopters who choose to use a UAM service (Straubinger et al., 2021). Kellermann and Fischer (2020) discovered that people see parcel and passenger drones as potential risks to safety and security. Survey participants were also concerned whether passenger drones would actually save them time because of the transit time required to get to take-off and drop-off points (Kellermann & Fischer, 2020). Various studies point out that the noise level of drones is another challenge (Hansman & Vascik, 2016;

Kellermann & Fischer, 2020; Reiche et al., 2018; Yedavalli & Mooberry, 2019). Yedavalli and Mooberry (2019) found that not only the level of noise but also the type of noise is a major concern. Manufacturers are seeking to develop quieter aircraft with lower noise emissions. However, the technical advantages of electric engines and rotors may be erased by the sheer numbers of flights and drones in the air at the same time (Kellermann & Fischer, 2020). Operators will need to work out an optimal level of eVTOLs per vertiport to accomplish appropriate average noise levels (Holden & Goel, 2016).

Although scholars and commenters have extensively discussed the variables that create acceptance for the active and passive use of drones, there is uncertainty as to which are the most critical factors (Kellermann & Fischer, 2020). User adoption is dependent on perceived advantages over traditional technologies and services as well as the direct benefits from using drones (Kellermann & Fischer, 2020). There is also a desire for high flexibility, dependability, and ability to control the drone (Kellermann & Fischer, 2020). Davis (1989) points out that, as part of the Technology Acceptance Model, perceived usefulness and perceived ease of use are the two fundamental theoretical measures for predicting and explaining use.

2.3 Electrical vertical take-off and landing (eVTOL) technology

An eVTOL vehicle is an electric powered manned or unmanned aerial vehicle, designed for transportation of passengers or goods with vertical landing and taking off capabilities, suited for use in urban and regional areas (Rakas et al., 2021; Rumba & Nikitenko, 2020; Sun et al., 2021; Volocopter, 2021). This aerial vehicle concept promises to be quieter, safer, and cheaper to produce and operate than conventional helicopters (Rothfeld et al., 2019).

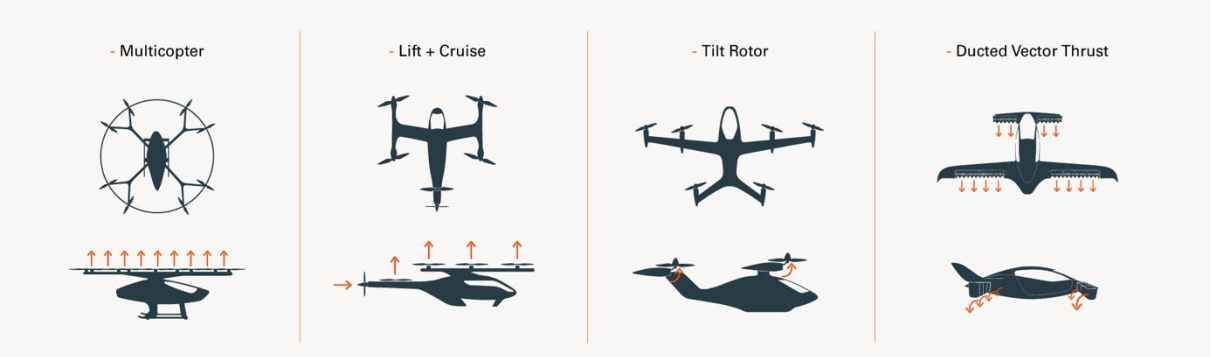

Figure 2: Overview of eVTOLs architecture concepts (Lilium, 2020)

The first category of eVTOLs is the multicopter architecture. This design is relatively simple and very efficient during hover and vertical take-off and landing procedures (Baur et al., 2018; Nathen, 2021; Palaia et al., 2021). Since multicopters do not have wings, they lack cruise efficiency and are therefore better suited for urban use cases (Nathen, 2021). Volocopter is one

of more manufacturers with this approach (Baur et al., 2018). A more detailed analysis is given by Pradeep and Wei (2019).

The second architecture is a lift and cruise design which consists of a vehicle with wings like conventional aircrafts with additional up-facing rotors. This enables the vehicle to be both efficient during vertical take-off and landing and during cruising (Nathen, 2021). The propellers are smaller to maximize the range by reducing the drag during cruising flight (Nathen, 2021).

The third category is called a tilt rotor architecture, where the pilot is able to either tilt the wing and the propellers or just the propellers (Palaia et al., 2021). This is conducted during the transition from hovering to forward flying and is more optimal than the lift and cruise architecture. The disadvantage however is the inherent technical complexity and larger overall size and weight. (Nathen, 2021)

The fourth category is different to the three above architectures because it uses a ducted fan architecture and not propellers. A significant advantage is the reduction of noise and a higher payload than a propeller aircraft. The disadvantage is that a lot of energy is required for hovering phases. Lilium is a manufacturer using this architecture. (Nathen, 2021)

2.4 Use cases of eVTOLs

Drones have multiple use cases, such as transporting goods (parcel delivery) and applications with sensor and communication tasks (agriculture, surveillance) (Straubinger et al., 2021). Passenger transportation entailing new aerial mobility is gaining interest. This thesis focuses on use cases that require drones to have lower range capabilities and are therefore clustered to be short distance and inner city use cases. However, the long-range use cases will not be neglected to ensure a complete analysis. This includes travel within urban areas along with *airport shuttles* (Straubinger et al., 2020), *air taxis* (SESAR Joint Undertaking, 2018) and *air metros* (NASA, 2018), and regional air mobility between regions and cities and from outside the city to the city center.

Ninety-three percent of international airports are within a 30 km radius to the city center and therefore lie within current range of the battery technology of eVTOLs to serve as airport shuttles (Volocopter, 2021). Customers around the world require long access times to get to airports (Straubinger et al., 2020). UAM is an opportunity for airlines to enable fast access to

airports and to city centers (Grandl et al., 2018; Shaheen et al., 2020). Advantages include avoiding traffic jams and enabling faster travel times while achieving increased comfort in last-mile transportation for passengers (Straubinger et al., 2021). Vehicle requirements for airport shuttles are higher speeds to cover longer distances while poorer hovering efficiencies and higher downwash speeds are suitable (Baur et al., 2018). A challenge for the airport shuttle is that passengers need to transport luggage with them, which is additional weight to be transported by the eVTOL, and that passengers require reliability (Schuchardt et al., 2021).
Other challenges are that landing areas for airport shuttles need to be integrated into existing airport infrastructure to enable a convenient service for passengers (Straubinger et al., 2021). Eurocontrol explained that the opening of controlled airspace for eVTOLs for a range of operations of unmanned aerial system (UAS) and UAM is not expected before 2027 (EUROCONTROL, 2018). Straubinger et al. (2021) conclude that the "integration of UAS and UAM into existing airspace around and at airports has been identified as an important subject, however so far not been addressed specifically" (Straubinger et al., 2021, p.371). The authors further conclude that flying within the CTR might become accessible for eVTOLs, while operations in proximity of airports and runways will remain off limits (Straubinger et al., 2021). Important factors for the feasibility of UAM as airport shuttles are the layouts of airports (open vs. closed), the location of vertiports, and the UAMs' connection to other means of transportation within airports (Straubinger et al., 2021). These challenges show that eVTOLs have to be embedded into the regulatory framework of airports just as helicopters are.

The use case of *air taxis* describes "inner city point-to-point" (Baur et al., 2018) transportation whereby passengers embark an eVTOL at a pickup location (vertiport) and are dropped-off at another vertiport (Hansman & Vascik, 2016; Mohamed et al., 2020; NASA, 2018; Reiche et al., 2018; SESAR Joint Undertaking, 2018; Volocopter, 2021). Flights would likely be on-demand, with vehicles operating autonomously with a passenger capacity of two to five passengers (NASA, 2018). Air taxis overcome the problem of congested highways and transit infrastructure while providing Mobility-as-a-Service at a price that is expected to be competitive to peer transportation modes (Hansman & Vascik, 2016; Mohamed et al., 2020; Volocopter, 2021). Additionally, air taxis will diversify mobility options for residents and increase accessibility of Central Business Districts (Hansman & Vascik, 2016). Urban and short distance travel (<35km) require high safety standards, low noise emissions, effective range and speed capabilities, sufficient passenger capacity, operating efficiency, and vehicle lifecycle reliability (Volocopter, 2021). High investment costs needed to enable air taxis with ubiquitous

vertiports are a constraint that limits 2030 viability (NASA, 2018). Additional constraints are the number of air taxis required to satisfy demand for frequent service and a sufficient network of vertiports to offer a direct point-to-point network (Baur et al., 2018). The most suitable vehicle architecture is multicopters due to their gust stability during hovering times for landing and taking-off maneuvers (Baur et al., 2018).

"*Air metros*" (NASA, 2018) would likely operate on pre-determined routes on regular schedules and defined stops in high traffic areas through each city (NASA, 2018). Piloted air metro services could be the first steps on the road to large-scale autonomous operations and are expected to be profitable by 2030 under the assumption that challenges, particularly related to regulations, are overcome (NASA, 2018).

A different category of air mobility is called regional air mobility and entails use cases that are *long distance* scenarios, such as inter-city transports to connect remote regions to city centers and cities with other cities, and to enable a more efficient form of commuting to the city center (Baur et al., 2018; SESAR Joint Undertaking, 2018; Straubinger et al., 2021; Volocopter, 2021). These use cases might be on-demand services for passengers in remote regions by offering a flexible connection to the city (Straubinger et al., 2021). This could lead to an improvement to the attractiveness of living in suburbs of big cities (Straubinger et al., 2021). These intercity flights could also be scheduled and operated between cities that are 50 to 250 km apart from each other and are not viable for commercial airlines (Baur et al., 2018). Intercity flights to other large urban areas would be favorable for commuters and business travelers because significant reductions in travel times are possible (Baur et al., 2018). A challenge is that demand is expected to be concentrated in peak hours, with minimal demand in off-peak hours, leading to an underutilization of the system (Schuchardt et al., 2021). Vehicle requirements for longer distances are higher forward speed enabled by larger battery capabilities (Baur et al., 2018). Improvements in battery technology and new forms of electric propulsion will increase today's ranges of 20 to 30 km to more than 100 to 250 km by 2030 (Baur et al., 2018).

2.5 eVTOL Operator

In order to understand how different UAM use cases with eVTOL technology are expected to be operated, the different potential eVTOL operators responsible for the overall management of UAM operations will be discussed along with their activities for safe and efficient operations.

2.5.1 Potential eVTOL operators

Commercial airlines are considered potential eVTOL operators and are encouraged to enter the UAM market (Michelmann et al., 2020). Their expertise in aircraft maintenance and operations, ability to establish well-known operational concepts (e.g., high aircraft utilization, fees for additional services, staff reduction), and capacity to optimize costs could make UAM profitable for them and affordable for customers (Michelmann et al., 2020).

Aerial mobility service providers could benefit from operating an UAM service by offering an intercity and regional transportation service alongside existing domestic and international flights (Straubinger et al., 2021). They have competitive advantages because of know-how pertaining to customer handling, operational processes, and being integrated into airports (Straubinger et al., 2021).

Aircraft manufacturers are also potential operators (Ploetner et al., 2020). UAM manufacturers could sell transport services in addition to vehicles, like original equipment manufacturers (OEMs) in the automotive sector (Straubinger et al., 2021). Volocopter and Airbus are manufacturers interested in this approach (Straubinger et al., 2021). Vertical integration within the UAM market could reduce dependency on third parties for maintenance, repair, and overhaul (MRO) services and could reduce production costs (Straubinger et al., 2021).

Alternative eVTOL operators are mobility platforms such as UBER, LYFT, and Cabify that already utilize digitalization and the sharing economy concepts to sell transport services without owning vehicles or hiring drivers (Straubinger et al., 2021). They would benefit by broadening their range of services with an air transportation offering, thereby providing a full suite of travel options through a multi-modal service (Straubinger et al., 2021).

Public transport providers promote social inclusion and economic growth through access to transportation (Straubinger et al., 2021). Their infrastructure assets and ability to integrate UAM services into other means of public transportation makes them attractive as operators (Straubinger et al., 2021).

2.5.2 Tasks of operators

Operators link stakeholders together and are responsible for ensuring that mobility services operate “safely, efficiently and (ideally) at a profit” (Baur et al., 2018, p.15). They are

responsible for the overall management of UAM operations (NextGen FAA, 2020), including provision of transportation service for passengers (Straubinger et al., 2020).

Operators facilitate a predictive traffic management system and ensure maximum utilization of the network as a whole (Baur et al., 2018). The Federal Aviation Administration (FAA) is the regulator of national aviation activities, including management of air traffic in U.S. airspace (U.S. Department of Transportation, 2018). The FAA established rules as part of the UTM where operators are responsible for coordination, execution, and management of operations (Federal Aviation Administration, 2021). Necessary elements of a predictive traffic management system and UTM are flight planning (Reiche et al., 2018; Straubinger et al., 2020), preflight risk analyses, and establishment of an Operations Control Center (OCC) to support risk management and flight monitoring (Reiche et al., 2018).

UAM services may transition to full automation (Michelmann et al., 2020; Reiche et al., 2018). Dispatch operators play a supervisory role and provide remote command capabilities when the autonomy of vehicles cannot handle an unexpected scenario (Mohamed et al., 2020). These OCCs host remote operators controlling multiple aircrafts (Reiche et al., 2018). Command and control over vehicles by authorized operators to ensure physical and cyber security of the eVTOL is important for protecting passengers (Nneji et al., 2017). The ability to change routes is important for passenger and vehicle safety (Rumba & Nikitenko, 2020). Maintaining and monitoring energy supply during flights and being aware of energy availability along the route are additional safety related tasks (Nneji et al., 2017).

Estimating and evaluating demand drivers is another task for an eVTOL operator (Reiche et al., 2018; Straubinger & Rothfeld, 2018). Operators are interested in optimizing capacity utilization by scheduling off-peak passenger demand periods for downtimes (Baur et al., 2018).

Additional tasks are securing efficient ground operation on vertiports in accordance with safety regulations including guidance and supervision (Michelmann et al., 2020), landing aircraft (Rumba & Nikitenko, 2020), ensuring check-in and boarding of passengers (Michelmann et al., 2020; Sun et al., 2021), operating charging infrastructure (Baur et al., 2018), MRO activities (Straubinger et al., 2020), and cleaning aircraft (Baur et al., 2018).

