

## Analyzing the Barriers of Adopting Air Taxis in Emerging Economy Context: A Decision-Making Framework

**Tahseen Arshi**

School of Business,  
American University of Ras Al Khaimah, UAE.  
E-mail: [tahseen.arshi@aurak.ac.ae](mailto:tahseen.arshi@aurak.ac.ae)

**Vaishali Agarwal**

Department of Marketing,  
Institute of Management Studies (IMS) Ghaziabad-B School,  
Ghaziabad, 201009, Uttar Pradesh, India.  
E-mail: [vaishali.agarwal@imgzb.ac.in](mailto:vaishali.agarwal@imgzb.ac.in)

**Naveen Virmani**

Department of Operations Management,  
Institute of Management Studies (IMS) Ghaziabad-B School,  
Ghaziabad, 201009, Uttar Pradesh, India.  
E-mail: [naveen.virmani@imgzb.ac.in](mailto:naveen.virmani@imgzb.ac.in)

**Gaurav Saxena**

Ramcharan School of Leadership,  
Dr. Vishwanath Karad MIT World Peace University, Pune, Maharashtra, India.  
*Corresponding author:* [gauravsaxena.gs2@gmail.com](mailto:gauravsaxena.gs2@gmail.com)

**Dimple Bhandari**

Department of Production,  
Hero MotoCorp, Gurugram, Haryana, India.  
E-mail: [bhandari.dimple04@gmail.com](mailto:bhandari.dimple04@gmail.com)

(Received on August 21, 2025; Revised on January 6, 2026 & February 7, 2026; Accepted on February 28, 2026)

### Abstract

In today's scenario, air taxis are getting lot of traction due to number of potential advantages. Since the concept is relatively new in the market, and there are various challenges along the path to the adoption of air taxis. Therefore, the study first explored the challenges using the scholarly literature and categorized them according to the Technological, Organizational, Environmental, and Human (TOEH) framework. It shows that urban air mobility (UAM) deployment in India faces several challenges, including unclear regulations and infrastructure, unclear business models, and public reluctance due to safety and cost concerns. After identifying the challenges, the study employed the Interpretive Structural Modelling technique to develop a hierarchical framework of the challenges. Further MICMAC analysis was applied to categorize the challenges into autonomous, linkage, independent, and dependent categories. The results show that most barriers fall under the linkage category, and regulatory and legal ambiguity have the highest driving power. The study results add to the existing literature by establishing a structural relationship among the anticipated barriers. Also, the results will help practitioners develop strategies to overcome the challenges with relative ease.

**Keywords-** Air-Taxi, TOEH, ISM, Barriers, MICMAC.

## 1. Introduction

The growing crowd and traffic have prompted significant improvements in urban transportation (Raza et al., 2025). Enhanced urbanization, increasing population density, and traffic intensity have pushed existing road networks to their limits (Takacs & Haidegger, 2022). The resulting surge in road traffic has led to increased mobility challenges, including air pollution and congestion (Zhang et al., 2025). Various countries around the world are making significant efforts to adopt air taxis (Naveen et al., 2024). With growing pressure, electric vertical take-off and landing (eVTOL) vehicles, commonly known as air taxis, have emerged as a solution (Rohrmeier et al., 2025). The air taxis are both futuristic and increasingly feasible in the coming times (Pak et al., 2025). It offers faster, cleaner, and more efficient modes of transportation than traditional cars and buses (Ahmed et al., 2024; Tripaldi et al., 2025; Wang & Qu, 2023).

Several nations are building Urban Air Mobility (UAM) by investing heavily (Spühler et al., 2025). UAM can disrupt urban transportation (Garrow et al., 2021). A few pilot initiatives for air taxis are already underway in cities such as Paris, Dubai, and Singapore (Cohen & Shaheen, 2024). However, India, considered the most crowded country, has yet to make tangible progress in this area (Ahmed et al., 2024). Air taxis would be highly beneficial for India; however, they remain a dream (Yan et al., 2024). The reason for its delayed adoption is not an inability or lack of ambition, but rather deep-rooted hindrances arising from technology, the existing regulatory framework, and public perception (Takács & Haidegger, 2022).

