Chapter 5

Urban Air Mobility:
A Paradigm Shift in Intelligent Transportation

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ABSTRACT

Urban air mobility (UAM) vehicles have the significant potential to transform urban transportation in many countries by allowing unrestricted movement within city airspace. However, implementing them presents numerous challenges, including the need for adequate infrastructure, navigating regulatory frameworks, reducing noise pollution, ensuring safety and reliability, addressing public perception and acceptance, promoting energy efficiency and sustainability, integrating with existing transportation systems, managing costs and affordability, and assessing environmental impact. Additionally, the advancement in Urban Air Mobility requires contributions from multiple engineering fields, such as aerospace engineering, electrical and electronic engineering, and IoT/AI. This chapter provides an overview of the key factors in implementing UAM, following a brief introduction. The chapter mainly focuses on the current developments reported in recent articles published between 2016 and January 2024.

1. INTRODUCTION

Later, in the early 20th century, inventors conceptualised plane cars for urban air transportation. Inventors, engineers and industrial designers have always visualised a future for flying cars (Pukhova,

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2021; Cohen, 2021). For example, From 1947 to 1971, helicopters were used to shuttle passengers and mail across numerous destinations within the Los Angeles basin(i.e. Disneyland and Los Angeles International Airport) by Los Angeles Airways (Harrison, 2017). Moreover, the VTOL technology-based air taxis are already in the innovation trigger phase (based on Gartner's Hype Cycle) (Straubinger et al., 2020). Urban Air Mobility (UAM) is envisioned to provide inter- and intra-urban transportation in an air taxi or ride-sharing service over congested urban areas using small air vehicles (Straubinger, 2020; Stouffer, 2021). However, owing to the current battery capacity constraints, intercity will become feasible in the following decades (Garrow et al., 2021). UAM is an on-demand aviation that can be utilised as an air taxi. The electric vertical take-off and landing (eVTOL) aircraft plays a significant role in the urban air mobility concept. In addition, in recent decades, the significant development in communications, sensors and data analytics, and power electronics, combined with substantial cost reductions due to the availability of high-performing commercial of-the-shelf components, have paved a smooth path for the practical feasibility of the concept of urban air mobility (Shamiyeh et al., 2017). It is advantageous over the existing transport solutions. Firstly, the travel time can be reduced as they can avoid gridlock and overfly obstacles. And secondly, the costs can be reduced too. These vehicles use electricity instead of fuel, reducing the energy cost compared to fuel-burning vehicles (Brown & Harris, 2020). In recent decades, the world's busiest metropolitan cities have been increasingly burdened by crippling traffic congestion. Without appropriate intervention, this trend is poised to escalate dramatically in the near future, exacerbating an already dire situation. Developing Urban Air Mobility solutions emerges as a promising remedy to combat the relentless growth of traffic congestion (Ploetner et al., 2020). In addition, As urbanisation accelerates, projections suggest that by 2050, over 70% of Europeans and more than 80% of North Americans could reside in urban regions (Pons-Prats et al., 2022). Hence, UAM attracts considerable interest and investment from industry (i.e. aeronautics and automobile pioneers, new start-ups, etc.) and government agencies. From an economic perspective, a recent leap in technologies like electric propulsion and battery storage has significantly impacted the evolution of UAM technologies (Thipphavong et al., 2018). More than 2 Billion USD were invested in the industries that are designing the eVTOL (Garrow et al., 2021). In addition, different configurations or designs of eVTOL-type aircraft were tested in global countries, including India, the USA, France, Singapore, and New Zealand. Models like Airbus-Vahana, Volocopter2x, and Cora are already in the testing stages of well-known companies like Airbus, ZEPHYR Airworks, and VOLOCOPTER GmbH.

A Significant aspect of UAM involves transferring flight-controlling/manoeuvring duties from human pilots to newly developed and advanced autonomy. Over a hundred UAM vehicles are currently in development or production. Most aim for fully autonomous vehicle operations, although fully autonomous flying cars are not anticipated immediately (Battiste & Strybel, 2023). It is designed to be safe, eco-friendly, and easily accessible within cities, serving passengers and goods, including emergency services. NASA researchers have outlined various potential applications for aerial services under UAM, including on-demand air taxi services, air cargo transport, an airborne equivalent of a metro system, emergency response operations, news coverage, and monitoring traffic and weather conditions (Ditta & Postorino, 2023). One important topic discussed is the need to plan out where to build vertiports for UAM services, which are crucial for flying vehicles to take off and land and to figure out the best places for vertiports (Wu, Z et al., 2021). The noise footprint caused by UAM and vertiports plays an essential role in the early stage (Yunus et al., 2023). Integration of UAM with existing transportation options is also critical. According to the urban transportation strategies and multi-modal initiatives, the UAM initiative will be a potential solution to ensure user-centric services and high-speed mobility (Pons-Prats et al., 2022).