2.6 Business Model Canvas

Osterwalder and Pigneur stated, "A business model describes the rationale of how an organization creates, delivers, and captures value" (2010, p.14). It can be defined as "the content, structure, and governance of transactions designed to create value through the exploitation of business opportunities" (Amit & Zott, 2001, p.501). A business model is envisioned to be implemented through organizational structures, processes, and systems. It is built of nine blocks that describe four main areas of conducting business, namely "customers, offer, infrastructure and financial viability" (Osterwalder & Pigneur, 2010, p.15) (see Figure 3) (Osterwalder & Pigneur, 2010). The Business Model Canvas (BMC) is applied to identify important and relevant factors for value creation and value delivery (McFarlane, 2017). The BMC breaks down the complexities of a business model "while not oversimplifying" (Osterwalder & Pigneur, 2010, p.15) how enterprises function. It is one of the best-known and most widely used models to support entrepreneurs' understanding of the complexities of every aspect of their business (SCORE Association, 2019). It has proven to be a useful and practical tool in businesses worldwide (Rytkönen & Nenonen, 2014) and, due to its practical applicability, the canvas is widely used among practitioners (Osterwalder & Pigneur, 2010).
The nine building blocks of the theoretical framework of this thesis are defined as follows: (Osterwalder & Pigneur, 2010, p.20-40)

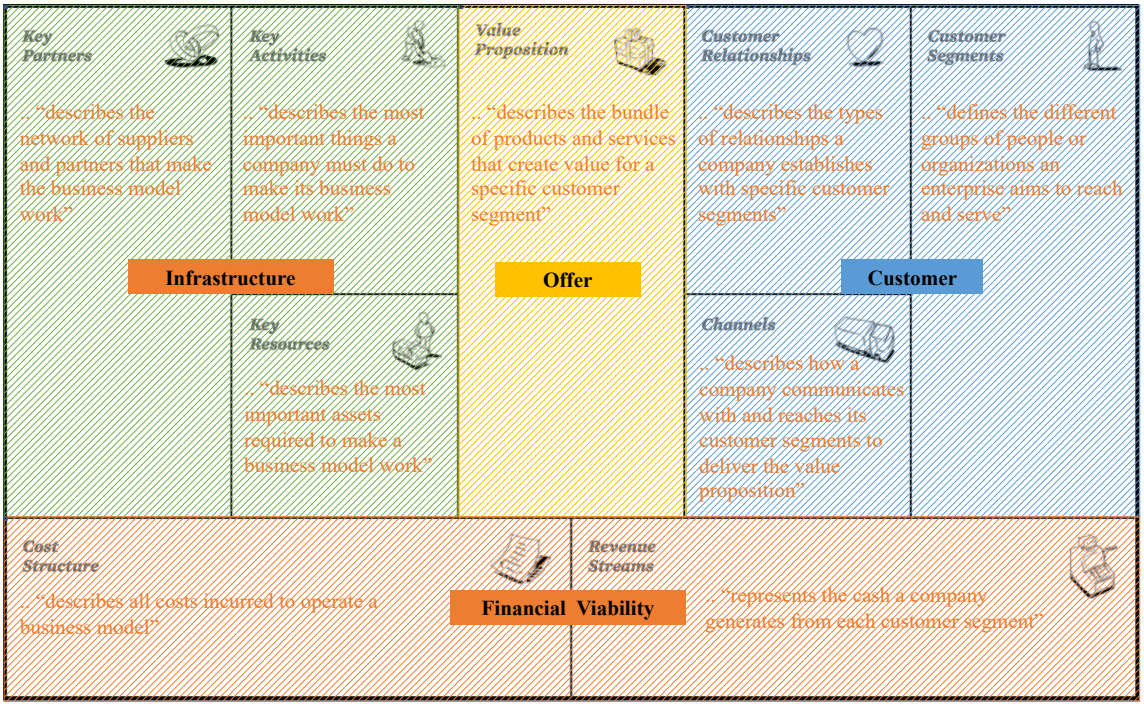

Figure 3: Business Model Canvas (adapted from Osterwalder & Pigneur, 2010, pp. 20-40)

3. Methodology

This chapter describes the research design, including the qualitative approach, the objective of the research, and the method to analyze the data. The primary and secondary data collection is described afterwards.

3.1 Research design

The research consists of three consecutive analyses. The first analysis is to determine which UAM use case is most promising for eVTOLs for a market entry. The second part of the research seeks to identify which operator would be the most viable in the short-term. The analyses focus on the short-term horizon developments in the UAM market. For the third step of the analysis, the author applies the BMC as described in the previous chapter (Chapter 2.6). During the conversations with experts, it became evident that due to the novelty and current developments of the industry, the analyses of the offer area (value proposition) and the infrastructure area (key resources, partnership and activities) are at this stage the most beneficial for extensive research. Therefore, this thesis focuses on these two areas due to additional time and space constraints. Moreover, the relevant information concerning aspects of the customer and financial perspectives of the BMC are still unavailable because it is still unclear how operations will be rolled out.
A qualitative approach, consisting of semi-structured interviews was used to answer the three research questions:

RQ1: *Which use case of eVTOLs will prevail with the operator in the short to medium term?*
RQ2: *What kind of market player or UAM stakeholder is bound to operate eVTOLs?*
RQ3: *What are the value propositions and key resources, activities, and partnerships for an eVTOL operator?*

This thesis used qualitative interviews to gain subjective insights and opinions from the interviewees through open dialogue (Bortz & Döring, 2006). There are several existing methods for conducting a qualitative review. The thesis followed Kaiser (2014) who describes three different interview formats: ethnographic interviews to receive the impressions of the interview partner on a specific topic; narrative interviews to collect biographic information about the interview partner; and expert interviews that focus on the extraction of information regarding a central problem (Jäger & Reinecke, 2009, p.35; Kaiser, 2014, p.3). The main advantage of expert interviews is that a collection of in-depth and meaningful insights for a specific situation

or problem can be achieved as well as the elimination of biases through diversity of questioned experts.

The qualitative summarizing content analysis (Mayring, 2015) was used to analyze the results of expert interviews and to identify similarities and differences between the experts. This method of evaluation allows the comparison of statements that are taken out of context (Gläser & Laudel, 2010) by using the basic techniques of summarizing, explicating, and structuring (2013, p.67). The length of transcripts (212 pages) was an additional reason for the author to use the summarizing content analysis. It was executed by following the process of adopting the following Z-Rules (Mayring, 1994, p.165).

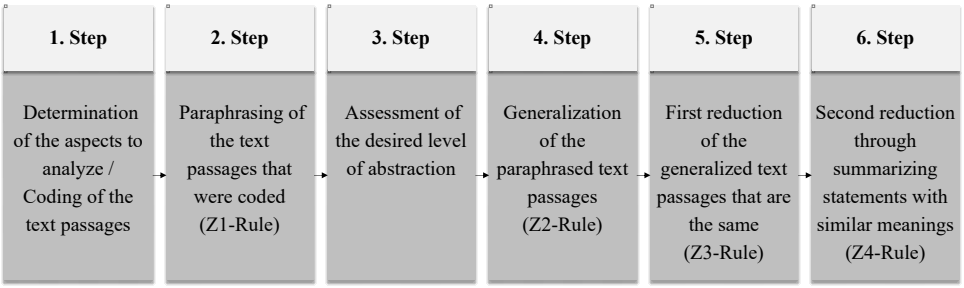

Figure 4: Qualitative summarizing content analysis (adapted from Mayring 1994)

In the first step, 344 text passages were determined and coded. These were assigned to seven deductive chosen categories being “use case”, “potential operator”, “value proposition”, “key activities”, “key resources”, “key partnerships”, and “similarities & differences”. Table 2 shows the number of coded statements per category per process step. After the sixth step of the analysis, 119 text passages were left, which are presented in the results chapter (Mayring, 1994, p.166).

	1. Step: **Coding**	2. Step: **Paraphrasing** (Z1-Rule)	4. Step: **Generalization** (Z2-Rule)	5. Step: **First Reduction** (Z3- Rule)	6. Step: **Second reduction** (Z4-Rule)
Use Case	36			32	16
Operator	43			31	22
Value Proposition	58			46	18
Key Activities	89			69	25
Key Resources	54			41	13
Key Partnerships	41			35	18
Similiarities & Differences	23			18	7
Total	**344**			**272**	**119**

Table 1: Overview of coded text passages during qualitative analysis (Author’s own illustration)

3.2 Data collection

3.2.1 Primary data collection

The primary data collection was achieved with semi-structured expert interviews. The author created an interview guideline (see Appendix A) which consisted of eight blocks of questions. The first block was asked to introduce the topic of urban air mobility to understand which problems exist and will be solved, what UAM's biggest potentials are, and where the main challenges lie. The second block targeted the understanding of which use case the expert is expecting to succeed in the short to medium term and why. The following questions sought to find out which potential operator was favored by the expert for such a use case. Blocks four to seven focused on the evaluation of the operator's value proposition, key resources, key activities, and key partnerships. The interviews were ended with a forecast on the future development, questioning whether the VP, KA, KR, and KP are expected to stay the same or change when a different use case is served as well as to what kind of market structure the concept of urban air mobility is expected to evolve. The open course conversation with UAM and aviation experts enabled the researcher to capture subjective impressions and personal opinions (Bortz & Döring, 2006, p.308), and provided the experts room for elaboration. Thus, this qualitative research enabled interpretative methods that recognize latent structures of meaning and allow for subjective perspectives.

In total 126 individuals from 44 different companies were contacted through the business network platform *LinkedIn*. A constraint during the expert interviewee acquisition process was the identification of individuals with published expertise in the area of UAM on their public *LinkedIn* profile.

In summary 16 interviews were conducted. All of the interviews were held through video calls with the online video platforms Zoom, WebEx, and Microsoft Teams. The interviewees were mainly contacted through *LinkedIn* messages and contact requests with an attached message. In addition, cold-calling E-Mails and referrals from personal contacts were used to acquire expert interviews. The participants were located in Germany, Great Britain, Brazil, the Netherlands, and Switzerland and were all employed in companies related to either the emerging industry of UAM or the aviation industry. The interviews took on average 41.78 minutes and were conducted between March 24, 2022 and April 4, 2022. A complete description of the participants can be found in table two below.

ID	Role of the interviewee	Type of Company	Range of Revenues 2020 (in millions)	Reason for carryout the interview with this interviewee
1	Senior Manager Global Business Development	eVTOL manufacturer	$0,05 - $0,2	Leading eVTOL manufacturing company
2	Senior Engineering Officer	eVTOL manufacturer	$0,7 - $1	Leading eVTOL manufacturing company
3	Senior Vice President Parking & Mobility	Commercial airport operator	€1500 - €2000	Potential UAM operator
4	Head of Strategy	Private / business aviation company	$200 - $300	Potential UAM operator
5	Director of Investor Relations	eVTOL manufacturer	$5 - $10	Leading eVTOL manufacturing company
6	Head of Business Development, EMEA	UAM technology or infrastructure provider	$5 - $10	UAM technology expert
7	Drone Project Manager	Regulatory entity / other experts	€100 - €150	European regulatory company
8	Lead Product & Business Development	UAM technology or infrastructure provider	not publicly disclosed	UAM technology expert
9	Aviation Manager	Commercial airport operator	€150 - €200	Potential UAM operator
10	Chief Executive Officer	Private / business aviation company	$200 - $300	Potential UAM operator
11	Senior Business Development Manager	eVTOL manufacturer	$0,7 - $1	Leading eVTOL manufacturing company
12	Head of Technology & Flight Ops	UAM technology or infrastructure provider	$1 - $5	UAM technology provider
13	Senior Specialist Aerospace & Defence	Regulatory entity / other experts	$600 - $700	General UAM expert
14	Project Manager	Commercial airport operator	$40 - $50	Potential UAM operator
15	Chief Executive Officer	Commercial airport operator	$1 - $5	Potential UAM operator
16	Business Manager	UAM technology or infrastructure provider	not publicly disclosed	UAM technology expert

Table 2: Overview of questioned experts (Author's own illustration)

3.2.2 Secondary data collection

Secondary data was collected from academic articles, journals, market studies, and company reports covered in the literature review. These sources largely include grade A and B papers, which are essential to laying a strong theoretical foundation on the discussed topics.

4. Results

In the following chapter, the results from the expert interviews will be presented in a descriptive manner. Each chapter represents one main category which itself is divided into several sub-categories. A frequency analysis for the sub-categories is embedded into the author's visualizations and represents the percentage of experts who mentioned the respective sub-category. At the end of Chapter 4.8, a frequency analysis including a summary, ranking, and comparison summarizes the results.

4.1 Use case

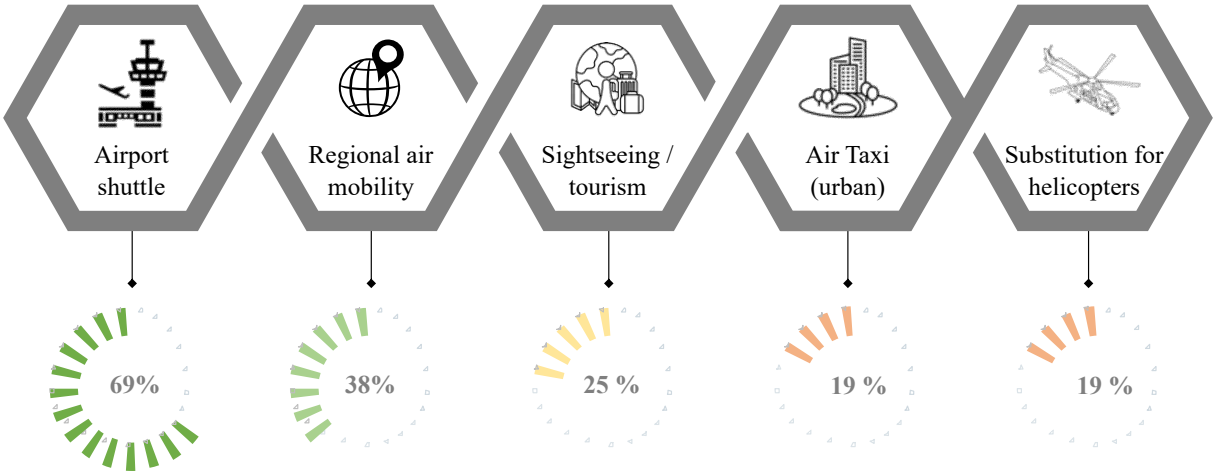

Figure 5: Overview of expected use case in the short to medium term (Author's own illustration)

The first use case to be operated is the shuttle connection between airports and vertiports. This was mentioned by 69% of the experts (E6, E7, E8, E12, E13, E14). E1, E2, and E9 add that the airport shuttle will make sense to be operated when there is a lot of traffic, when adequate transport is lacking and when people are time sensitive. According to E2, E14 and E16 the shuttle would also include transportation between different airports in a certain region. Complex organizational, safety, and regulatory constraints may form implementation challenges particularly around existing airports (E3, E6, E7, E8).

The regional air mobility is another potential use case for eVTOL operators and was mentioned by 38% of the experts (E1, E4, E5, E10, E12, E16). This use case will connect remote communities with other locations. The reason for this use case is that regional or commercial airlines are flying these routes infrequently or not at all (E10, E12, E16).

The eVTOLs are expected to be used in the beginning for sightseeing and tourism flights (by 25% of experts) around cities and sights, thereby replacing existing conventional helicopters (E3, E5, E8, E10). E10, E12 and E15 (19% of experts) mention the replacement of conventional

helicopters with eVTOLs as a potential separate use case. The use cases would be to connect regional airfields in addition to transporting people between for example gas platforms and mining sites (E10, E12, E15).

Another reported use case is air taxis, which connect two urban points. E3, E4 and E11 (19% of experts) see these flights as another potential use case because these specific eVTOLs are the closest to certification and because the inner-city routes are shorter and therefore require less advanced battery technology.

4.2 Potential operator

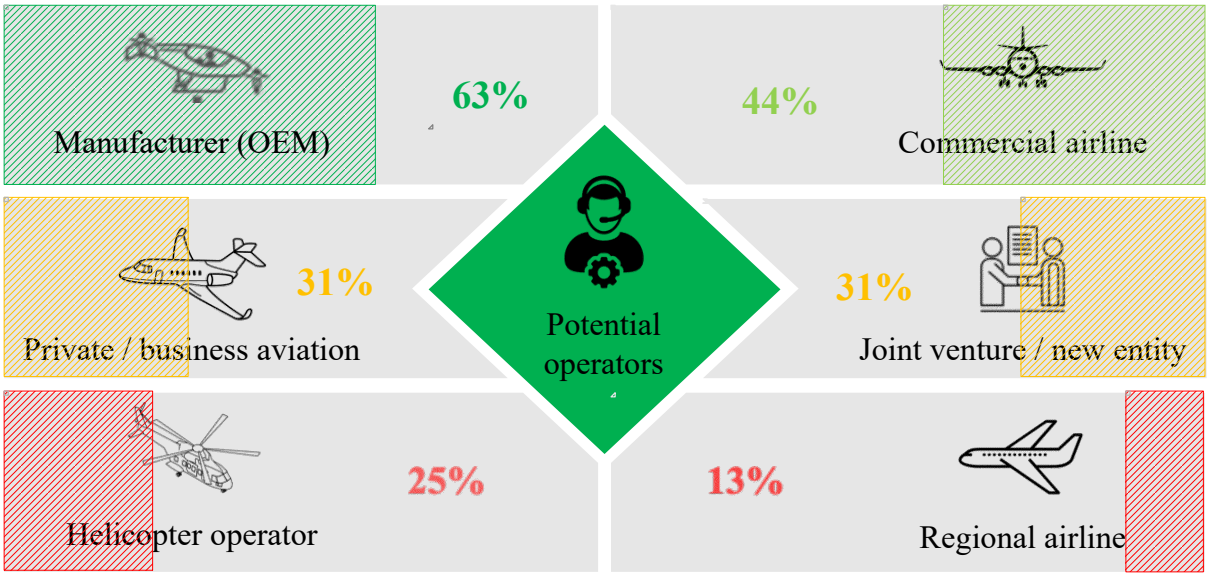

Figure 6: The different market players as potential eVTOL operators (Author's own illustration)

The manufacturers are mentioned by 63% as a potential eVTOL operator. E1, E6, E7, E8, E10, E11, and E13 explain that manufacturers want to prove that their service offering attracts customers and that their operations are safe while they are integrating vertically to gain experience and establish a service with an adequate standard. E7, E8, and E11 further specify that by integrating all elements in the initial phase, operations will be simplified and easier. In the long term, however, the manufacturer is expected to either develop partnerships or separate the manufacturing from operation (E7, E8, E11). E14 points out that including manufacturing and operational risk in one entity is questionable from the investor's perspective. E1, E6, and E14 expect the eVTOL manufacturers not only to produce the vehicles, but also to build the infrastructure/vertiports and operate the vehicles as well. E12 and E16 acknowledge the manufacturers in the short term as potential operators to keep everything within their control, and in the long term, commercial airlines to operate the eVTOLs on their own or to be

contracted by manufacturers. E12 and E16 conclude that the company acting as operator depends on the OEM and the structure they want to follow.