The use of eVTOLs as an alternative to traditional vehicles is a potential solution, and several private companies are keen to invest in them. There is limited literature about the systematic barriers that could overcome the adoption of air taxis (Krylova, 2022). The existing literature focuses on the technical feasibility of deploying air taxis; however, other relevant factors are not adequately addressed (Di Vito et al., 2025). Also, the existing studies have not considered the challenges unique to a country like India, given its social, economic, infrastructural, and regulatory landscape. Thus, a fundamental theoretical framework is required to analyse the barriers of air taxi from diverse perspectives, such as institutional and human factors.

Air taxis offer a transformative solution to the growing traffic problem, particularly in India's metropolitan cities. Metropolitan cities are experiencing severe traffic congestion (Shkera & Patankar, 2025; TomTom, 2023). Travel time both between and within cities can be reduced effectively with the adoption of air taxis. It offers a point-to-point aerial mobility as an alternative to the on-ground traffic. The adoption of air taxis will lead to job growth, new business models, and novel aerospace technologies in this field. Air taxis can help in enhancing digital and smart mobility. It will help create a modern, sustainable, and efficient transportation system that meets the needs of the rapidly growing business landscape.

Rapid urbanization, growing population density, and traffic bottlenecks are accentuating pressure on India's urban transportation systems. According to the TomTom (2023), cities such as Delhi, Mumbai, and Bengaluru are consistently among the most congested in the world. The average in-city daily commute time is more than an hour (NITI Aayog, 2021). Air taxis are a vertical, congestion-free alternative to traditional ground infrastructure (Eve, 2022; Tripathi et al., 2022). It reduces travel time significantly. The need is even greater at present because India's urban population is expected to grow to more than 600 million by 2031 (MoHUA, 2022). Also, Bauranov & Rakas (2021) stated that air taxis will help close the mobility gap by enabling smooth, point-to-point travel and reducing surface traffic and emissions. It is possible with the effective utilization of VTOL technology and electric propulsion. The Indian government's policies, such as the National Electric Mobility Mission, focus on smart and sustainable mobility. It also makes UAM solutions more important for improving urban mobility and boosting economic productivity.

The Indian government has taken several initiatives to promote UAM. It demonstrates its potential to encourage green transportation, ease in-city traffic, and generate innovative ideas in the aerospace industry. The MoCA released Drone Rules 2021, which added flexibility to the rules for unmanned aircraft systems and set the stage for air taxi operations (MoCA, 2021).

Governments around the world are increasingly emphasizing UAM. Also, there is growing concern about reducing carbon emissions, which requires alternative ways to get around. The U.S. Federal Aviation Administration (FAA) has begun implementing the Advanced Air Mobility (AAM) plan. This plan lays out a step-by-step plan for adding air taxis to the national airspace by the middle of the 2030s (FAA, 2023). The UAE, especially Dubai, has partnered with companies like Joby Aviation and EHang. The Dubai Civil Aviation Authority's air mobility roadmap (DCAA, 2023) will help them start commercial air taxi services by 2026. According to its K-UAM Roadmap, South Korea plans to fully deploy UAM by 2035, with smart vertiports and 5G-enabled traffic control (MOLIT, 2022).

India needs a comprehensive UAM vision to mitigate this policy gap. It should encourage coordination among many stakeholders and include aerial mobility plans for smart city infrastructure. This study develops the Technology Organization Environment Human (TOEH) framework, an extension of the well-known Technology Organization Environment (TOE) model formulated by Tornatzky and Fleischer (1990). The utilization of the TOE model to examine innovation adoption across several industries is illustrated in the literature. The additional dimension of "Human" enables a more nuanced understanding of air taxi adoption. The TOEH model encompasses not only systems and structures but also perceptions, fears, trust, and concerns (Vongvit et al., 2024). This perspective is particularly important in India, where different cultural values, concerns about safety, and differences in wealth can significantly influence how individuals adopt and use air taxis. Therefore, the research questions are stated as follows:

RQ1: What are the critical barriers of adopting air taxi?

RQ2: How can the TOEH framework help us group these barriers in a useful way?

RQ3: How to develop a structural hierarchical framework among air-taxi barriers?

The remaining sections are discussed as follows: next Section 2 presents literature review followed by research methodology in Section 3. Then, case illustration is discussed in Section 4. The second last section presents discussion and managerial implications. Lastly, conclusion, limitations and scope of future work are presented.

