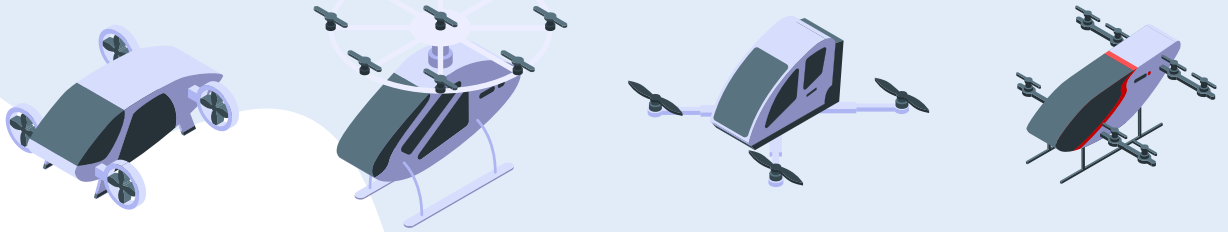


BroadBranch Advisors

Opportunities and challenges for the emerging flying taxi market

Entering a new market or deciding to invest in it requires careful consideration of the various external forces impacting the industry. A helpful strategy tool to conduct such an analysis is the PESTEL analysis which looks at Political, Economic, Social, Technological, Environmental, and Legal factors. This tool allows decision-makers to carefully consider the rank of issues & challenges in a market but is not meant to provide a recommendation on whether or not to invest in a business or to enter a market rather it aims to highlight the factors that any actors should consider and address when making a decision. It is especially useful when exploring a nascent industry.

While most people are familiar with helicopters, these aircraft are probably closer to scaled-up versions of small drones with multiple rotors providing lift.

Flying Taxis

A recent emerging industry that is rapidly developing is the market for urban air transportation. Science fiction fans will agree that one of the most commonly used tropes for a futuristic environment is the flying car. Be it in The Jetsons or in classics like Blade Runner, flying cars have been used by filmmakers as a tool to communicate to the viewer that they are watching a scene set in the future. Instead of spending time on clogged-up roadways, occupants could be whisked away in comfort and speed to their destination by weaving through futuristic-looking skyscrapers.

Air taxis have now become a very real possibility. Recent technological advancements have made eVTOLs (electric Vertical Take off and Landing) aircraft possible. Many companies are racing to be the first to offer autonomous eVTOL aircraft and air traffic services in what promises to be a disrupting and potentially lucrative market.

e-what?

But what exactly is an eVTOL? As the name suggests, eVTOLs are aircraft powered by electricity that take off and land vertically (like a helicopter). While most people are familiar with helicopters, these aircraft are probably closer to scaled-up versions of small drones with multiple rotors providing lift. Their size and take-off/landing capabilities make eVTOLs perfect candidates for short trips in environments with limited space and high ground traffic congestion or large obstacles (e.g., rivers).

Close to 200 companies worldwide are currently in the process of developing eVTOL aircraft . Design approaches differ, but many companies are using what is called a tilt-rotor concept, while others, like Eve, use two different sets of motors and rotors. Yet another approach uses many ducted fans built into an articulating wing (e.g., Lilium).

Companies are paying particular attention to the noise these aircraft will generate since the majority of eVTOLs are being conceived for the Urban Air Mobility (UAM) market. The concept of UAM, which is defined by the FAA as “a safe and efficient aviation transportation system that will use highly automated aircraft that will operate and transport passengers or cargo at lower altitudes within urban and suburban areas,” envisions large urban landscapes with the necessary infrastructure to support eVTOL operations which will reduce ground traffic congestion.