A commercial airline or an airline subsidiary was also proposed by 44% as a potential operator. Their own business model is a close proxy to the expected market development and they have full control over all aspects including marketing, customer, and cost management. In addition, they have placed the biggest orders for eVTOLs so far (E4, E9, E12). E6 and E13 expect commercial airlines in the long term to become operators after acquiring smaller companies and collecting the knowledge to turn it into a profitable business.

E1, E5, E4, E10, and E14 also see private/business aviation companies (PBAC) (31% of experts) as future operators for eVTOLs, and E4 mentioned that the company consortium he is working for is already preparing its operations. E1, E2, E6, E7, and E15 (31% of experts) declare new companies/entities, joint ventures, and start-ups as potential operators. E4, E5, E9, and E12 (25% of experts) report that helicopter operators and regional airlines (E4, E5: 13%) are potential operators because the business model of helicopter operators is the closest and because some regional airlines have already placed orders at eVTOL manufacturers.

4.3 Value proposition

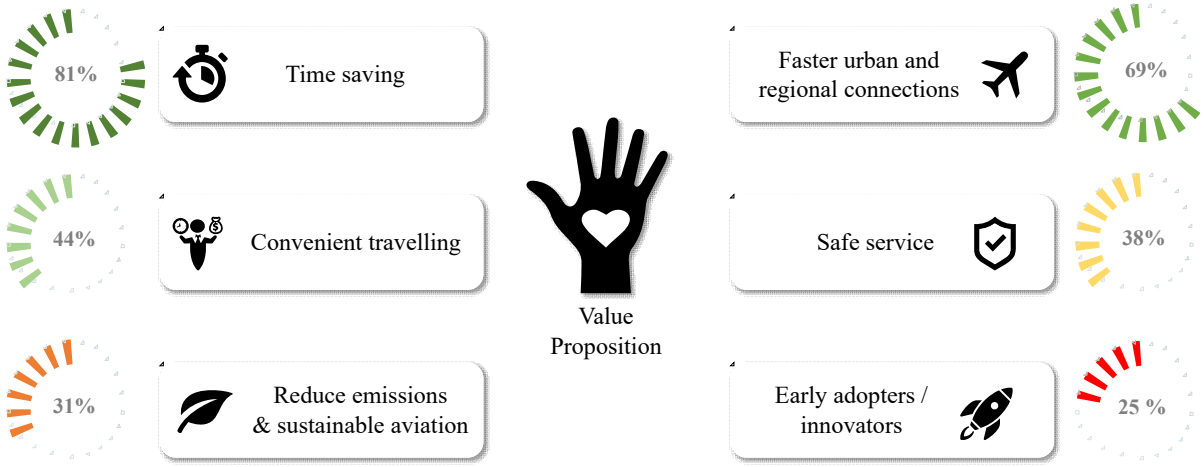

Figure 7: The different value propositions of an eVTOL operator (Author's own illustration)

The main value proposition (81%) for the operator is to enable time saving for the passenger by shortening their travel times (E1, E16). This also includes proposing a quick and safe flight at affordable prices (E2, E3, E5). The time saving is also achieved by combining the eVTOL trip with other means of transportation, thereby creating a multimodal transportation network where the full customer journey is integrated and connected (E3, E8, E13). In addition, it is key for the operator to save passengers time by facilitating better connectivity on short to medium distances (E3, E12, E15).

Experts would also expect operators to improve all aspects of time management including faster turnaround times (E6, E8, E11), reducing waiting times at vertiports (E3, E8, E9), and providing the most convenient locations for the vertiports - all geared at serving the private and business customer. E9 and E10 state that time saving is enabled through selling a faster service than in commercial aviation by minimizing the dependency on other people and processes.

The value proposition to provide faster urban and regional connections was acknowledged by 69%. E7, E8, E14, and E15 declare that it is the value proposition to facilitate an easier and faster connection between two different locations in urban areas. Key arguments would be a faster and more convenient connection where currently no or little connections exist (E7, E8, E14, and E15). Passengers may use a more direct and new means of transportation with less required changes (E11, E14, E16). An additional value proposition is to extend passengers' access to transportation hubs and thereby to improve access to remote communities. In the long term, the operator will enable customers to live further outside the city by offering a connection into urban areas (e.g., their workspace). However, a prerequisite for offering a connection between cities that are 200 to 300 kilometers apart are significant improvements in battery technology (E7, E10, E12).

The value proposition to offer a convenient form of travelling was proposed by 44% of the experts and was embedded into other value propositions in various ways. One form of explained convenience includes a less crowded, more private, and exclusive mean of transportation. However, experts expect to have a high level of convenience from the moment they enter the vertiport until they leave the vertiport at their target destination (E2, E4, E5, E6, E9, E11, E14).

The value proposition to have a safe environment and a safe flight was acknowledged by 38% of the experts. E2 and E4 declared the safety to be a prerequisite for operation. Other experts highlighted that the value proposition is to provide a safer flight than in a helicopter (E2, E3, E4, E5, E6, E10, E14).

Another value proposition is to provide a more sustainable means of transportation (by 31% of experts) which reduces carbon emissions, creates environmental benefits, and supports a more sustainable form of aviation. In addition, the operator enables corporate clients to show their carbon emission offset and their use of sustainable aviation fuel (electricity) transparently, which creates accountability for corporates on the amount of carbon emissions they are offsetting (E1, E4, E5, E6, E10).

In the short term, E1, E2, E6, and E10 (25% of experts) acknowledge that the value proposition will be to offer an expensive service, but without any special kind of value. The service will be demanded due to the novelty of the eVTOL technology and for passengers to take pictures with

it. Passengers strive to be first movers and early adopters (E1, E2, E6, E10). In the long term, the service will become beneficial for an ordinary user when travelling between locations with a prescheduled timeline and when the service is integrated with other means of transportation (E1, E2, E6, E10).

4.4 Key activities

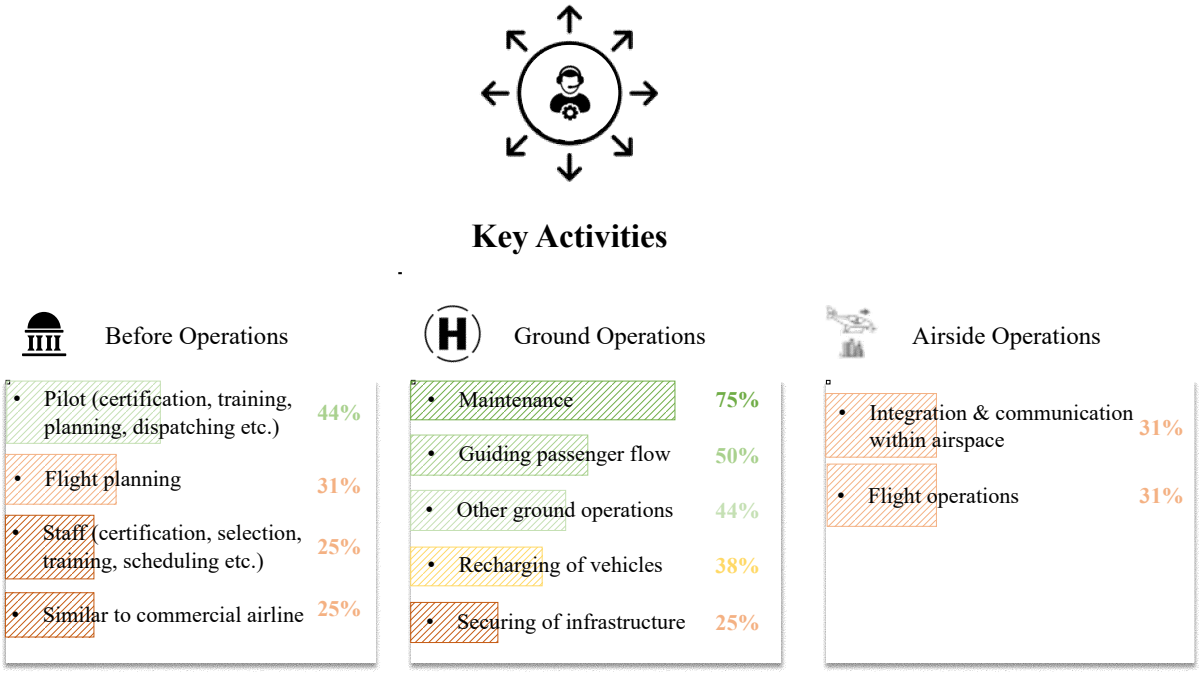

Figure 8: Key activities of an eVTOL operator (Author's own illustration)

The most mentioned key activities (by 75% of experts) for the operator are to coordinate and conduct effective, preventative, and efficient maintenance of the vehicles, including frequent technical checks. Part of the key activity of maintenance is ensuring that the MRO activities can be facilitated at the vertiport. All these activities are aimed at maintaining a safe service and environment for the passenger and people on the ground (E3, E5, E7, E8, E10, E11, E12, E13, E16).

The second most important key activity, mentioned by 50%, is the guidance of the passenger flow on the vertiport. E3, E5, E8, and E16 would include an easy booking process and E3, E9, E11, E12, and E14 add that handling hospitality services for the passengers is essential. The passenger journey includes security checks, weight checks, luggage screening and weighing, and potentially offering food and beverages. The next steps in the passenger journey are to embark and disembark the passengers meaning accompanying them on a safe way to the

eVTOL and after the flight to the exit. The operator additionally must take care of the passenger in case of disruptions and malfunctions (E4, E12, E16).

Of the experts, 44% explained that ground operations are a key activity for the operator. This includes managing processes, stakeholders, and the eVTOL itself on the vertiport. The operations were compared to the ground operation procedures of conventional helicopters (E1, E3, E4, E8, E11, E14, E16).

Other human related key activities for the operator are the selection, training, scheduling, and quality control of the pilots and crew. This activity was acknowledged by 44% (E3, E7, E10, E12, E13). In addition, 25% of the experts highlight the same tasks for crew and ground handling staff (E3, E4, E10, E11).

Of the experts, 38% proposed that the operator should be responsible for a sufficient energy supply, the handling of batteries, the charging processes, and for designing processes and infrastructure that allow for high utilization (E2, E3, E4, E5, E16). Related key activities are dealing with energy constraints, including calculating necessary buffers and planning battery capacities (E2, E4, E5).

E2, E3, E6, E8, and E16 (31%) point out that additional key activities are to be connected to the ATC to plan and receive clearance for flights with the air traffic management (ATM) and to be in contact with U-Space in Europe and with ATC close to airports. In addition, the operator has to take care of the air traffic management and control, including checking the availability of suitable corridors and maintaining and releasing the corridors in cooperation with the aviation authority, and submitting a flight request (E2, E3, E6, E8, E16).

Of the experts, 31% additionally highlight that flight operations and flight planning are essential for an operator. Flight planning includes scheduling and dispatching flights, planning the constant availability, and monitoring the eVTOLs during the flight (E3, E4, E6, E7, E15).

Other key activities of the operator are to guarantee safe operations by operating software to plan flights quickly and efficiently (proposed by 31%). This is done by including a data exchange and integration system with other airspace users to track the location of each vehicle, to predict potential hazards, to operate dynamic deconfliction and to plan for alternative routes in case of malfunctions (E3, E4, E6, E7, E15).

Of the experts, 25% declared that ensuring the safety of the infrastructure is a key activity for the operator. E10 and E14 state that the operator must guarantee safety in the air and on the ground. A part of ensuring a safe environment for the passenger is also handling landing and take-off procedures at the vertiports. Safety is additionally guaranteed by building restricted areas and by removing unauthorized people and endangering objects from the landing and

taking off area. It is also key to check weather conditions to guarantee safe operations (E3, E6, E7, E14, E16).

The key activities of an operator are similar to the activities conducted by commercial airlines, state 25% of the experts. The activities include hiring pilots, training staff, owning an operator certificate, owning the vehicle, performing maintenance, handling flight and ground operations, flying with them and enabling passengers to book the flights (E4, E7, E11, E16).

4.5 Key resources

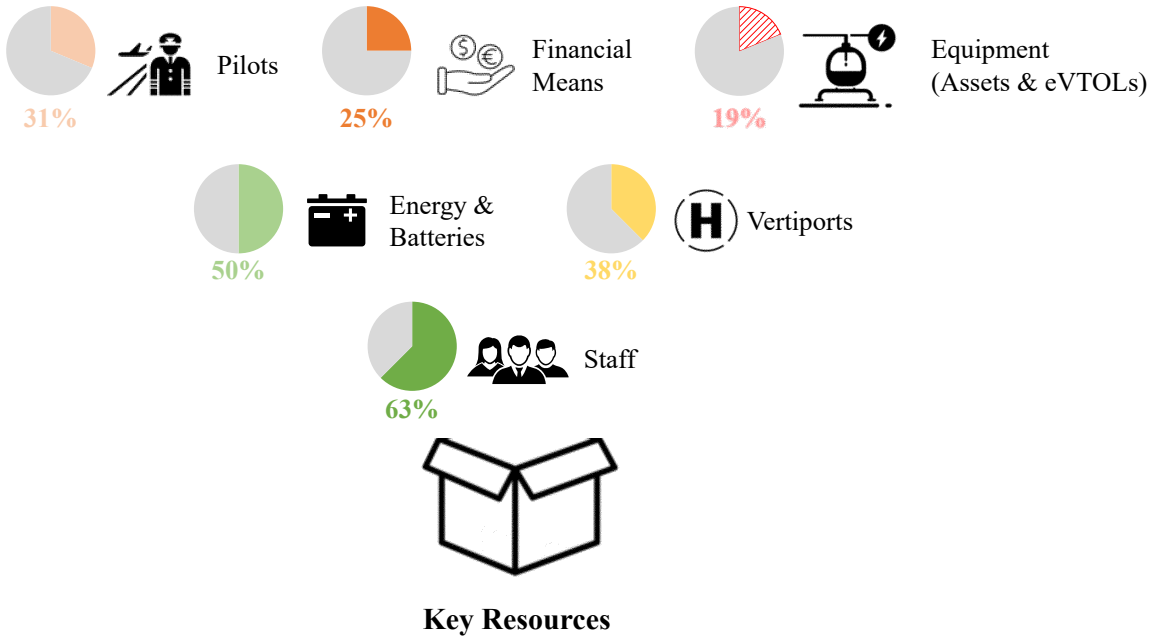

Figure 9: Key resources of an eVTOL operator (Author's own illustration)

Human staff was highlighted by 63% of the experts as a key resource for the operator. This involves a team of staff with the right knowledge and competencies. These include flight attendants to guide and support passengers, customer service agents to offer hospitality services, engineers and maintenance agents to handle and conduct MRO activities, and other relevant people for operations to execute ground-handling activities, conduct security checks, and arrange dispatching. In addition, air traffic controllers are required to monitor all operations, to communicate with other airspace users and to share location and flight information (E1, E6, E8, E9, E10, E11, E13, E14, E15, E16).