## **2. Literature Review**

### **2.1 TOEH Framework for Adopting Air-taxi**

Urban Air Mobility (UAM), such as electric vertical take-off and landing (eVTOL) passenger aircraft or air taxis, is a potential way to relieve urban congestion. Due to increasing travel demand and congestion in road networks (Ahmed et al., 2024; Spühler et al., 2025), air taxis are being scaled up in urban transportation systems in megacities, especially in developing economies such as India.

First, this paper explored barriers to adopting air taxi using the Technology Organization Environment Human (TOEH) framework; for this, scholarly research articles were reviewed from reputed databases like Scopus and Web of Science. Tornatzky & Fleischer (1990) introduced Technology Organization Environment (TOE) Model is used in variety of applications developing model for smart ecotourism villages (Hande & Aslan, 2026), analyzing strategy for blockchain technology adoption (Alnoor et al., 2025), assessing critical success factors for digital transformation (Zhong et al., 2025), and examining green

innovation perspectives (Lou et al., 2025). Therefore, this research identifies barriers in the TOEH domains of air taxi adoption, synthesizing knowledge from classic adoption theories and current UAM research.

## 2.2 Barriers to Air-Taxi Adoption

The barriers are bifurcated into four categories i.e., technological, organizational, environmental and human.

### 2.2.1 Technological Barriers

Technological barriers relate to the safety, reliability, and technical feasibility of air taxi systems (Di Vito et al., 2025; Raza et al., 2025). UAM technology is still maturing, and several key barriers remain to be addressed (Ahmed et al., 2024). It is important to look at safety and reliability in vehicles. To comply with the high safety standards regulators, require, stakeholders will have to meet stringent certification requirements (Spühler et al., 2025). Also, Al Haddad et al. (2020) considered perceived safety a key factor in driving adoption intentions among potential users. Technical reliability considerations — particularly system redundancy, avionics robustness, and emergency handling capability — affect the observed level of safety. Cohen & Shaheen (2024) identify the potential challenges of UAM includes passenger mobility and affordability, visual disturbances, noise pollution, range anxiety, increased aircraft activity over residential areas, safety & certifications, traffic management issues, technical & operational concerns.

UAM technology has proved to be well ahead of the curve; however, it is still burgeoning and faces considerable challenges (Ahmed et al., 2024). A study by Bhaduri & Choudhury (2026) found that people in the USA and Australia are more opinionated about urban air mobility. In contrast, in Germany and India, public discourse is somewhat neutral. Stringent safety standards are required for air taxis to gain public and regulatory confidence (Spühler et al., 2025). Also, Tripaldi et al. (2025) noted that current eVTOL concepts are constrained by aerodynamic and battery limitations. Apparently, the issue of air taxi routing viability concerns limited battery capacity for flight distance and payload (Wang & Qu, 2023).

Furthermore, noise reduction technology is essential for the commercialization of air taxis (Tian et al., 2018). Without silent propulsion technologies, it might be harder for the government and communities to accept and approve. There is still an issue with high-frequency rotor noise, even though electric propulsion is often quieter than helicopter propulsion. For example, Korean research suggested that when noise levels are too high, people are less likely to consider air taxis (Yan et al., 2024).

Most countries lack the technical capacity for UAM. For take-off, landing, and recharging to operate efficiently, new infrastructure in the form of vertiports (urban sky ports) needs to be built. Building vertiports in dense cities, however, has its own challenges from an urban planning and technological perspective. Senthilnathan et al. (2025) analyzed optimal facility location in the USA using a hybrid genetic algorithm (GA)- based metaheuristic-simulation, with various parameters including population density, road accessibility, distance to subway stations, and distance to bike stations. It will help facilitate sustainable UAM and create a positive ecosystem by minimizing emissions and congestion. Another study by Hagspühl et al. (2025) used choice-based optimization to plan an airport shuttle network in Munich, Germany. It concluded that vertiports must be meticulously designed at appropriate locations to maximize travel time savings.