PESTEL

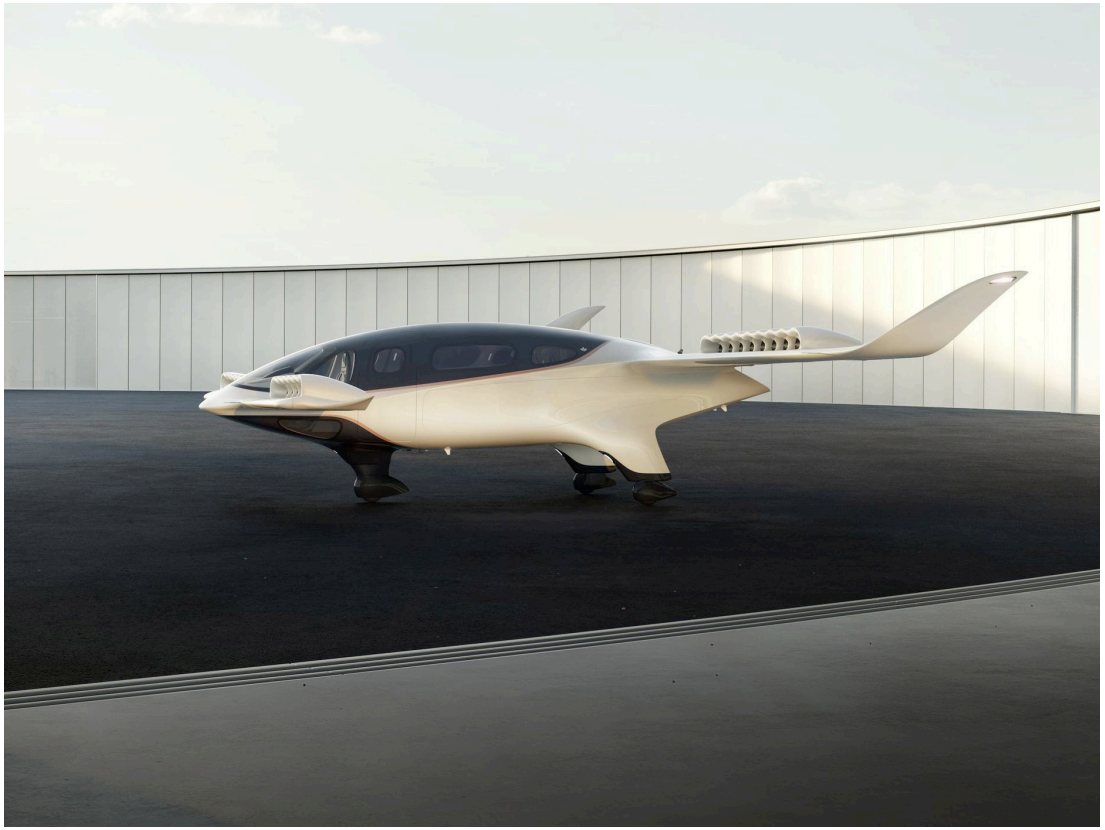
Emerging technologies like eVTOLs are exciting, but the long-term widespread adoption of any technology is not necessarily guaranteed. eVTOLs, like any disrupting technology, will face headwinds and challenges. The PESTEL analysis is by no means exhaustive but is meant to illustrate the wide range of challenges and opportunities that affect this budding industry.

Political

UAM and eVTOLs redefine the concept of urban transportation and, therefore, urban planning. For a UAM program to be successful, decisions about infrastructure investment, construction permits, licensing, etc., will have to occur on the local & regional government level. While federal regulators have been working hard on developing new standards and guidelines for eVTOLs and UAM (see Legal), many local governments have yet to develop any plan.

Planning for a new mode of infrastructure is challenging and brings with it a lot of unknowns, but city planners can orient themselves by looking at cities or regions like New Jersey and Los Angeles which have already developed UAM visions and concepts.

While decisions for planning are made on the government level, a coordinated approach to planning between regulating agencies, manufacturers, operators, and the public is essential for the successful rollout of UAM.



from Lilium

Economic

Like all new technologies, eVTOLs will likely follow the standard technology adoption cycle starting with early innovators using the technology at a high cost before it becomes more mainstream. Initially, eVTOL flights will exert a premium price well beyond the means of the majority of the population (similar to taking a conventional helicopter ride).

To lower costs and ticket prices, economies of scale can help. Airlines like United and Delta have invested in eVTOL programs at Joby and Archer Aviation and will be able to not only bring substantial aircraft operating experience with them but, far more importantly, they will be able to provide a pool of passengers to ferry for feeder flights to and from airports.

Even though the vision for UAM using eVTOLs foresees autonomous flight, passenger operations in the first years will certainly require the presence of an operating pilot to reduce risk. Qualified pilots are expensive, and taking up 20% of a five-seater eVTOL passenger capacity will contribute significantly to high operating costs.

As one engineer working on eVTOL puts it, "It will kill that industry if they have an incident like the Uber self-driving car incident in Arizona. Safety will be a key issue." Companies cannot afford to wait until a fully autonomous operation is viable "Players who wait for autonomous aircraft will simply run out of capital".

Given these financial risks and challenges, eVTOL operators may opt to hedge their bets and explore other non-passenger revenue flights. Beta Technologies' eVTOL aircraft is specifically designed to provide cargo operations, which may be easier to launch as a service due to a lower regulatory burden and higher load revenue density.

All these strategies, however, will have to deal with a problem that already challenges existing air

from Beta Technologies

transportation, namely the tight and complex labor market for certified pilots. Aircraft operators are already experiencing a shortage of qualified pilots for existing operations. This shortage is likely to persist for some time, and training new pilots requires years of training and certifications. This factor alone remains a substantial risk to the viability of the eVTOL industry.