The second most important key resource with 50% of experts agreeing for the operator are the access to energy, the energy itself, the batteries, adequate power stations and the amount of available energy (E2, E5, E8, E9, E11, E12, E13, E15).

The infrastructure and the charging facilities to charge eVTOLs, but also the access to it were mentioned by 38%. E9 points out that this infrastructure does not yet exist and therefore needs to be built (E1, E5, E8, E9, E11, E15, E16).

In the beginning, pilots inside the eVTOL, in a second stage with remote control capabilities, are another key resource, separately highlighted to the key resource human staff by 31% of the experts. Backup pilots are needed in case of an emergency (E2, E5, E6, E7, and E12).

Additional key resources are complete and secured finances (25%) for the business plan (including leasing or buying the vehicles) in the long term because operations are not going to be profitable in the beginning (E4, E5, E10, E14).

Key resources for the operator are also safe vehicles (eVTOLs), additional equipment and other assets required (19%) for operations (E7, E15, E16).

4.6 Key partnerships

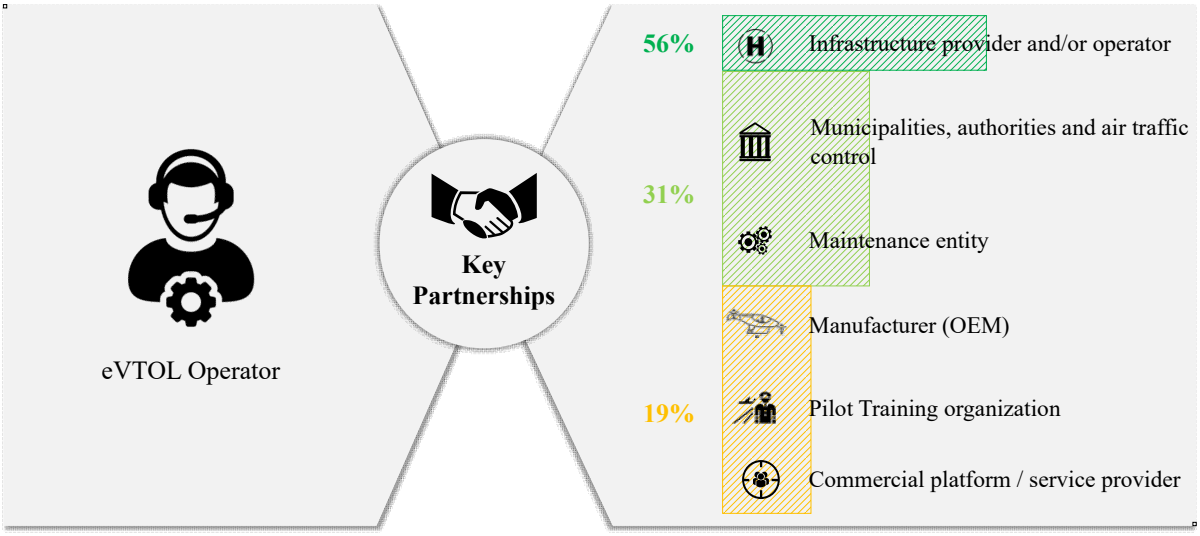

Figure 10: Key partnerships for an eVTOL operator (Author's own illustration)

E12 agrees with E3 that partnerships are very important, especially in the beginning, but as the industry matures and automation is required, operations will change, and strategic partnerships will become less important but the ability to integrate with other systems will become essential (E12).

The operators are advised (by 56% of experts) to form a partnership with the provider and/or owner and/or operator of the infrastructure. This is because the infrastructure needs to be provided and integrated into operations just like at any commercial airport. The partnership is also needed because the vertiport operator in some cases handles takeoff and landing (E3, E5, E5, E7, E8, E10, E11, E13, E16). Another key partner (31%) is with the maintenance entity to ensure fully integrated operations and to ensure the aircrafts airworthiness (E1, E2, E10, E11,

E13). Another proposed relationship for the operator (by 31%) is with municipalities and local or city authorities to receive permits. In addition, partnerships with local civil aviation authorities (CAA) and with rulemaking authorities such as the European Union Aviation Safety Agency (EASA) are key to having an influence on the decision-making process. Lastly, partnerships with the air traffic control center (ATC) are important for integrating the information that is needed to operate the vehicle in the air (E1, E2, E3, E8, E16).

The manufacturer (19% of experts), if the manufacturer itself is not the operator, is another valuable partner for integrating the operators' needs into the vehicles in advance (E7, E8, E11). E2, E11, and E16 (19%) highlight having a partnership with the entity that provides the pilot training. Partnerships with a commercial platform to create and handle the demand and capacity planning and with the service provider, which distributes the services to customers, are also essential for operation (E4, E5, E10).

4.7 Similarities & differences

The resources, activities and partnerships are expected to be the same (by 56%) when serving either short or long-distance passenger transporting use cases because it is about providing a safe operation. In addition, maintenance and customer interface is always required and it is important to own the right data, to share the data, manage and operate the airspace and landing areas (E1, E6, E7, E11, E12, E13, E14, E16).

E6, E9, and E13 (19%) oppose and state that the resources, activities and partnerships are going to slightly change because with scale the operations will become more complex, but with the right data, infrastructure, and integration, it is not going to be an issue.

E10 and E15 (13%) expect only the partnerships, while E8, E9, and E12 (19%) expect the resources, activities, and partnerships of the operator to change over time depending on the served use case because the infrastructure requirements might be different, the routes are going to be easier to operate and control, and new players will join the value chain. In addition, the resources, activities, and partnerships will depend on the geographical jurisdictions and might change when eVTOLs are not flown by IFR but autonomous in the future (E8, E9, E12).

4.8 Frequency analysis

4.8.1 Summary

Figure 11 highlights the most often mentioned sub-categories of the expert interviews. The full table with all sub-categories is attached in the appendix (Appendix B: Frequency analysis matrix).

Use Case	Total	%	Potential Operator	Total	%	Value Proposition	Total	%	Key Activities	Total	%	Key Resources	Total	%	Key Partnerships	Total	%
1. Airport Shuttle	11	69%	1. eVTOL Manufacturer	10	63%	1. Time saving	13	81%	1. Maintenance	12	75%	1. Staff	10	63%	1. Infrastructure provider and/or operator	9	57%
2. Regional Air Mobility	6	38%	2. Commercial airline	7	44%	2. Faster urban and regional connections	11	69%	2. Guiding passenger flow	8	50%	2. Energy & Batteries	8	50%	2. Maintenance entity	5	31%
						3. Convenient travelling	7	44%	3. Pilots	7	44%	3. Infrastructure	6	38%	3. Municipalities, authorities and air traffic control	5	31%
									3. Ground operations	7	44%						

Figure 11: Ranking and overview of the top three mentioned sub-categories (Author's own illustration)

The setup of the questionnaire allowed for multiple answers per sub-category, which resulted in double entries included in the analysis.

The airport shuttle use case was mentioned by 11 experts (69%); therefore, it is expected to be the first one to be operated. The regional air mobility use case follows with six expert mentions (38%).

Ten experts (63%) expect the eVTOL manufacturer to be the first potential operator. Seven interviewees (44%) proposed commercial airlines to step into the market in the long term.

The main value proposition is to enable passengers' timesaving and was mentioned by thirteen (81%) interviewees. The value proposition to provide faster urban and regional connections was acknowledged by 11 experts (69%). The third most important value proposition is to empower passengers to experience a convenient form of travelling, which was mentioned by seven interviewees (44%).

The key activities are maintenance, pointed out by twelve experts (75%), and the guidance of the passenger flow on the vertiport, mentioned by eight experts (50%). The certification, training and dispatching of pilots and the execution of ground operations were both acknowledged by seven interviewees (44%).

The most essential key resource is human staff, which was acknowledged by ten experts (63%) while energy and batteries were the second most important key resource with eight mentions (50%). Infrastructure consisting of the vertiport and charging facilities was proposed by six interviewees (38%).

The most important key partnership for an operator is with the infrastructure provider and/or operator. It depends on the company if it is only providing or also operating the infrastructure. It was declared so by nine experts (56%). The entity that is responsible for maintenance was mentioned by five interviewees (31%), making it the second most essential partnership. The key partnership with municipalities, local, or city authorities and with traffic control was raised by five experts (31%).

4.8.2 Ranking and comparison of expert clusters

The 16 questioned experts were divided into five clusters based on their business role: eVTOL manufacturers, private/business aviation company, UAM technology and/or infrastructure providers, commercial airport operators, or regulatory entity/other experts. The analysis focuses on the top five most mentioned sub-categories of the main categories value proposition, key activities, key resources, and key partnerships.

Index	1 100% - 80%	2 79% - 60 %	3 59% - 40%	4 39% - 20%	5 19% - 0%	Weig. Av.	% Av.
eVTOL manufacturer	1	7	8	5	0	2.81	55%
Private / Business aviation company	6	0	8	0	7	3.10	48%
UAM technology and/or infrastructure provider	1	5	5	7	3	3.29	43%
Commercial airport operators	1	3	5	6	6	3.62	35%
Regulatory entity / other experts	3	0	7	0	11	3.76	31%

Table 3: Ranking and comparison of the five company clusters (Author's own illustration)

The number of responses to the sub-categories were counted by each cluster (*Figure 11*) and presented as a frequency percentage for each sub-category and expert cluster (Appendix B: Frequency analysis matrix). Afterwards an index (1-5) was created to categorize and count the frequencies per sub-category and expert cluster (*Table 3*).

For example, four out of the four eVTOL manufacturers mentioned “time saving” as a main value proposition. Therefore, the frequency percentage for the main category: value proposition, sub-category: “Time saving” and cluster: eVTOL manufacturer is 100%. Consequently, the column with index one is increased by one, in this specific example it shows a one, because it only happened once that all four manufacturers mentioned the same sub-category.

The results of this analysis show that the eVTOL manufacturers have a weighted average score of 2.81 and therefore have the best score among the five clusters. The eVTOL manufacturers therefore have a higher likelihood to indicate the top five sub-categories. This implies that the opinions of the eVTOL manufacturer experts match the expectations of the market, meaning the overall expectation of all experts with a higher percentage. In addition, on average 55% of the eVTOL manufacturers mentioned each key sub-category. PBAC follow with the second-best weighted average of 3.10. The PBAC experts on average have stated 48% of each sub-category. The UAM technology and/or infrastructure provider scored a weighted average of 3.29 and 43% of the experts declared each sub-category as essential. The commercial airport operator follows with a weighted average of 3.62 and the regulatory entity and other experts with a score of 3.76.

5. Discussion

5.1 The emerging technology: eVTOLs

eVTOL technology enables consumers to travel between specific destinations by providing a new type of transportation in a third dimension. This technology is faster and more convenient than existing transportation means and, more importantly, offers a sustainable and exclusive mobility alternative. eVTOLs might be a trigger for the initial stage of the emergence of a new industry because eVTOLs are a scientific and technological development (Malerba & Orsenigo, 1996; Phaal et al., 2011). This technology is expected to compete with existing products and services (Hargadon & Douglas, 2001; Mezias & Kuperman, 2001; Munir & Phillips, 2002; Van de Ven & Garud, 1993), in this case with other means of ground transportation. eVTOLs give consumers an alternative to satisfy their mobility needs. In addition, eVTOLs will be used for short and long-range connections depending on the developments and improvements of battery technology. This might revolutionize the urban and regional transportation industry and the way passengers combine different means of travel. eVTOLs are an emerging technology because they might change the status quo of moving through the air. This emerging technology is creating a new market by providing a new form of transportation in a space where nothing similar previously existed (Christensen et al., 2015).

5.2 Helicopter or commercial airport operations

eVTOLs are electric powered aircraft that are expected to be seen in the air by the year 2026. Their operations were compared to commercial airlines and helicopter operations by various experts. When mentioned in the context of helicopters, eVTOLs were seen as a substitute to helicopters with very similar operation characteristics. In the context of commercial airport operations, it was expected that commercial airlines would operate eVTOLs as an additional aircraft in their aircraft portfolio. However, the experts highlighted that commercial airlines do not have any acute interest in operating eVTOLs from the beginning. In addition, they do not have the expertise for small-scale operations and helicopter-like vehicles. Their concept of operations might become feasible in the long term when operations are scaled, the UAM stakeholder ecosystem is diversified, companies have established themselves, and expertise can be captured through acquisitions.

The operation of eVTOLs is expected to be similar to the existing operation of helicopters. The design of eVTOLs shows common features with conventional helicopters; however, the source of propulsion is a significant and superior difference. The experts agreed with Rothfeld et al. (2019) that eVTOLs will be cheaper to operate than conventional helicopters because

conventional helicopters require huge amounts of fossil fuel, which results in high operation costs. eVTOLs are powered by electricity, which is expected to bear significant cost savings that will be transferred to the passenger by offering a service at affordable prices. Aside from the potential cost savings for customers, the main advantage of eVTOLs is the opportunity to reduce carbon emissions from the aviation industry significantly. Rothfeld et al. (2019) additionally pointed out that eVTOLs are promising to be quieter and safer.

eVTOLs and helicopter operations have essential commonalities in their vertical land and take-off approach, in their passenger capacity (4-6 passengers), their potential use cases, and their operation and maintenance requirements. Of the experts surveyed, 38% (E3, E5, E8, E10, E12, E15) highlighted that eVTOLs will be used to replace conventional and commercially used helicopters. Helicopters are currently mostly used for leisure, tourism, and sightseeing tours around cities or for transporting important human staff (e.g., engineers and maintenance agents) between operating sites (e.g., gas and oil platforms and mining sites). The same use cases are appropriate to be served by eVTOLs. Of the experts, 25% pointed out that, due to the similarities of business models, helicopter operators are also potential eVTOL operators. Therefore, eVTOLs might not only serve the proposed use cases (Chapter 4.1), but also, in addition, replace conventional helicopters due to their lower noise emissions, sustainable propulsion, and cheaper operating costs. Evidence in favor of this argument is that one of the eVTOL manufacturers, Eve Air Mobility, has partnered with several Australian helicopter operators (i.e., Microflite, Aviair, and HeliSpirit) and has already sold about 90 units to them (Pritchard, 2022).

5.3 The airport shuttle

The first use case of eVTOLs for operation is going to connect airports with each other or with urban vertiports. This enables passengers to save time while travelling to or from the airport, reduce the dependency on ground transportation, and channel themselves efficiently from longer to shorter connections. Two experts acknowledged that the operation still faces safety and regulation related barriers but highlighted that the use case to connect the airport with urban vertiports will be operated in 2024 at the Olympic Games in Paris by EASA and Volocopter. EUROCONTROL (2018) explained that the opening of controlled airspace for eVTOLs is not expected before 2027. Straubinger et al. (2021) added that CTR might become accessible for eVTOLs, but operations close to airports will remain off limits. However, 69% of experts expect the airport shuttle to be the first operated eVTOL use case. Expert E10 explained that the environment of airports is very dynamic because of delays, weather problems, and other

factors. In addition, other aircraft, such as police, private and business helicopters and air ambulance helicopters, are integrated and planned for on short notice all the time. E10 therefore concludes, “We will be able to adopt and adapt, adopt new procedures but also adapt to them. It will be more like an evolution, rather than a revolution. We'll go step by step” with the integration of eVTOLs into the airspace at airports (E10, L. 468-469).

In the end, which use case they want to serve will again depend on the manufacturers, depending on their choice of eVTOL design and technology and their battery technology.
However, despite the different perspectives on the first operated use case and on the market player operating it, most experts have pointed out that the resources, activities, and partnerships are going to stay the same independent of the served use case. Depending on the geographical jurisdictions (EASA, FAA or others), regulations and company structures might differ. In addition, complexity of operations will increase with scaling operations, which will lead to changes in the processes and partnerships. Nevertheless, in the short to medium term, the derived resources, activities, and partnerships will be critical for any type of operator serving any type of use case.