As for low-altitude airspace, Yan et al. (2024) points out that UAM depends heavily on the right vertiport networks and modern air traffic control (ATC) systems. The country's crowded cities and slow infrastructure development make it particularly difficult to build vertiports with safe approaches in India. Also, there are legitimate concerns regarding the UAM technology's readiness from weather and climate

perspectives. Some conditions that could hamper eVTOL operations include extreme heat, low visibility, or heavy rain — all common in many Indian cities. Therefore, several technical challenges remain to be addressed before we see air taxis in use, even with recent eVTOL progress. Among them, we need to ensure safety, improve battery and vehicle performance, reduce noise, integrate infrastructure and air traffic control systems, and protect against adverse weather conditions.

### **2.2.2 Organizational Barriers**

Among the biggest challenges to launching an air taxi service are the high costs of getting started and the uncertainty about its return on investment. The cost of R&D makes electric vertical takeoff and landing (eVTOL) aircraft prohibitively expensive. Moreover, the customers' ability to pay for it is an important factor in the introduction. According to Sadrani et al. (2025), investment risk is quite significant, suggesting the difficulty of obtaining long-term financing when returns are uncertain. Particularly in nascent UAM markets, companies and investors are hesitant to invest in projects with limited prospects for profitability. Also, Senthilnathan et al. (2025) noted that although air taxi adoption is gaining traction, research on service operationalization is limited. The authors applied the clustering large applications (CLARA) method to evaluate key solutions to infrastructure problems in the USA. They concluded that the optimal number of operating stations is five, with an average customer time of 32 minutes and a waiting time of 13 minutes per customer.

Additionally, there is a lack of collaboration among the wide range of actors involved in urban mobility (i.e., transport authorities, energy providers, city planners, service providers, and manufacturers). Another obstacle companies face is bringing all stakeholders together to collaborate. It would require cooperation among Indian commercial tech entrepreneurs building eVTOL prototypes, as well as numerous government agencies, including the civil aviation authority and the ministries responsible for urban development. Moreover, there are currently no operational rules that set a limit on how much luggage a passenger can carry.

### **2.2.3 Barriers to the Environment and Regulations**

The lack of well-established UAM regulatory frameworks is befuddling in this sector (Di Vito et al., 2025). Each nation's aviation standards seldom cover the innovations introduced by air taxis, including the ability to fly independently in overcrowded urban airspace and the creation of vertiport infrastructure (Cohen & Shaheen, 2024). On a global scale, efforts to develop eVTOL certification standards are underway. According to Raza et al. (2025), air taxis need to obtain certification for legal operation.

The rules on urban zoning, the placement of vertiports in cities, air-taxi pilot certification, and the autonomy and control of low-altitude air traffic are moving slowly. There are major issues with regulatory uncertainty (Yan et al., 2024). Regulatory issues are the biggest hurdle to achieving an integrated air space distribution and traffic control. Unlike ground vehicles, air taxis must operate in the same airspace as planes, drones, and helicopters (Cohen & Shaheen, 2024). For safety compliance, regulators will limit operations by air taxis on the basis of instructions received from air traffic control, which involves robust automation and digital coordination (Raza et al., 2025).

Limited space availability poses problems in designing and developing the vertiports infrastructure. According to Yan et al. (2024), vertiports themselves can be sensitive; conflicts in land and location perspectives may arise if they are not carefully placed. Strong urban planning and coordination and cooperation between public bodies and the private sector are crucial if land is to be made available for developing vertiports and connected with existing transportation centers in Indian settlements (for example, airports or metro stations).

It is observed that noise was a significant concern that reduced the acceptance level of UAM (Spühler et al., 2025). There are also questions related to environmental deficits. Although the electric air taxis themselves are not causing any pollution during operation, their net effect on global warming depends on power sources and energy intensity during their production (Wang & Qu, 2024). Additionally, the public or policy makers perception is that due to high cost, elite people can only avail this facility (Cohen & Shaheen, 2024).