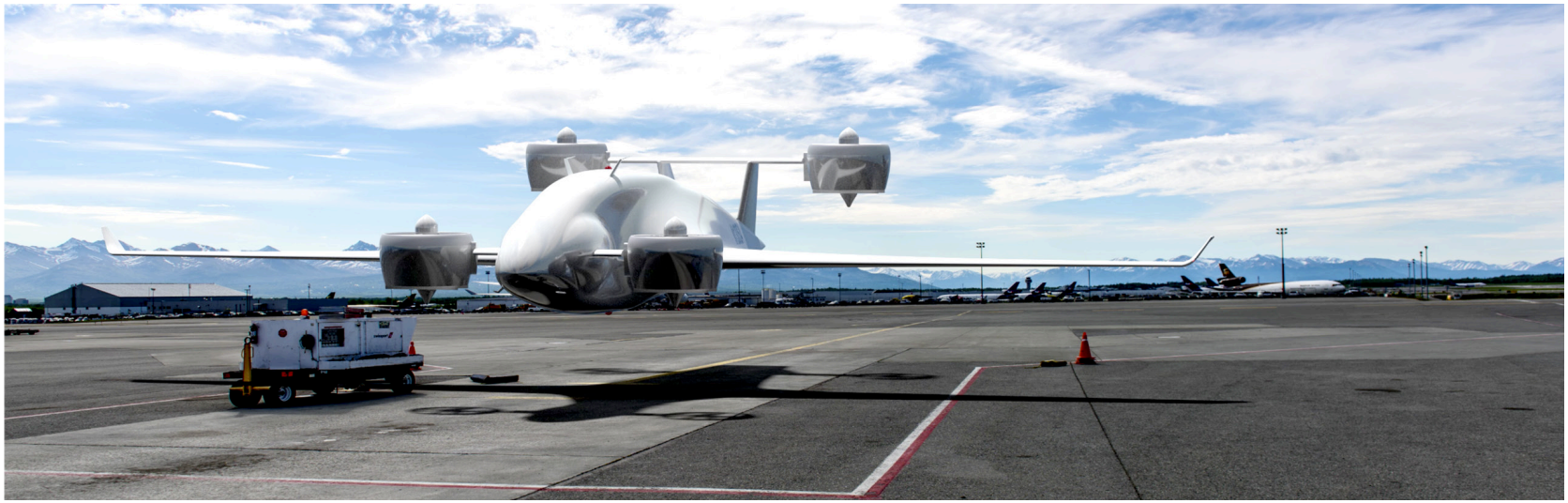
Societal

If the eVTOL manufacturers are to be believed, eVTOLs will usher in an era of profound transportation improvement, making it easier for consumers to get to their destination. Traffic congestion will become a thing of the past as more and more consumers take to the sky. The reality is, however, more tricky.

eVTOLs affect a variety of stakeholders who won't necessarily directly benefit from their deployment. Externalities such as increased air traffic noise, real estate usage, traffic to and from heliports, and privacy concerns will affect everyone in the flight path and regions served by eVTOLs. Managing societal acceptance of eVTOLs will therefore be key to their success.

UAM operators will need to work with the public to fight "nimbyism" and listen to its concerns to avoid opposition that will hinder the adoption of UAM. Only if the public

from Volocopter



from [Sabrewing Aircraft Company]

accepts and understands the benefits of UAM will its use in large urban environments be possible.

Technological

Compared to conventional aircraft, eVTOLs (autonomous or not) have posed significant technological challenges to designers.

To qualify as an eVTOL, the aircraft must use electricity for its propulsion. The electricity can be produced through a turbine system or provided through batteries. While battery technology has greatly improved over the past years with the rising popularity of electric cars, even modern batteries are notoriously heavy. This may not affect cars that remain grounded, aircraft are substantially more impacted by the additional weight. As conventional aircraft use up fuel, their weight decreases, which increases the aircraft's efficiency. Batteries do not add this benefit and therefore pose a real challenge to payload limitations. Increasing battery density is, therefore, a key challenge that the industry is working to solve.

An alternative to battery-powered aircraft is the promise of hydrogen fuel cell powered aircraft (or a hybrid), which companies like HyPoint are developing. Unlike batteries, fuel cells generate electricity through a chemical reaction between hydrogen and oxygen. Fuel cells promise a much higher power density per kg of weight compared to batteries, but they are not without challenges. First, a

separate infrastructure providing hydrogen and oxygen will be required at landing sites to refuel fuel cell-powered eVTOLs. Second, fuel cells generate heat, and aircraft designers will need to devise clever and efficient ways to cool the system without adding weight to the aircraft.