5.4 eVTOL operators: Manufacturers and commercial airlines

The results show that, in the short term, eVTOL manufacturers are going to be the first UAM stakeholders to operate eVTOLs because their expectations of the offer and infrastructure area match with those of the market with the highest probability (Chapter 1.8.2). In addition, by integrating all elements vertically along the value chain, operations will be simplified and easier to control. Manufacturers are highly motivated to prove and accomplish their business case and to create standards for safety, reliability, and profitability. The establishment of standards during the co-evolutionary stage of emerging industries counteracts the existing and emerging uncertainties (Rosenkopf & Tushman, 1998). In addition, standards improve compatibilities and interoperability between companies to generate network effects at a later stage (Katz & Shapiro, 1986). By operating the service, manufacturers are likely to own direct customer contact and receive feedback first-hand. The vertical integration enables manufacturers to own the full profit margin and not to give shares of it away. In addition, all collected data on eVTOLs, customer interaction, and processes on the vertiports can be analyzed and used for improvements. Straubinger et al. (2021) added that, by integrating vertically, the dependency on MRO service providers and production costs can be reduced. eVTOL manufacturers who are planning to follow the approach of vertical integration are for example Volocopter, Joby, and Airbus. Other eVTOL manufacturers such as Eve Air Mobility, Lilium, and Vertical have

articulated their interest or have already signed agreements to partner with private/business aviation companies and regional airlines (e.g., Lilium & Netjets (Netjets, 2022), Lilium & Luxaviation (Luxaviation, 2021)).

In the long term, commercial airlines are expected to step into the UAM market as operators due to the expectations that the UAM market will show similarities with the existing aviation industry. This is to be expected in the growth phase because, as Leblebici et al. (1991) note, new market players from related domains enter the new industry in response to intensified competition for "institutionally defined resources." Of the experts, 44% expect commercial airlines to apply their gathered expertise in the aviation industry to the eVTOL market. This coincides with the literature of Michelmann et al. (2020) who acknowledged that, due to their knowledge in aircraft operations and ability to establish an operational concept that aims for maximum efficiency, they are encouraged to enter the UAM market in the long term. However, the results have shown that the trend depends on the manufacturer's decision and on the scale of operations. With increasing scale, number of eVTOLs, and passengers, operations are going to become very complex. With growing complexity, the responsibilities are expected to be outsourced to more specialized partners who focus on only one step within the value chain. Commercial airport operations are an example, where the maintenance entity, vehicle operations, customer handling, and airport operations are conducted by different entities.

5.5 Offer and infrastructure area of an eVTOL operator

Concerning the combination of key resources, activities and partnerships for an operator, the following details stand out:
The topic of maintenance is declared as a key activity and an essential key partnership. Baur et al. (2018) and Straubinger et al. (2021) agree that maintenance is necessary to ensure successful and safe operations. Whether maintenance is executed internally by the operator or conducted by a partner must be evaluated by the manufacturer and depends on its complexity and on the skills and expertise of the operator.

The vertiport was proposed to be a key infrastructure resource while a partnership with the provider/operator is also considered crucial. Baur et al. (2018), Hansman and Vascik (2016), and Nikitas et al. (2020) point out that planning and development of vertiports are essential for operation to ensure execution capabilities. The infrastructure is currently in the planning and development phase and is expected to be built simultaneously with eVTOLs. The fact that six of the 13 key activities (i.e., maintenance, ground operations, recharging of vehicles, handling

of luggage, securing safety of infrastructure, and guiding passenger flow) are facilitated at the vertiport highlights the importance of available infrastructure.

The sufficient supply of energy and efficient batteries are auxiliary key resources. The recharging of vehicles is a key activity and the relationship with the local energy supplier is a key partnership for an operator. This emphasizes that energy is very essential for operation of eVTOLs. Therefore, any challenges related to energy are of highest relevance for an operator. Baur et al. (2018) and Straubinger et al. (2021) have mentioned the supply of energy to recharge eVTOLs as one of many challenges.

Human resources are the fourth result to be discussed. The certification, training, scheduling, and dispatching of pilots and of staff is a key activity, while staff and pilots are also acknowledged as a key resource for operators. Existing certifications and trainings for pilots are not adequate to operate eVTOLs due to the novelty of the eVTOL technology. That is why 44% of experts declared that new certifications and new trainings are required to be developed to have qualified pilots flying eVTOLs. The determination of guidelines to define what kind of skillset and training eVTOL pilots require is key to enable safe operations. The focus of the literature lies on the full autonomy of vehicles. As Reiche et al. (2018) point out, eVTOLs will be remotely controlled by command-and-control centers. However, the results have shown that, from a technology and regulatory perspective, fully autonomous operations will only be possible in the long term, by the estimated year 2030.

6. Conclusion, limitations and future research

To ensure the success of this digital mobility transformation facilitated through the air, the following digital enablers are important. The most obvious are the key resources, activities, and partnerships that were listed in the previous chapter. These are crucial to enable operation but also to ensure high level of safety on the ground and in the air. They are also essential to guarantee efficient and effective operations in various ways. In addition, the battery technology was mentioned various times as a key digital enabler because it governs the eVTOL maximum radius of operation. Third, it is crucial to embed cybersecurity measures into the eVTOL vehicles and their systems and into any system that connects or communicates with them. This is important to prevent hostile control over the eVTOLs and therefore protect them from being piloted or guided by unauthorized people. Adversarial control of eVTOLs could lead to crashes, which are especially dangerous in urban areas. The data exchange and close communication with air traffic management are also crucial for the safety of passengers and others, ensuring safe operations by planning for malfunctions and avoiding any kind of contact with other airspace users or aircraft.

In summary, the underlying research contributes to the academic research of the air mobility market by focusing on one specific stakeholder within the UAM ecosystem, the operator of the eVTOL technology. Within the next years, the eVTOL technology will be operated to transport passengers through the air and enable significant reductions in travel times. The outcome of governmental and economic decisions will influence which use cases are going to be predominantly offered and which market player is going to operate and offer the service. Thus, further research will highlight the impact of an operator and the technology itself on the means of transportation.

As with all empirical studies, the conducted analysis faces several limitations that should be considered due to their potential influence on the results. First, the sample size of 16 experts is quite high for a qualitative study. Still, the sample size lacked the inclusion of other major OEM companies, other regulatory entities from other jurisdictions, and more businesses from the infrastructure provision market. In addition, it must be pointed out that the clusters of companies (e.g., eVTOL manufacturers, PBAC, etc.) did not include the same number of experts due to challenges during the expert interview acquisition. Due to the listed limitations and due to time and space constraints, it is evident that the results are neither fully representative nor

generalizable and only give an indication for the first use case, the potential operator, the value proposition and key activities, resources, and partnerships for the eVTOL operator.
Second, the responsibilities and entity set-up of the operator are currently being planned, developed, and prepared for. The operator is expected to operate in about two to three years. It was difficult to identify individuals who have expert knowledge of the topic of an eVTOL operator because the industry is currently in its infancy. The identified and questioned experts, however, hold biased views due to their cultural backgrounds, their perspective on the evolution of this market, and their employers' proposed strategies.
Another limitation of this study is that the focus lies on the offer and infrastructure area of the business model canvas and therefore left the customer and financial validity areas out of the analysis. As a result, the author failed to provide a holistic approach on the business model of an operator, presenting the opportunity for future research to combine the extensive collected knowledge on the infrastructure and offer area with additional research on the customer and financial validity area. Since the closer the market gets to operation, the more relevant the cost structures, the different revenue streams, and the customer segment will become. In addition, it might be interesting to analyze the financial structures with investors, governments, and other financially involved stakeholders. This combination would then present a holistic and in-depth analysis of a potential eVTOL (vehicle) operator.

Future research on the eVTOL operator should focus its analysis on a specific jurisdiction, within either the authority of EASA (Europe) or FAA (America) or other jurisdictions. This is because the regulatory entities have massive influences because they decide which rules to implement and, most importantly, with what effort and timeline. The applicability and execution of UAM therefore lies to quite a large extent in the hands of aviation authorities and local and state regulators. Consequently, the research within this specific jurisdiction should focus on a particular geographical area because certifications and regulations differ even though they operate under the same authority. The development of the certifications and regulations is currently being executed and still going to evolve in the next years. Therefore, it has a significant impact on the execution of operations. A study that focuses more closely on a specific jurisdiction and a geographical area within could be an exciting future research topic.

List of References

Agarwal, R., & Bayus, B. L. (2002). The Market Evolution and Sales Takeoff of Product Innovations. *Management Science*, *48*(8), 1024–1041. https://doi.org/10.1287/mnsc.48.8.1024.167

Agarwal, R., & Bayus, B. L. (2004). CREATING AND SURVIVING IN NEW INDUSTRIES. In J. A. C. Baum & A. M. McGahan (Eds.), *Business Strategy over the Industry Lifecycle (Advances in Strategic Management, Vol.21)* (Vol. 21, pp. 107–130). Emerald Group Publishing Limited. https://doi.org/10.1016/S0742-3322(04)21004-X

Alexander, J. M., Newman, N. C., Porter, A. L., Chase, J., & Roessner, J. D. (2012). *Emergence as a Conceptual Framework for Understanding Scientific and Technological Progress*. https://www.researchgate.net/publication/248391856

Amit, R., & Zott, C. (2001). Value creation in E-business. *Strategic Management Journal*, *22*(6–7), 493–520. https://doi.org/10.1002/smj.187

Baur, S., Schickram, S., Homulenko, A., Martinez, N., & Dyskin, A. (2018). *Urban Air Mobility - The rise of a new mode of transportation*.

Bortz, J., & Döring, N. (2006). Qualitative Methoden. In J. Börtz & N. Döring (Eds.), *Forschungsmethoden und Evaluation* (pp. 295–350). Springer. https://doi.org/10.1007/978-3-540-33306-7_5

Burr, T. (2006). Building community, legitimating consumption: creating the U.S. bicycle market, 1876–1884. *Socio-Economic Review*, *4*(3), 417–446. https://doi.org/10.1093/ser/mwl015

Caves, R. E. (1984). Economic Analysis and the Quest for Competitive Advantage. *American Economic Review*, *74*(2), 127–132.

Christensen, C. M., Raynor, M. E., & McDonald, R. (2015, December 1). What Is Disruptive Innovation? *Haward Business Review*.

Corrocher, N., Malerba, F., & Montobbio, F. (2003). *The emergence of new technologies in the ICT field: main actors, geographical distribution and knowledge sources*. https://www.researchgate.net/publication/5127667

Cozzens, S., Gatchair, S., Kang, J., Kim, K.-S., Lee, H. J., Ordóñez, G., & Porter, A. (2010). Emerging technologies: quantitative identification and measurement. *Technology Analysis & Strategic Management*, *22*(3), 361–376. https://doi.org/10.1080/09537321003647396

Daskilewicz, M., German, B., Warren, M., Garrow, L. A., Boddupalli, S.-S., & Douthat, T. H. (2018, June 25). Progress in Vertiport Placement and Estimating Aircraft Range

Requirements for eVTOL Daily Commuting. *2018 Aviation Technology, Integration, and Operations Conference*. https://doi.org/10.2514/6.2018-2884

Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, *13*(3), 319. https://doi.org/10.2307/249008

Day, G. S., & Schoemaker, P. J. H. (2000). Avoiding the Pitfalls of Emerging Technologies. *California Management Review*, *42*(2), 8–33. https://doi.org/10.2307/41166030

Dietrich, A., & Wulff, Y. (2020). *Urban Air Mobility. Adding the third dimension to urban and regional transportation.* . https://www.communityairmobility.org/uam101

EUROCONTROL. (2018). *UAS ATM Integration Operational Concept*.

European Commission. (n.d.). *A European Strategy for low-emission mobility*. Retrieved May 11, 2022, from https://ec.europa.eu/clima/eu-action/transport-emissions_de

European Environment Agency. (2021, November 18). *Greenhouse gas emissions from transport in Europe*. https://www.eea.europa.eu/ims/greenhouse-gas-emissions-from-transport

Federal Aviation Administration. (2021, October 15). *Integration Pilot Program Lead Participants*. https://www.faa.gov/uas/programs_partnerships/completed/integration_pilot_program/lead_participants/

Forbes, D. P., & Kirsch, D. A. (2011). The study of emerging industries: Recognizing and responding to some central problems. *Journal of Business Venturing*, *26*(5), 589–602. https://doi.org/10.1016/j.jbusvent.2010.01.004

Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. *Research Policy*, *31*(8–9), 1257–1274. https://doi.org/10.1016/S0048-7333(02)00062-8

Geister, D. (2017). *"Concept for Urban Airspace Integration“ - DLR Blueprint*. http://www.dlr.de/fl/desktopdefault.aspx/tabid-11763/20624_read-48305/

Gläser, J., & Laudel, G. (2010). *Experteninterviews und qualitative Inhaltsanalyse* (4th ed.). VS Verlag für Sozialwissenschaft.

Grandl, G., Cachay, J., Salib, J., Ostgathe, M., Doppler, S., & Ross, H. (2018). *The Future of Vertical Mobility*.

Gustafsson, R., Jääskeläinen, M., Maula, M., & Uotila, J. (2016). Emergence of Industries: A Review and Future Directions. *International Journal of Management Reviews*, *18*(1), 28–50. https://doi.org/10.1111/ijmr.12057

Hansman, R. J., & Vascik, P. D. (2016). *Operational Aspects of Aircraft-Based On-Demand Mobility*.

Hargadon, A. B., & Douglas, Y. (2001). When Innovations Meet Institutions: Edison and the Design of the Electric Light. *Administrative Science Quarterly*, *46*(3), 476–501. https://doi.org/10.2307/3094872

Holden, J., & Goel, N. (2016). *Fast-Forwarding to a Future of On-Demand Urban Air Transportation*. http://inrix.com/scorecard/

Ibañez Rivas, J. N., & Christidis, P. (2012). *Measuring road congestions.* Publications Office.

Jacobides, M. G. (2005). Industry Change Through Vertical Disintegration: How and Why Markets Emerged in Mortgage Banking. *Academy of Management Journal*, *48*(3), 465–498. https://doi.org/10.5465/amj.2005.17407912

Jäger, U., & Reinecke, S. (2009). *Empirische Mastertechniken - eine anwendungsorientierte Einführung für die Marketing- und Managementforschung* (C. Baumgarth, M. Eisend, & H. Evanschitzky, Eds.). Gabler Verlag. https://doi.org/10.1007/978-3-8349-8278-0

Kaiser, R. (2014). *Qualitative Experteninterviews*. Springer.

Kapoor, R., & Furr, N. R. (2014). Complementarities and competition: Unpacking the drivers of entrants' technology choices in the solar photovoltaic industry. *Strategic Management Journal*, *36*(3), 416–436. https://doi.org/10.1002/smj.2223

Katz, M. L., & Shapiro, C. (1986). Technology Adoption in the Presence of Network Externalities. *Journal of Political Economy*, *94*(4), 822–841. https://doi.org/10.1086/261409

Kellermann, R., Biehle, T., & Fischer, L. (2020). Drones for parcel and passenger transportation: A literature review. *Transportation Research Interdisciplinary Perspectives*, *4*. https://doi.org/10.1016/j.trip.2019.100088

Kellermann, R., & Fischer, L. (2020). Drones for parcel and passenger transport: A qualitative exploration of public acceptance. *Sociologia y Tecnociencia*, *10*(2), 106–138. https://doi.org/10.24197/st.2.2020.106-138

Leblebici, H., Salancik, G. R., Copay, A., & King, T. (1991). Institutional Change and the Transformation of Interorganizational Fields: An Organizational History of the U.S. Radio Broadcasting Industry. *Administrative Science Quarterly*, *36*(3), 333–363. https://doi.org/10.2307/2393200

Lim, E., & Hwang, H. (2019). The Selection of Vertiport Location for On-Demand Mobility and Its Application to Seoul Metro Area. *International Journal of Aeronautical and Space Sciences*, *20*(1), 260–272. https://doi.org/10.1007/s42405-018-0117-0

Luxaviation. (2021, May 21). *Luxaviation x Lilium*. https://www.luxaviation.com/luxaviation-x-lilium/

Lyons, G. (2018). Getting smart about urban mobility – Aligning the paradigms of smart and sustainable. *Transportation Research Part A: Policy and Practice*, *115*, 4–14. https://doi.org/10.1016/j.tra.2016.12.001

Malerba, F., & Orsenigo, L. (1996). The Dynamics and Evolution of Industries. *Industrial and Corporate Change*, *5*(1), 51–87. https://doi.org/10.1093/icc/5.1.51

Martin, B. R. (1995). Foresight in science and technology. *Technol. Anal. Strateg. Manage*, *7*(2), 139–168.