### 2.2.4 Human Related Barriers

Zhyriakov et al. (2025) discussed that occupants’ safety is of utmost importance in Urban air mobility. Also, the authors discussed the mechanics behind the spinal cord and suggested ways to enhance impact resistance. Also, Papenfuss et al. (2025) discussed that customer trust and perceived ease of use impact intentions to use air taxi. Also, it is highly important to assess the revenue-generating capacity of air taxi, which ultimately decides whether air taxi is feasible or not. Reimer et al. (2025) applied design thinking and a user-centred approach in enhancing urban air mobility and highlighted the relevance of awareness in enhancing its acceptance among customers. Bhaduri & Choudhury (2026) applied large language models for analyzing public perception of adopting urban air mobility. The authors conducted a cross-country investigation, including various clusters: cluster 1- USA and Australia; cluster 2- UK & Canada; cluster 3- India; cluster 4- Germany. It was concluded that stakeholders must pay utmost attention to public acceptance, trust, and safety parameters for the successful adoption of air mobility.

The TOEH barriers are discussed in **Table 1**.

**Table 1.** TOEH view of air taxi adoption barriers in India.

TOEH View	Notation	Barrier	Description	References
<b>Technological</b>	B1	Airspace Management & UTM	Lack of UAV Traffic Management (UTM) systems causes concerns over safety and routing.	Baum (2021)
	B2	Technological Immaturity	Lack of technological maturity in eVTOL designs: battery performance, redundancy, weather adaptability.	Altouq (2024)
	B3	Cybersecurity and Data Vulnerability	Hacking threats to global positioning systems (GPS), flight management systems, and absence of real-time data pose safety issues.	Alqahtani & Kumar (2024)
<b>Organizational</b>	B4	High Capital Investment	Large investment in research and development, aircraft, and infrastructure with uncertain return on investment (ROI).	Goyal et al. (2021)
	B5	Fragmented Stakeholder Ecosystem	Lack of coordination between private firms, regulators, and city planners causes bottlenecks.	Expert Opinion
	B6	Absence of Operational Standards	No norms exist for training, airworthiness, service guidelines, or urban integration.	Budde et al. (2021)
	B7	Limited Urban Mobility Synergy	Lack of integration with existing public transport systems delays multimodal adoption.	Liu & Gao (2024)
	B8	Risk-Averse Organizational Culture	Aviation and transport organizations tend to resist unproven tech due to liability and stability issues.	Yoo et al. (2022)
<b>Environmental</b>	B9	Regulatory (Routing) and Legal Ambiguity	Regulators are ambiguous about low-altitude aviation, eVTOL classification, and permissions.	Ferrão et al. (2022)
	B10	Urban Density & Space Constraints	High population density and poor spatial planning restrict vertiport development.	Zhao & Feng (2024)
	B11	Noise Pollution and Public Opposition	Noise pollution can cause discomfort and health concerns.	Ferrão et al. (2022)
	B12	Climate Vulnerability	Subcontinent's extreme climate patterns make regular air taxi services challenging.	Ferrão et al. (2022)
	B13	Lack of Environmental Risk Assessment & communication	Absence of lifecycle impact assessments for batteries, noise, and emissions.	Mahashabde et al. (2011)

Table 1 continued...

<b>Human</b>	B14	Safety and Crash Concerns	Concerns over vertical takeoff/landing safety, bird strikes, and technical failure affect public confidence.	Tepylo et al. (2023).
	B15	Trust in AI/Automation	Low trust in air taxis, pilotless or semi-autonomous systems limits customer willingness.	Papenfuss et al. (2025)
	B16	Paying capacity of customers	Lower paying capacity hinders the adoption of air taxis	Expert Opinion
	B17	Awareness and Tech Literacy	Limited exposure to the concept of Urban Air Mobility among the Indian middle and lower segments delays mass adoption.	Al Haddad et al. (2020), Reimer et al. (2025)

### 3. Research Methodology

The presented research applied the Interpretive Structural Modeling approach to develop a structural hierarchical framework among barriers in the pathway of air taxi adoption. Gonçalves et al. (2025) applied the ISM technique to analyze factors impacting the resilience of small and medium enterprises (SMEs), thus enhancing value-based thinking. Another study by Roy et al. (2025) used ISM to analyze a resource-efficient circular supply chain and enhance sustainability and resilience. Since the adoption of any technology is subject to barriers, specifically during its initial phase of implementation. ISM helps to explore and investigate relationships among variables/criteria/enablers/barriers. Also, it facilitates listing down driving barriers that trigger others, as they have a significant impact on dependent variables. Thus, ISM helps to establish meaningful relationships among dependent and independent variables (Dohale et al., 2023). The steps involved in the ISM technique are as follows:

#### Step 1: Developing Self Structural-Interaction Matrix (SSIM)

Area experts having vast experience were consulted to develop SSIM using V, A, X and O symbols with the help of following rules. Let the row and column element be represented as (k, l).

