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eVTOLs: Time for Asian Militaries to Take a Closer Look?

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SYNOPSIS

Commercial deployment of eVTOL aircraft is expected to commence in the next few years though it will be some time before we see high-volume eVTOL operations in urban environments. Such vehicles are expected to serve a number of niche, low-volume use cases in the initial years, including as a premium transportation service, for B2B logistics and for emergency response. As commercial deployment begins, it is an opportune time for Asian militaries to consider how they can tap on the technology.

COMMENTARY

Last month, US-based Joby Aviation announced that it would provide up to nine of its electric vertical take-off-and-landing (eVTOL) aircraft to the US Air Force under a contract, with the first two to be delivered by early 2024. These will likely be the world's first eVTOLs to be delivered to a military establishment. US military pilots have already piloted, in-person and remotely, eVTOLs from companies like Joby and Beta Technologies in test flights.

eVTOL: A Technology whose Time has come?

The buzz over eVTOLs is escalating. Several players expect to have their eVTOLs certified for commercial operations by the US Federal Aviation Administration and the European Aviation Safety Agency in the next 1-2 years. This includes Germany's Volocopter, which flew the world's first inner-city eVTOL flight over Singapore's Marina Bay in 2019 and plans to launch commercial services in Paris in time for the 2024 Olympics.

Demonstrating market confidence in the technology, major aviation players like United

Airlines, American Airlines and Virgin Atlantic have placed pre-orders with eVTOL original equipment manufacturers (OEMs). Brazil's Eve Air Mobility, an Embraer spin-off, has pre-orders worth more than US$8 billion for over 2,700 of its Eve aircraft, while the UK's Vertical Aerospace has more than US$5 billion in pre-orders for over 1,400 of its VX4 aircraft. The 10 most well-funded eVTOL OEMs have raised more than US$7 billion to date.

Remember the Jetsons?

Many may remember the "flying cars" in the 1960s American TV animation series *The Jetsons* or in movies like *Blade Runner*. We are close but not quite there yet, at least not in terms of the futuristic "anti-gravity" engines their fictional cars have. eVTOLs, the "flying cars" of today (also sometimes called "air taxis"), are expected to provide a new mode of emission-free aerial mobility via propeller or jet engines and come in various form factors.

Currently, there are multicopter eVTOLs (e.g., from Volocopter), which are like helicopters but with more propellers. Another type are the tilt-rotor eVTOLs (e.g., from Joby), where after take-off, the propulsion systems are rotated to provide forward thrust (like the V-22 Osprey). Yet another are the lift-and-cruise eVTOLs (e.g., from Beta Technologies), where a set of propellers provides upward thrust and another set of propellers provides forward thrust.

Most are designed to carry between two to seven people, including the pilot, although there are some eVTOLs designed for one such as Singapore's Neo Aeronautics Crimson S8. Fully charged, most can travel between 30 to 250 km, with tilt-rotor and lift-and-cruise eVTOLs having much longer range compared to multicopter eVTOLs.

The main technical constraint remains battery technology, which limits range, endurance and payload capacity, as well as the ability to fast charge (to allow quick turnarounds for the next flight). The industry nonetheless anticipates that the current specifications would suffice for a range of use cases, even as further improvements in battery technology are expected.

Most eVTOL OEMs are working on the premise that eVTOLs will be piloted at first (whether in-person or remotely), with the long-term aim of removing the pilot altogether (i.e., autonomous flight) for operating and cost efficiency. For now, several eVTOLs from companies like Joby can already be remotely piloted, although remote pilotage in urban environments is still warily regarded by regulators.

Autonomous flight is sometime away, given the need for eVTOLs to be equipped with sensors and systems like those of autonomous vehicles, for which the technologies are not yet mature, as well as have access to secure low-latency, high-data rate connectivity. The Unmanned Air Systems Traffic Management (UTM) systems capable of coordinating such flights are also currently under development.

Commercial Use Cases and Challenges

While the eventual aim is for eVTOLs to serve as "air taxis" for everyday commuters, the initial civilian use cases will likely be for niche, low-volume use cases such as

sightseeing flights, transportation services for premium customers, and emergency response.

It will be some time before we see high-volume eVTOL operations in a congested urban environment, given that the concept of operations, air traffic management solutions and regulations needed to manage many hundreds or thousands of eVTOLs flying concurrently in urban airspace are still being developed. In the interim, eVTOLs are expected to use the regime for helicopter flights, which is designed to handle low-volume flights.

Regulators and the public would need some time to become comfortable with high-volume eVTOL operations, from the safety and security (especially with remotely piloted or autonomous flights), noise (eVTOLs will be quieter than helicopters but will still emit noise) and even visual pollution (i.e., eVTOLs blotting out our view of the sky) perspectives.

Moreover, it would take time for high-throughput ground infrastructure – the “vertiports” where eVTOLs would pick up and drop off passengers, recharge or swap out their batteries – as well as the necessary communication architectures and networks to be developed, and even for charging infrastructures to be standardised.

Recognising this, OEMs are exploring cargo variants to serve business-to-business (B2B) logistics as well as military (and government) applications to expand the range of use cases. B2B cargo haulage, as opposed to passenger operations or business-to-consumer deliveries, over more limited routes will likely be more easily accepted by regulators. Similarly, the risk appetite of militaries will be different, given their area of operations (AOs) and use cases, with US military airworthiness approval already granted to several players.

Military Applications of eVTOLs

Many industry players and experts see eVTOLs to be ideal for militaries, which largely operate in non-urban AOs and less congested airspace. Military use cases include personnel transport, resupply, search and rescue and medical evacuation, including high-risk missions where unmanned eVTOLs mean humans are not put at risk.

Like helicopters, eVTOLs can take off and land vertically without the need for a runway, but the use of electric motors and smaller rotors make eVTOLs stealthier compared to helicopters, which is important for military missions. Zero-emission eVTOLs also check a box at a time when sustainability is a key focus for militaries.

Notably, eVTOLs are expected to be less costly compared to helicopters and other transport aircraft like the V-22, both in terms of capital as well as operating costs. The initial unit cost already appears to be lower compared to helicopters, and this is expected to come down further when the commercial market scales.

On the operating cost front, eVTOLs are less complex with fewer moving parts, which make them more reliable and easier to maintain. Electricity from the grid is also much cheaper compared to aviation fuel.

However, there are operating constraints such as eVTOLs' limited range and endurance (less than half of helicopters) and the difficulty of charging or swapping batteries in challenging field environments. Until these constraints are alleviated, there may be some limitations in the missions eVTOLs can perform.

That said, some OEMs have already designed eVTOLs with hybrid powertrains to alleviate range and endurance limitations (but with trade-offs such as in terms of aircraft complexity and operating costs), and battery technology is expected to improve in coming years. eVTOLs are, in any case, not meant to fully replace helicopters; they simply give militaries more operational options for short-to-medium range missions.

Seeing the potential, the US Air Force has already spent over US$100 million since 2020 as part of its Agility Prime programme to explore how it can tap on commercial eVTOL technology. As commercial deployment begins in the next few years, it is an opportune time for Asian militaries to consider whether they can also do so, including how eVTOLs can feature in their force design and acquisition choices given the operational, cost, sustainability and other advantages.

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