Mayring, P. (1994). Qualitative Inhaltsanalyse. In *Texte verstehen : Konzepte, Methoden, Werkzeuge* (pp. 195–175). UVK Univ.-Verl. Konstanz.

Mayring, P. (2015). *Qualitative Inhaltsanalyse - Grundlagen und Techniken* (12th ed.). Beltz Verlag.

McFarlane, D. (2017). Osterwalder's business model canvas- Its genesis, features, comparison, benefits and limitations . *Westcliff International Journal of Applied Research*, *1*(2).

Mezias, S. J., & Kuperman, J. C. (2001). The community dynamics of entrepreneurship. *Journal of Business Venturing*, *16*(3), 209–233. https://doi.org/10.1016/S0883-9026(99)00057-9

Michelmann, J., Straubinger, A., Becker, A., al Haddad, C., Plötner, K. O., & Hornung, M. (2020). *URBAN AIR MOBILITY 2030+: Pathways for UAM - A Scenario-based Analysis*.

Mohamed, N., Al-Jaroodi, J., Jawhar, I., Idries, A., & Mohammed, F. (2020). Unmanned aerial vehicles applications in future smart cities. *Technological Forecasting and Social Change*, *153*. https://doi.org/10.1016/j.techfore.2018.05.004

Munir, K. A., & Phillips, N. (2002). The concept of industry and the case of radical technological change. *The Journal of High Technology Management Research*, *13*(2), 279–297. https://doi.org/10.1016/S1047-8310(02)00046-9

NASA. (2018). *URBAN AIR MOBILITY (UAM) MARKET STUDY*.

Nathen, P. (2021). *Architectural performance assessment of an electric vertical take-off and landing (e-VTOL) aircraft based on a ducted vectored thrust concept*.

Netjets. (2022, March). *NETJETS + LILIUM*. https://www.netjets.com/en-us/lilium-evtol-partnership

NextGen FAA. (2020). *Urban Air Mobility (UAM) Concept of Operations (ConOps)*.

Nikitas, A., Michalakopoulou, K., Njoya, E. T., & Karampatzakis, D. (2020). Artificial intelligence, transport and the smart city: Definitions and dimensions of a new mobility era. *Sustainability (Switzerland)*, *12*(7), 1–19. https://doi.org/10.3390/su12072789

Nneji, V. C., Stimpson, A., Cummings, M. M., & Goodrich, K. H. (2017). Exploring concepts of operations for on-demand passenger air transportation. *17th AIAA Aviation Technology, Integration, and Operations Conference, 2017*. https://doi.org/10.2514/6.2017-3085

Osterwalder, A., & Pigneur, Y. (2010). *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*. John Wiley & Sons, Inc.

Palaia, G., Abu Salem, K., Cipolla, V., Binante, V., & Zanetti, D. (2021). A Conceptual Design Methodology for e-VTOL Aircraft for Urban Air Mobility. *Applied Sciences*, *11*(22), 10815. https://doi.org/10.3390/app112210815

Phaal, R., O'Sullivan, E., Routley, M., Ford, S., & Probert, D. (2011). A framework for mapping industrial emergence. *Technological Forecasting and Social Change*, *78*(2), 217–230. https://doi.org/10.1016/j.techfore.2010.06.018

Ploetner, K. O., al Haddad, C., Antoniou, C., Frank, F., Fu, M., Kabel, S., Llorca, C., Moeckel, R., Moreno, A. T., Pukhova, A., Rothfeld, R., Shamiyeh, M., Straubinger, A., Wagner, H., & Zhang, Q. (2020). Long-term application potential of urban air mobility complementing public transport: an upper Bavaria example. *CEAS Aeronautical Journal*, *11*(4), 991–1007. https://doi.org/10.1007/s13272-020-00468-5

Pradeep, P., & Wei, P. (2019). Energy-Efficient Arrival with RTA Constraint for Multirotor eVTOL in Urban Air Mobility. *Journal of Aerospace Information Systems*, *16*(7), 263–277. https://doi.org/10.2514/1.I010710

Pritchard, J. (2022, February 18). *Eve Air Mobility signs agreements with Aviair, Helispirit and Microflite and increases order book for its eVTOL aircraft*. https://evtolinsights.com/2022/02/eve-air-mobility-signs-agreements-with-aviair-helispirit-and-microflite-and-increases-order-book-for-its-evtol-aircraft/

Pyka, A., & Saviotti, P. P. (2011). Economic Growth Through the Emergence of New Sectors. In *Sectors Matter!* (pp. 55–101). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-18126-9_4

Rakas, J., Jeung, J., So, D., Ambrose, P., & Chupina, V. (2021). EVTOL Fleet Selection Method for Vertiport Networks. *AIAA/IEEE Digital Avionics Systems Conference - Proceedings*, *2021-October*. https://doi.org/10.1109/DASC52595.2021.9594309

Reiche, C., Cohen, A., Goyal Rohit, Serrao Jacqueline, Kimmel Shawn, Fernando Chris, & Shaheen Susan. (2018). *Urban Air Mobility Market Study*. https://doi.org/10.7922/G2ZS2TRG

Rosenkopf, L., & Tushman, M. L. (1998). The Coevolution of Community Networks and Technology: Lessons from the Flight Simulation Industry. *Industrial and Corporate Change*, *7*(2), 311–346. https://doi.org/10.1093/icc/7.2.311

Rothfeld, R., Straubinger, A., Fu, M., al Haddad, C., & Antoniou, C. (2019). Urban air mobility. In *Demand for Emerging Transportation Systems: Modeling Adoption, Satisfaction, and Mobility Patterns* (pp. 267–284). Elsevier. https://doi.org/10.1016/B978-0-12-815018-4.00013-9

Rumba, R., & Nikitenko, A. (2020). The wild west of drones: A review on autonomous- UAV traffic-management. *2020 International Conference on Unmanned Aircraft Systems, ICUAS 2020*, 1317–1322. https://doi.org/10.1109/ICUAS48674.2020.9214031

Rytkönen, E., & Nenonen, S. (2014). The Business Model Canvas in university campus management. *Intelligent Buildings International*, *6*(3), 138–154. https://doi.org/10.1080/17508975.2013.807768

Schuchardt, B. I., Becker, D., Becker, R.-G., End, A., Gerz, T., Meller, F., Metz, I. C., Niklaß, M., Pak, H., Schier-Morgenthal, S., Schweiger, K., Shiva Prakasha, P., Sülberg, J. D., Swaid, M., Torens, C., & Zhu, C. (2021, August 2). Urban Air Mobility Research at the DLR German Aerospace Center – Getting the HorizonUAM Project Started. *AIAA AVIATION 2021 FORUM*. https://doi.org/10.2514/6.2021-3197

Schultz, P. L., Marin, A., & Boal, K. B. (2013). The impact of media on the legitimacy of new market categories: The case of broadband internet. *Journal of Business Venturing*, *29*(1), 34–54. https://doi.org/10.1016/j.jbusvent.2012.11.001

SCORE Association. (2019, December 19). *Benefits of Using the Business Model Canvas*. https://philadelphia.score.org/blog/benefits-using-business-model-canvas-2

SESAR Joint Undertaking. (2016). *European Drones Outlook Study Unlocking the value for Europe*.

SESAR Joint Undertaking. (2018). *European ATM Master Plan: Roadmap for the safe integration of drones into all classes of airspace*.

Shaheen, S., Cohen, A., Broader, J., Davis, R., Brown, L., Neelakantan, R., & Gopalakrishna, D. (2020). *Mobility on Demand Planning and Implementation: Current Practices, Innovations, and Emerging Mobility Futures*. https://rosap.ntl.bts.gov/view/dot/50553

Sine, W. D., & Lee, B. H. (2009). Tilting at Windmills? The Environmental Movement and the Emergence of the U.S. Wind Energy Sector. *Administrative Science Quarterly*, *54*(1), 123–155. https://doi.org/10.2189/asqu.2009.54.1.123

Straubinger, A., Michelmann, J., & Biehle, T. (2021). Business model options for passenger urban air mobility. *CEAS Aeronautical Journal*, *12*(2), 361–380. https://doi.org/10.1007/s13272-021-00514-w

Straubinger, A., & Rothfeld, R. (2018). Identification of Relevant Aspects for Personal Air Transport System Integration in Urban Mobility Modelling. *7th Transport Research Arena*.

Straubinger, A., Rothfeld, R., Shamiyeh, M., Büchter, K. D., Kaiser, J., & Plötner, K. O. (2020). An overview of current research and developments in urban air mobility – Setting the scene for UAM introduction. *Journal of Air Transport Management*, *87*. https://doi.org/10.1016/j.jairtraman.2020.101852

Suarez, F. F., Grodal, S., & Gotsopoulos, A. (2014). Perfect timing? Dominant category, dominant design, and the window of opportunity for firm entry. *Strategic Management Journal*, *36*(3), 437–448. https://doi.org/10.1002/smj.2225

Sun, X., Wandelt, S., Husemann, M., & Stumpf, E. (2021). Operational Considerations regarding On-Demand Air Mobility: A Literature Review and Research Challenges. In *Journal of Advanced Transportation* (Vol. 2021). Hindawi Limited. https://doi.org/10.1155/2021/3591034

U.S. Department of Transportation. (2018, May 2). *Federal Aviation Administration*. https://www.transportation.gov/briefing-room/safetyfirst/federal-aviation-administration

van de Ven, A., & Garud, R. (1989). A framework for understanding the emergence of new industries. In R. S. Rosenbloom & R. A. Burgelmann (Eds.), *Research on Technological Innovation, Management and Policy* (Vol. 4, pp. 195–226). JAI Press.

van de Ven, A., & Garud, R. (1993). Innovation and Industry Development: the case of cochlear implants. *Research on Technological Innovation, Management and Polics*, *5*, 1–46.

van de Ven, A., & Garud, R. (1994). The coevolution of technical and institutional events in the development of an innovation. In A. C. Baum & J. v Singh (Eds.), *Evolutionary Dynamics of Organizations* (pp. 425–443). Oxford University Press.

van Merkerk, R. O., & Robinson, D. K. R. (2006). Characterizing the emergence of a technological field: Expectations, agendas and networks in Lab-on-a-chip technologies. *Technology Analysis & Strategic Management*, *18*(3–4), 411–428. https://doi.org/10.1080/09537320600777184

Volocopter. (2021). *THE ROADMAP to scalable urban air mobility*. https://www.volocopter.com/content/uploads/20210324_Volocopter_WhitePaper_Roadmap_to_scalable_UAM_m.pdf

Yedavalli, P., & Mooberry, J. (2019). *An Assessment of Public Perception of Urban Air Mobility (UAM)*. https://storage.googleapis.com/blueprint/AirbusUTM_Full_Community_PerceptionStudy.pdf

Appendices

Appendix A: Interview guideline

Appendix B: Frequency analysis matrix

Appendix C: Expert interview summaries

Appendix A: Interview guideline

Urban Air Mobility

1. What are the three main problems which urban air mobility will solve?
2. What is the biggest potential of urban air mobility?
3. What is the main challenge for the operationalization of urban air mobility?

Use Case /Scenario

3. Which UAM use case will be the first to take off?
4. Why do you believe that this use case will take of the first?
5. What are the benefits of that specific scenario (previous answer)?
6. Which are the biggest limiting factors for other use cases?

Potential operator for the scenario – based on previous response

7. Which market player is most likely to undertake operations for that use case?
8. Which are the advantages of this operator over others?

Business model canvas – Offer: Value Proposition

9. What is the special customer value proposition?
10. Which customer problems are being solved?
11. What are the key elements of the service?

Business Model canvas - Infrastructure

12. Which are the most important **activities** of the operator to secure safe and efficient operations?
13. Which are the day-to-day tasks of the operator?
14. Which **key resources** does the operator need to operationalize this use case?
15. Which **partnerships** are essential for the operator?
16. What is the purpose of each essential partnership?

Outlook and Trends

17. Will the operators' activities, resources and partnerships vary when serving a different use case?
18. What does the concept of UAM create? Would you describe it as a new industry, a new market or a new sector within the aviation industry?

Appendix B: Frequency analysis matrix

inductive chosen sub-categories of deductive chosen main categorries	Interviewee ID	Preferred Use Case						Preferred Market Player as Operator								Value Proposition									
		Airport Shuttle	Air Taxi / Urban Air mobility	Substitution for helicopter	Medical purposes	Sightseeing / Tourism	Regional Air Mobility	eVTOL Manufacturer	Commercial Airline	Private/ business aviation	New Entity / Start up / Joint Venture	Helicopter operaors	Regional Airlines	Commercial airport operators	Infrastructure provider / operator	Time Saving	Faster urban and regional connections	Convenient travelling	Safe Service	Reduce emissions and support sustainable aviation	Early adopters / Innovators	Affordable service / money saving	Multimodal transport network	Reliable service	Access to remote locations
		1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
eVTOL manufacturer	1	1					1	1		1	1					1				1	1				
	2	1									1					1	1	1	1		1			1	
	5	1				1	1		1	1		1	1			1	1	1	1	1		1			
	11		1					1								1	1	1							
Commercial airport operator	3		1			1										1	1		1			1	1		
	9	1							1			1		1		1	1	1							
	14	1						1	1	1							1	1							
	15			1							1					1	1					1			
Private aviation service provider	4		1				1		1	1		1	1					1	1	1				1	
	10			1	1	1	1	1		1						1			1	1	1				1
UAM technology &OR infrastructure provider	6	1						1	1		1				1	1	1	1	1	1	1				
	8	1				1		1								1	1						1		
	12	1		1			1	1	1			1				1	1								
	16	1					1	1						1		1									1
Regulatory entity / other experts	7	1						1			1						1								
	13	1						1	1							1							1		
	Ranks	**14**	**6**	**4**	**5**	**10**	**16**	**17**	**12**	**10**	**9**	**6**	**4**	**3**	**14**	**13**	**11**	**7**	**6**	**5**	**4**	**3**	**3**	**2**	**2**
Mentioned in Total:		69%	19%	19%	6%	25%	38%	63%	44%	31%	31%	25%	13%	13%	6%	81%	69%	44%	38%	31%	25%	19%	19%	13%	13%
	#																								
eVTOL manufacturer	4	75%	25%	0%	0%	25%	50%	50%	25%	50%	50%	25%	25%	0%	0%	100%	75%	75%	50%	50%	50%	25%	0%	25%	0%
Commercial airport operator	4	50%	25%	25%	0%	25%	0%	25%	50%	25%	25%	25%	0%	25%	0%	75%	100%	50%	25%	0%	0%	50%	25%	0%	0%
Private aviation service provider	2	0%	50%	50%	50%	50%	100%	50%	50%	100%	0%	50%	50%	0%	0%	50%	0%	50%	100%	100%	50%	0%	0%	50%	50%
UAM technology &OR infrastructure provider	4	100%	0%	25%	0%	25%	50%	100%	50%	0%	25%	25%	0%	25%	25%	100%	75%	25%	25%	25%	25%	0%	25%	0%	25%
Regulatory entity / other experts	2	100%	0%	0%	0%	0%	0%	100%	50%	0%	50%	0%	0%	0%	0%	50%	50%	0%	0%	0%	0%	0%	50%	0%	0%