Environmental

From an environmental perspective, eVTOLs promise a welcome change to the often maligned aviation sector, which still relies on burning large amounts of fossil fuel. Provided that the electricity being used to charge eVTOLs is produced sustainably, eVTOLs have a very real potential to offer a carbon-neutral option for air transport.

Given that the UAM scenario foresees them operating in urban areas, the potential for noise disruption will need to be addressed. As an employee of the FAA puts it:

> There is considerable regulatory risk. The FAA may not move fast enough, and it has no incentive to do so. Many companies can and will go bankrupt during the time to certification.

"The biggest source of aircraft pollution is actually noise. Aircraft are loud."

To address the concern of noise pollution, eVTOL manufacturers are making strides too. One German company, Volocopter, has placed a bet to focus on reducing noise. A researcher from the University of Pennsylvania who BroadBranch spoke with recently noted, "Their design is meant to be used in urban areas, they have lowered acoustic pollution way below that of a helicopter. At 120m above ground, the noise is about 65 decibels, or about the level of a normal conversation."

Legal

In order to be successful in the long term, eVTOLs will need to operate safely and securely. eVTOLs will be subject to strict regulations and safety requirements. As the governing body for aircraft regulation and safety, the FAA has begun issuing rules and guidelines that will govern future eVTOL operations.

The biggest requirement for any eVTOL to fly and take on passengers is its airworthiness certificate. Receiving this certificate is no small task. eVTOLs are an entirely new aircraft type, and the FAA generally takes between 5 and 9 years to certify the airworthiness of new aircraft types. As the head of policy for one eVTOL manufacturer puts it: "The biggest obstacle we currently have is the FAA

certification. We are going through the process of getting our aircraft certified. Once that is done, the rest of the pieces will fall into place." At the time of writing, no eVTOL has been issued their certificate by the FAA. However, people familiar with the matter expect the first type of certification to be completed by 2024.

"There is considerable regulatory risk. The FAA may not move fast enough, and it has no incentive to do so. Many companies can and will go bankrupt during the time to certification", noted a product manager for an eVTOL Manufacturer backed by a large automobile company. He also noted that second movers would have an advantage over the first movers who invested in building out the regulatory frameworks, " Second movers can just watch it all unfold and then make a decision," they add.

In terms of clear guidelines, the FAA is working on establishing industry standards. In September 2022, the FAA released a guideline for vertiport (vertical takeoff and landing stations) design, and it has committed to releasing an eVTOL implementation plan by May 2023. But even with the definition of new airspace rules and standards for eVTOLs, the FAA will still need to integrate them into the existing Air Traffic Control (ATC) resources to ensure a safe and seamless operation which can take time.

To circumvent uncertainty, some companies like Sabrewing have chosen an approach that will ensure they operate under current certification requirements and airspace rules using turbine-driven cargo aircraft (albeit not electric), which is in contrast to the approaches of other manufacturers.

from Wisk

Strategic Approach

There is no doubt that eVTOLs and UAM will be here to stay in the near future. But, like other new technologies, the success criteria are still being developed. Some early movers may have an advantage as they can define an industry standard; however, second movers may benefit by learning from first-mover companies' mistakes and waiting for industry regulations to become clearer.

It is, therefore, important for eVTOL manufacturers and operators to carefully consider the approach to rolling out eVTOLS. Companies with large investment backing may feel pressure to launch their vehicles as soon as possible.

One of the key criteria will be to launch any UAM program in a region with large urban sprawl. Key strategic markets are countries like Japan, China, and South Korea, as well as urban areas in the U.S. like Los Angeles, Dallas, or New York City. Regulatory openness and low governmental opposition of a region to UAM is also an important factor. Companies should take advantage of existing UAM visions drafted by early-moving cities (e.g., Los Angeles) rather than wait for a national framework or standard to develop.

The success of the initial eVTOL roll-out will be crucial in determining its societal acceptance and economic feasibility. Companies should focus on serving areas with as much pre-existing infrastructure as possible (e.g., airport feeders) to keep initial investment to a minimum. Operators may also choose to "de-risk" their operations by launching a freight/cargo operation before they expand into passenger transportation.

In conclusion, the eVTOL technology space and UAM market are exciting new opportunities to consider, which offer the potential for a paradigm shift in urban transportation and new revenue opportunities for the aviation industry. But, like any pilot will tell you, it is vital to go through a checklist that covers major areas of risk before you take off to avoid a crash. The eVTOL industry decision-makers are well advised to follow that approach.

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