Key Activities													Key Resources								Key Partnerships										Outlook 1			
Maintenance	Guiding passenger flow	Pilot (Certification, Training, Planning, Dispatching)	Ground Operations	Recharging of vehicles	Integration and communication within the airspace	Flight Operations & Planning	Staff (Selection, Training, Certification, Scheduling etc.)	Similar to commercial airline	Securing safety of infrastructure	Wind, Weather and airspace data	Handle the Luggage	Fleet management	Staff	Energy & Batteries	Infrastructure (Vertiports & Charging)	Pilots	Financial Means	Equipment (Assets & Vehicles)	Certification	Digital Systems & Knowledge	Infrastructure provider and/or operator	Maintenance entity	Municipalities, Authorities and air traffic control	Manufacturer	Pilot Training	Commercial platform / service provider	Investors	Other UAM/RAM Operators	Local energy supplier	Ground Operations	Resources, Activities and Partnerships **exactly the same**	Resources, Activities and Partnerships **similiar**	Resources, activities and partnerships will depend on the use case	Partnerships might vary
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**	**4**
			1										1		1							1	1							1	1			
1				1	1									1		1						1	1		1					1				
1				1										1	1	1	1		1		1					1	1				1			
1	1	1	1	1			1	1				1	1	1							1	1		1	1					1			
1	1	1	1	1	1	1	1			1	1	1								1	1		1						1				
	1												1	1	1																	1	1	
1	1		1						1		1		1				1												1		1			49
						1							1	1	1			1																1
1	1	1	1	1		1	1	1									1									1		1						
1		1					1						1				1				1	1				1								1
					1	1			1	1			1			1					1							1			1	1		
1	1		1		1					1			1	1	1				1	1	1		1	1								1		
1	1	1												1		1															1		1	
1	1		1	1	1			1	1		1		1		1			1			1		1		1						1			
1		1				1		1	1							1		1			1			1							1			
1		1											1	1							1	1									1	1		
12	**8**	**7**	**7**	**6**	**5**	**5**	**4**	**4**	**4**	**3**	**3**	**2**	**10**	**8**	**6**	**5**	**4**	**3**	**2**	**2**	**9**	**5**	**5**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**9**	**3**	**3**	**2**
75%	50%	44%	44%	38%	31%	31%	25%	25%	25%	19%	19%	19%	63%	50%	38%	31%	25%	19%	13%	13%	56%	31%	31%	19%	19%	19%	13%	13%	13%	13%	56%	19%	19%	13%
75%	25%	25%	50%	75%	25%	0%	25%	25%	0%	0%	0%	0%	50%	75%	50%	50%	25%	0%	25%	0%	50%	75%	50%	25%	50%	25%	25%	0%	0%	50%	75%	0%	0%	0%
50%	75%	25%	50%	25%	25%	50%	25%	0%	25%	25%	50%	25%	75%	50%	50%	0%	25%	25%	0%	25%	25%	0%	25%	0%	0%	0%	0%	0%	50%	0%	25%	25%	25%	25%
100%	50%	100%	50%	50%	0%	50%	100%	50%	0%	0%	0%	0%	50%	0%	0%	0%	100%	0%	0%	0%	50%	50%	0%	0%	0%	100%	0%	50%	0%	0%	0%	0%	0%	50%
75%	75%	25%	50%	25%	75%	25%	0%	25%	50%	50%	25%	50%	75%	50%	50%	50%	0%	25%	25%	25%	75%	0%	50%	25%	25%	0%	25%	25%	0%	0%	75%	25%	50%	0%
100%	0%	100%	0%	0%	0%	50%	0%	50%	50%	0%	0%	0%	50%	50%	0%	50%	0%	50%	0%	0%	100%	50%	0%	50%	0%	0%	0%	0%	0%	0%	100%	50%	0%	0%

Appendix C: Expert interview summaries

Interview – E1 – 24.03.22

I: Which UAM use case will be the first to take off?
E1:
- E1 believes in airport shuttles and not the intercity travel
- Most viable are the ones with a lot of traffic
- Main benefits for the airport shuttle is to have shorter and faster connection to the airport which benefits many passengers

I: Which market player is most likely to undertake operations for that use case?
E1:
- It will have to be a certified air carrier with a particular skill set and integrated as a mobility as a service stack
- They will either operate themselves, contract somebody or work with manufacturers
- It could be airlines, private aviation companies or a new entity
- If an operator would want to they would need to acquire all skills inhouse and apply for an AOC certificate in every country they want to operate in

I: What is the special customer value proposition?
E1:
- Time saving!
- Passengers will spend a lot of money to feel prestige, in the beginning it will be fancy and later it will become a commodity

I: Which key resources does the operator need to operationalize this use case?
E1:
- Access to the right infrastructure
- Financial resources
- People with knowledge
- Regulatory relationships

I: Which partnerships are essential for the operator?
E1:
- Relationship with EASA to influence the rulemaking
- Maintenance is key, especially in the beginning, and when operating with high frequency
- Good ground handlers within an intermodal system

I: Will the operators' activities, resources and partnerships vary when serving a different use case?
E1:
- This is all relatively general, so they are likely to be the same

Interview – E2 – 28.03.22

I: Which UAM use case will be the first to take off?
E2:

- The airport shuttle in for example Frankfurt is not viable, in Dubai it would be
- The first step, it is going to be the state of the art
- Exotic use case would be from Nizza airport to Nice to a super yacht

I: Which market player is most likely to undertake operations for that use case?
E2:

- there are going to be several players involved.
- a player which sits in the middle and is responsible for the aircraft and all kinds of air transportation issues
- infrastructure operator for the fixed infrastructure for the local infrastructure.
- A commercial airline is not expected to become an operator
- Maybe a joint venture

I: What is the special customer value proposition?
E2:

- Really safe to operate
- In the beginning, no special kind of value. After months or years beneficial for ordinary user
- Competitive regarding time comfort and reliability
- The whole process needs to be easy, fast, smooth and effortless

I: Which are the most important activities of the operator to secure safe and efficient operations?
E2:

- Most difficult activity to fit the service into the complicated air traffic environment
- Check of suitable corridors and evaluation of flying zones, especially at airports
- Handling of energy and recharging, calculating buffers
- Keep vehicles flying in the air and not stuck at maintenance
- Fire protection

I: Which key resources does the operator need to operationalize this use case?
E2:

- Backup pilots
- Backup command and control center
- Energy comes first

I: Which partnerships are essential for the operator?
E2:

- Support with surface level operation
- Organization for pilots and airside operation
- Maintenance of the aircraft

Interview – E3 – 28.03.22

I: Which UAM use case will be the first to take off?
E3:
- Inner city is the preferred use case
- To the airport is always difficult because of controlled airspace and because it is hectic and complicated
- First there will be one route that you can book, then a second one will be added and thereby it will turn into an on-demand service

I: Which market player is most likely to undertake operations for that use case?
E3:
- Manufacturer has it own application and wants to do it themselves (VOLOIQ)

I: What is the special customer value proposition?
E3:
- Time saving, ideally at the same price as a cab
- Integration into a multimodal transportation network
- Connection between cities, especially in Asian region

I: Which are the most important activities of the operator to secure safe and efficient operations?
E3:
- Book the service and assign and communicate it to the customer
- Fleet management including necessary maintenance (after hours, cycles and pre-flight)
- Achieve homogenous distribution of aircrafts
- Collect customers, collect their weight and luggage weight
- Provide battery and check battery infrastructure
- Check of weather conditions
- Check readiness of pilot and aircraft
- Dispatching
- Emergency planning / flightpath planning
- Maintenance of corridors and communication with authorities
- Summarized: provision of flight service and process after landing

I: Which key resources does the operator need to operationalize this use case?
E3:
- Little need for physical products (for VoloIQ)
- Platform
- Backend for the platform
- Ensuring of constantly running servers

I: Which partnerships are essential for the operator?
E3:
- Partnership with infrastructure provider
- Electricity provider
- Partnership with cities and municipalities
- There are a huge number of important partnerships

Interview – E4 – 30.03.22

I: Which UAM use case will be the first to take off?
E4:

- It will start with regional air mobility and urban air mobility will be an extension
- There will be a transition phase until proof of concept is validated and accepted, then it will be scaled up
- Vertiports will be close to city centers and will function as gateways into the city
- In the US and Asia: commuting approach
- Europe: intercity because many medium cities and sub regions
- Therefore it will depend on the structure of the respective market

I: Which market player is most likely to undertake operations for that use case?
E4:

- Airlines with knowledge of the market, the prices, marketing
- They can build an operating company
- Also OEMs to be operators in the long term
- Authorities prefer to have diversified product chain and not full vertical integration
- Helicopter operators or business aviation operator or also airline commercial operator

I: What is the special customer value proposition?
E4:

- Reliability and quality of the service
- Safety
- Agility to take a new type of vehicle to travel to a new destination
- Most important: sustainable transportation

I: Which are the most important activities of the operator to secure safe and efficient operations?
E4:

- Optimization of passenger flow at the facility
- Hire pilots
- Perform maintenance
- Operator certification
- Training organization
- Flight and ground operations
- Backend for the IT for integration of all different systems for automation
- Vehicle charging
- Maneuvering on the ground
- Energy supply
- Luggage handling
- Operator for ground facilities and FBO
- Operator, air operator or ground infrastructure operator
- Infrastructure operator: automation of technology to ensure smooth services and reduced waiting times

I: Which key resources does the operator need to operationalize this use case?
E4:

- Expertise
- Agility for new setup with new vehicles, mixed fleet and a lot of turnover in the staff

- Vision and ambition to operate long-term
- Financial solidity

I: Which partnerships are essential for the operator?
E4:
- Partnerships with other operators to complement each other within the network
- With commercial platform for demand planning and capacity planning
- Other than that no partnerships required
- They would all be procurement or supply chain relation

Interview – E5 – 30.03.22

I: Which UAM use case will be the first to take off?
E5:
- Shuttle services to existing platforms
- For tourist purposes
- Replacement for conventional helicopters with an electric vehicle
- In the beginning it depends on the battery technology

I: Which market player is most likely to undertake operations for that use case?
E5:
- Regional airline operators, judging from the bulk of orders (SkyWest and Republic)
- Helicopter operators (Halo, Blade)
- For both to diversify their business

I: What is the special customer value proposition?
E5:
- Time saving
- Quick flights at affordable prices
- Safe flights
- Reduce carbon emissions

I: Which are the most important activities of the operator to secure safe and efficient operations?
E5:
- In general: Maintenance is the most important activity
- Maintain a safe environment for passengers and people on the ground
- Customer service (selling tickets, being competitive, offering flights to the demanded destinations)
- Fast recharging service
- Preventative maintenance

I: Which key resources does the operator need to operationalize this use case?
E5:
- Financing and cash to buy or lease vehicles
- Building of infrastructure and vertiports
- Energy and breadth with clients
- High load factor of 60% to 70%
- Certification

- Pilots
- Pilot training and certification
- Certification for aircrafts and manufacturing plants
- capillarity of their network and capillarity of clients as well.

I: Which partnerships are essential for the operator?
E5:
- with vertiports, still has to be build and worked out
- financial institution to finance the operations (including buying the vehicles)
- partnership for the distribution of the service
- real estate partnership for the space and not the vertiport itself

I: Will the operators' activities, resources and partnerships vary when serving a different use case?
E5:
- Infrastructure, resources are exactly going to be the same
- The use case does not matter
- Operations might be more or less profitable but the costs are going to be exactly the same

---

Interview – E6 – 01.04.22

I: Which UAM use case will be the first to take off?
E6:
- Connection between central business district to the airport
- Before that connection between regional hubs outside the controlled airspace or on its edge
- Most value is expected to come from the connection to the airport, but it is also the most complex with the most parties involved, a lot of regulation and safety requirements

I: Which market player is most likely to undertake operations for that use case?
E6:
- The infrastructure provider such as Skyports would be a good example, they own the infrastructure and operate the service as well
- The operator could also be one of the manufacturers while Skyports is just owning the infrastructure
- Some manufacturers want to built the infrastructure, the vehicle and operate it
- An operator can also be completely independent and typically will be because when rising complexity it is better to focus on one
- Commercial airlines are in the long term also potential operators, after collecting knowledge and experience and acquiring smaller companies
- In the near term new entities will be the real driving force between and around UAM

I: What is the special customer value proposition?
E6:
- Time saving and convenience of location
- Travelling to the airport
- Quick and efficient transport

- Reliable and safe
- Reducing congestion, reductions of emissions and environmental benefits
- Operator supports passengers to travel between different locations
- Arrange and organize full trip for passengers

I: Which are the most important activities of the operator to secure safe and efficient operations?
E6:
- Ensure a safe environment at the vertiport
- Monitor wind conditions in local environments
- Monitoring the airspace and present rules and stakeholders
- Conduct quick and efficient flight planning
- Track the vehicles
- Arrange tactical and dynamic deconfliction with all technology
- Integrating and sharing data between air space users
- Contact with traffic management and conduct fleet management
- Submit flight request to the routing platform

I: Which key resources does the operator need to operationalize this use case?
E6:
- Human staff at each vertiport
- Maintenance staff
- Pilots in each vehicle, later less pilots with improving automation
- Air traffic controller
- Communication with other airspace users to keep everything safe

I: Which partnerships are essential for the operator?
E6:
- Outsourcing of staff to other entities, compared to airports
- Partnership with commercial and service level kind of relationship between the different operators but also vertiport providers
- Partnership with big parent body like CANSA or EASA that controls everything and creates standards

I: Will the operators' activities, resources and partnerships vary when serving a different use case?
E6:
- From a service provision standpoint it is quite consistent to fly and operate safely
- Important is to have the right data, the ability to share data and to operate the airspace
- So overall they will be the same, operations will just become more complex and the same problems have to be solved more often per day

Interview – E7 – 01.04.22

I: Which UAM use case will be the first to take off?
E7:

- There is a real case and a project as well as the political will from the French government to activate the airport shuttle in two years from now
- It will be a prototype but it is going to be an airport shuttle from the airport to the Olympic village
- After that the airport shuttle will connect the airport with a few defined vertiports inside cities

I: Which market player is most likely to undertake operations for that use case?
E7:

- It is not going to be classical airlines
- The manufacturer will be the operator, they intend to produce and operate at least for the initial phase
- Having one company simplifies the interaction and interfaces
- From the business side it might be complicated to able to provide a perfect service in all domains

I: What is the special customer value proposition?
E7:

- Connection between cities which are 200 to 300 kilometres apart, as soon as battery power will improve the rang will also improve and a faster connection will be offered
- Easier connection to reach one part of the city
- Offer a safe and reliable system

I: Which are the most important activities of the operator to secure safe and efficient operations?
E7:

- Activities are very similar to those done by normal other commercial operations
- Security of vertiports within cities might be different
- Exactly the same activity like other airlines have in place today
- Making sure the aircrafts is in safe conditions before take-off
- Normal maintenance before and after each flight
- Ensuring that the pilots have the right competencies
- Identify the metrological condition and other sources of problems of the area of take-off and landing
- Operation planning

I: Which key resources does the operator need to operationalize this use case?
E7:

- Safe pilots and safe aircrafts
- The resources are related to the service and how it is organized

I: Which partnerships are essential for the operator?
E7:

- It will depend on the inhouse and outsourced activities
- Partnerships to integrate metrological information inside cities and lower level of airspaces
- Partnership for the management of take-off and landing at vertiports

- Partnership with the producer of the vehicles to make sure that the vehicle is in safe conditions to fly and in order to inform the manufacturer in case of risks or problems

I: Will the operators' activities, resources and partnerships vary when serving a different use case?
E7:
- No, because it needs to be a safe flight, with safe operations by a skilled pilot

---

Interview – E8 – 04.04.22

I: Which UAM use case will be the first to take off?
E8:
- Leisure case in tourism, specific transportation for specific purposes
- It will be an iterative manner, where special operations will add and add an add and a new situation will become normal
- In New Zealand and Lake Takahoe you can fly around the lake in a Wisk eVTOL
- In Paris, Volocopter and connecting the airport and different Olympic sights
- The airport shuttle is a very valid case, because passengers can be efficiently channeled from longer destination to short destinations and flights

I: Which market player is most likely to undertake operations for that use case?
E8:
- The separation between the operator, the service provider and the technical provider or vehicle provider is not so clear
- In the beginning we will not see a differentiation between the OEM, the operator and the service provider
- There will come a point where these functions will separate in the future

I: What is the special customer value proposition?
E8:
- Not sure what the value proposition is going to be
- Seamless integration into other means of transportation is a winning service, meaning transferring to a bike or taxi or something else
- USP will be in time and speed in terms of transportation
- The differentiation between the different type of travelers, e.g. business travelers, luxury travelers are by the design of the hangars or waiting areas and to offer different solutions and shopping opportunities at the vertiport
- This will also be an additional mean of transportation in urban areas which benefits by time and efficiency compared to other ground means of transportation

I: Which are the most important activities of the operator to secure safe and efficient operations?
E8:
- Maintenance, repair and overhaul tasks
- Integrating and organizing the customer journey through an app or desktop version
- Option to book a flight for passengers
- Receiving wind and terrain information
- All information need to be integrated into the operating system and provided in some way to the customers

- Ground handling activities at the vertiport, including cleaning the vehicle and guiding the passengers to the vehicle, providing security installations and all other ground handling activities
- Receiving permission and flight clearance and connecting to the ATC

I: Which key resources does the operator need to operationalize this use case?
E8:
- MRO staff with certifications
- Low budget people to do the cleaning and filling up and ground handling
- Precise digital and IT knowledge to combine the technical needs and the customer
- New infrastructure on the ground which is integrated into new buildings or equipping existing infrastructure with charging technology
- Batteries and energy

I: Which partnerships are essential for the operator?
E8:
- Partnership to have a connection to the vertiport, to be integrated into the infrastructure just like at an airport
- Partnership/good relationship with the ATC
- Connection with the OEM to integrate the operators need into the vehicles in advance

I: Will the operators' activities, resources and partnerships vary when serving a different use case?
E8:
- They will change dependent on the use case
- There will be no one fits all solution or one fits all partner
- The geographical separation is the reason, the EASA, FAA, CAC pave the way in their geographical jurisdiction

---

Interview – E9 – 04.04.22

I: Which UAM use case will be the first to take off?
E9:
- The connection between the airport and a destination within the city in a metropolitan area where there is a lot of traffic, like Sao Paulo or another huge city

I: Which market player is most likely to undertake operations for that use case?
E9:
- Helicopter operators are the closest, from their business model
- Has not heard of any helicopter operator embracing the topic
- Also airlines and airports are potential operators as a strategic opportunity

I: What is the special customer value proposition?
E9:
- Time saving
- More direct transportation with less often required changes of transportation
- Less of a hustle compared to normal airlines
- Faster than travelling with an airplane

- Less waiting times, because eVTOLs are like a shuttle service, similar to a scheduled train

I: Which are the most important activities of the operator to secure safe and efficient operations?
E9:
- Operations will be about scale and efficiency
- It is key to control the costs, this depends a lot on the image of eVTOLs in public
- The main activities are related to the safety of the infrastructure and operations
- Reliability is also very important to customers and for operation
- The reaction in case of disruptions and the right handling of passengers

I: Which key resources does the operator need to operationalize this use case?
E9:
- Infrastructure, because there is not sufficient infrastructure existing at the moment
- Human resources, ultimately less than a commercial airline because of the smaller dimension of eVTOLs
- Electricity, because society is increasing its need for electricity

I: Will the operators' activities, resources and partnerships vary when serving a different use case?
E9:
- Infrastructure is really going to be a challenge, this is going to be the main bottleneck for operations, especially with scale and rising complexity
- In regards to resources, it will be the same with electricity

---

Interview – E10 – 04.04.22

I: Which UAM use case will be the first to take off?
E10:
- Offer an eVTOL service for customers to complete their journey, eVTOLs then replace conventional helicopters and beyond what they can do
- Second use case is to service remote/island communities, where transport links are difficult and where there is infrequent airline service
- Third use case is the transfer of organ transplants across the city or regionally, so medical use case
- Another use case is for travel and tourism, to connect to resort hotel in for example Seychelles where eVTOLs would be an alternative to seaplane or boat
- Helicopter tours in cities are more quite, sustainable and enjoyable than with a conventional helicopter

I: Which market player is most likely to undertake operations for that use case?
E10:
- We will be a significant aircraft operator (private aviation company)
- The group of company has decided to operate eVTOLs, just not under which brand yet
- They have private aviation companies, helicopter operators in various cities and countries
- Maybe Joby, lilium or vertical will also operate eVTOLs

I: What is the special customer value proposition?
E10:

- Speed and not waiting for other people
- Sustainability
- Accountability of corporate clients for their carbon offsetting
- Image of innovation and pure interest from customers to experience the service
- Access for transport links to remote communities
- Transform the safety of the helicopter industry

I: Which are the most important activities of the operator to secure safe and efficient operations?
E10:

- Training and utilizing a pilot
- Choosing suitable pilots (competencies, trainings, backgrounds, new category of pilots?)
- Training of ground crew
- Engineering support (spare parts, regular and on demand maintenance)
- Having the infrastructure
- Controlling operating conditions
- Overall activity is to ensure safety

I: Which key resources does the operator need to operationalize this use case?
E10:

- A lot of cash and funding
- The team is resource one (and their experience and commitment)
- Pilots

I: Which partnerships are essential for the operator?
E10

- Partnerships are going to be key for a majority of operators
- It will vary, some operators want to own and do it themselves
- The majority will not be able to that in every location
- Partnerships similar to commercial airlines will be key

I: Will the operators' activities, resources and partnerships vary when serving a different use case?
E10:

- The partnerships will depend on the different use case
- The activities, resources and partnerships will vary depending on the use case
- There is a difference between remote communities and remote locations then in comparison to locations near cities

Interview – E11 – 06.04.22

I: Which UAM use case will be the first to take off?
E11:
- When talking about passenger transportation, it will be a urban use case
- So flying within the city from point A to point B because these vehicles are in the market closest to certification
- Inner city routes are shorter and require less advanced battery technology in the beginning

I: Which market player is most likely to undertake operations for that use case?
E11:
- The manufacturers of the aircrafts will also be the operators to gain experience and to make sure that certain standards are rolled out
- The OEM will try to integrate everything from the beginning
- Over time I expect that to change with scale
- The OEM will stay involved in operations, maybe with partnerships

I: What is the special customer value proposition?
E11:
- Easier and faster connection
- Independent of ground traffic
- Availability and predictability
- Time saving, especially for businessperson with short turnaround times
- High speed connections to areas where currently none exist

I: Which are the most important activities of the operator to secure safe and efficient operations?
E11:
- Pretty similar to an airline today but on a different scale and level
- OEM are basically building airlines inside their companies, based on the existing regulations
- Maintenance of the aircrafts (light, regular checks)
- Coordination on the vertiport
- Crew planning and crew training
- Flightpath and aircraft planning
- Pilots with the right training and licenses
- Flight scheduling and dispatching
- Ground handling and ground support
- Maneuvering of eVTOLs at the vertiport (charging position/landing position/parking position)
- Battery handling
- Customer service (greeting, answering questions, helping with check in and other hospitality services)

I: Which key resources does the operator need to operationalize this use case?
E11:
- Aircrafts
- Pilots
- Additional human resources (dispatchers, ground staff and so on)
- Energy

- Infrastructure with power supply, access and availability of it

I: Which partnerships are essential for the operator?
E11:
- Partnerships are not essential for the operator
- It is important to procure the services, they don't want to do
- It is unrealistic for the urban air mobility company (OEM) to prosper if they want to do everything themselves, that will require a lot of funding
- Partnerships for pilot training and maintenance
- Most companies will start with an integrated approach where the operator does many tasks along the value chain themselves and that will be handed over to partners with scale at a later stage

I: Will the operators' activities, resources and partnerships vary when serving a different use case?
E11:
- They are going to be quite similar
- There should be synergies across all of these because the aircarafts are similar
- There are not much variation between regional and urban air mobility
- Partnerships will be very similar

Interview – E12 – 07.04.22

I: Which UAM use case will be the first to take off?
E12:
- Replacing of helicopters, transfer and transport of people between gas platforms or mining sites
- Connection of location with geographical boundaries, such as connecting islands with the mainland or in a more luxurious environment the city of New York with the Hamptons
- the airport shuttle is going to generate a lot of traffic
- airlines could sell the airport shuttle as a bundle with their first-class ticket

I: Which market player is most likely to undertake operations for that use case?
E12:
- airlines will be the operators, either operating them themselves or operated by a subsidiary
- oil and gas operators have also placed orders to replace their existing expensive helicopters
- Joby and Volocopter want to own the entire value chain and operate themselves
- Vertical and eve air mobility follow the more traditional approach with just manufacturing and leaving the operation to airlines
- Therefore, it depends on the OEM what trend they want to follow

I: What is the special customer value proposition?
E12:
- It is for people with high value of time
- For people who need to commute longer distances every day
- For people who are willing to spend a bit more to save 2 to 3 hours a day

- Connect urban areas and enable people to live further away outside the city and still be well connected to workplace in the city

I: Which are the most important activities of the operator to secure safe and efficient operations?
E12:
- Maintenance
- Piloting of aircrafts
- Own the security elements
- Share necessary information with passengers
- Accompanying the passengers to the aircraft

I: Which key resources does the operator need to operationalize this use case?
E12:
- Training for the pilots
- Human resources (customer service agents, light maintenance agents, operational schedulers) in a sense similar to a traditional airline to make the operation work
- Energy supply / power

I: Which partnerships are essential for the operator?
E12:
- Partnership and integration with an airline to provide a seamless transfer
- With other modalities such as ground transport
- Partnerships are incredibly important initially
- With scale it will be less about strategic partnerships and more about having the ability to integrate with other systems

I: Will the operators' activities, resources and partnerships vary when serving a different use case?
E12:
- The biggest driver will be the overall maturity of the industry
- As the industry matures and more stuff gets outsourced to third parties, I am expecting that the mission complexity is going to increase.
- With increasing complexity, it will become more difficult to integrate with each other
- A big driver for partnerships is going to be way to integrate with each other
- In the beginning they are going to be very similar

Interview – E13 – 08.04.22

I: Which UAM use case will be the first to take off?
E13:
- Single use case from the airport to a city center because range limitations all OEMs have with their vehicles
- It will be rather short distances than long distances, about 20 kilometers long

I: Which market player is most likely to undertake operations for that use case?
E13:
- The OEMs will do it themselves to prove their case and show that it is working and safe
- And afterwards other operators will enter the field, I expect airlines to be at the forefront

I: What is the special customer value proposition?
E13:

- Flexibility for the overall consumer
- The product is not clear from the customer perspective
- It would make sense to connect different transportation modes with each other
- Time saving through integration with other modes of ground transportation
- Seamless customer journey by having one ticket for an intermodal trip and by combining different tickets from different providers and then included in the overall mobility ecosystem

I: Which are the most important activities of the operator to secure safe and efficient operations?
E13:

- Maintenance of vehicles on a regular basis and after each flight
- Pilots on board with sophisticated processes for recruitment and screening
- Training for pilots
- Reduction of noise compared to conventional helicopters to create a safer feeling for the passenger when travelling with this vehicle

I: Which key resources does the operator need to operationalize this use case?
E13:

- Access to power and electricity
- Human staff (engineers, customer facing flight attendants)
- Logistical set up for luggage handling
- Data from all kinds of perspective from the customer but also flight data

I: Which partnerships are essential for the operator?
E13:

- With vertiports
- With airport providers
- Logistical company to handle the luggage issue (when it cannot be transported on the eVTOL)
- With MRO company

I: Will the operators' activities, resources and partnerships vary when serving a different use case?
E13:

- They will be slightly different
- Partnerships might vary to regional air mobility
- But the rest like maintenance is always the same

Interview – E14 – 09.04.22

I: Which UAM use case will be the first to take off?
E14:

- Airport shuttle will be the attractive use case, in about 3 to 4 years from today
- Especially in Europe where there are many airports, such as in London
- It takes passengers about one hour to get to the airport, this could really be in makret in London or New York for example

I: Which market player is most likely to undertake operations for that use case?
E14:

- Possibly OEMs step into the role of fleet operators
- I am not sure because of the risk perspective of having the manufacturing risk as well as operational risk
- OEMs might be the quick win
- In the second step we will see airlines such as Azul or Japan airlines to step in even though we have not seen them in Europe so far
- Hopefully there will be commercial airlines to do that
- Or alternatively private jet companies
- In general the ecosystem will be similar to civil aviation with airlines, airport operator and other parties such as service providers

I: What is the special customer value proposition?
E14:

- Speed by enabling quicker connections between point A and point B
- This is especially interesting in urban areas with a lot of traffic jams ir no connected railway station
- So eVTOL are a more convenient form of transportation
- It is also less crowded than in trains, and therefore more private and exclusive

I: Which are the most important activities of the operator to secure safe and efficient operations?
E14:

- Terminal operations and airside operations
- Ensure safety on the vertiport
- Ground services and ground operation procedures
- Building appropriate infrastructure to handle the passenger process (weight check, luggage check, security checks, food and beverages)
- Maintenance
- The operator is responsible for the eVTOL and its operation in the air and possibly on the ground

I: Which key resources does the operator need to operationalize this use case?
E14:

- Financial capability and liquidity to build the infrastructure on the ground and to be able to operate the infrastructure while it is not profitable
- Available space
- Human staff for low cost OPEX operations

I: Which partnerships are essential for the operator?
E14:

- Holistic approach with all ecosystem partners interacting with each other
- Energy supplier
- Vertiport operator and provider

I: Will the operators' activities, resources and partnerships vary when serving a different use case?
E14:
- From the vertiport operators' perspective, it doesn't matter which use case is served
- There are not going to be big differences in the network design and route design

---

Interview – E15 – 08.04.22

I: Which UAM use case will be the first to take off?
E15:
- In the beginning these vehicles will connect existing platforms, e.g. airfield and platforms for helicopters. They will play a crucial role in the development of this new form of mobility
- These will be similar to helicopter operations
- Airport shuttle plays a crucial role due to its potential

I: Which market player is most likely to undertake operations for that use case?
E15:
- It is not going to be today's helicopter operators
- I would expect companies like Tesla or apple to go into this market

I: What is the special customer value proposition?
E15:
- Time saving and connectivity on short to medium distances
- Cost savings through cheaper prices for the customer
- Fast point to point connection
- Time is absolutely money for some customers

I: Which are the most important activities of the operator to secure safe and efficient operations?
E15:
- Organization of the customers trip from point A to point B, from the airport to the hotel

I: Which key resources does the operator need to operationalize this use case?
E15:
- Human resources
- The equipment and assets
- Infrastructure
- Huge batteries with significant power stations and energy
- Acceptance of the passengers to travel in autonomous systems (in terms of safety, reliability and in case of emergencies)

I: Which partnerships are essential for the operator?
E15:

- The helicopter companies and line charter operators hold basic b2b relationships and do not need partnerships
- Some of them maintain partnerships with business jet operators

I: Will the operators' activities, resources and partnerships vary when serving a different use case?
E15:
- I think it will change because new partners will come into play and operators will need new partners in the value chain

---

Interview – E16 – 11.04.22

I: Which UAM use case will be the first to take off?
E16:
- In the short term because infrastructure is already in place, it will be the connection of airports with each other
- An influence will have the fact if the airport has a connected train station
- And secondly the connection of region to region or remote location A with remote location B

I: Which market player is most likely to undertake operations for that use case?
E16:
- The operator is going to operate the vertiport just like an airport operator today
- Airports will take the role of being the vertiport operator
- But that is not exactly the same as a vehicle operator
- The vehicle operator will be the OEM initially
- In the long-term commercial airlines will be the vehicle operators
- In Europe and the US a few airports are interested to extend their real estate and because it allows them to have a new form of revenue model and attract new customers
- The OEMs will want to keep everything within their control and at a later stage the existing aviation industry will step in and take a prominent role

I: What is the special customer value proposition?
E16:
- Connection and new way of transport for difficult areas with limited access
- Time saving through new connections
- It is a way for rich people to be different and for showing off

I: Which are the most important activities of the operator to secure safe and efficient operations?
E16:
- The vertiport operator does not have responsibilities during flight procedures
- Vehicle operator:
    - Clearing of landing pads of obstacles
    - Enabling booking for passengers
    - Embarking and disembarking passengers
    - Charging or battery swapping
    - Vehicle maintenance
    - Ground handling operations

    - Luggage, passenger checks
    - Landing and taking off procedures
    - Contact with airspace integration and ATC close to airports
    - Flying the vehicle

I: Which key resources does the operator need to operationalize this use case?
E16:

- Vertiport
- Vertiport manager who is managing two to three vertiports
- Ground handling people for security and customer service
- Other human staff and vehicles

I: Which partnerships are essential for the operator?
E16:

- Real estate investors
- Good relations with municipalities and local governments
- Infrastructure manufacturers
- Regulatory bodies
- Other investors
- Pilot training

I: Will the operators' activities, resources and partnerships vary when serving a different use case?
E16:

- Differences between airport shuttle and regional air mobility use case are not that large
- Other use cases such as medical use case need a little bit of adaption