V: if row element impact column element, A: if column element impact row element; X: if both row and column element impact each other; O: if neither row element nor column element impact each other.

#### Step 2: Developing initial reachability matrix

Symbols are replaced with 1 and 0 using the following rules:

If symbol is V, (k, l) element is replaced by 1 and (l, k) element is replaced by 0

If symbol is A, (k, l) element is replaced by 0 and (l, k) element is replaced by 1

If symbol is X, (k, l) element is replaced by 1 and (l, k) element is replaced by 1

If symbol is O, (k, l) element is replaced by 0 and (l, k) element is replaced by 0

#### Step 3: Developing final reachability matrix

This is developed using principle of transitivity, it implies that if element k impacts l, and l impacts m, then k also impacts m.

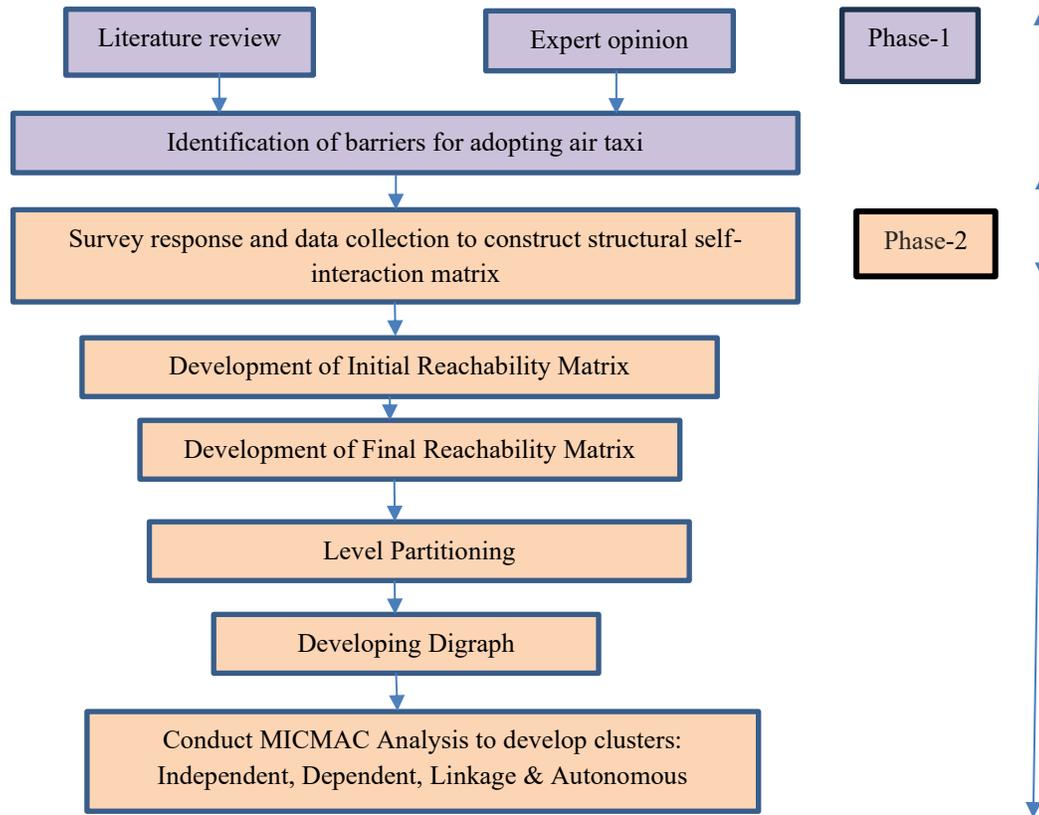
#### Step 4: Calculating driving and dependence power

Driving power is calculated by performing row sum, and dependence power is computed using column sum.

#### Step 5: Level partitioning

Level partitioning is done by using various iterations, where antecedent set, reachability set and intersection set are computed for each barrier. The barrier corresponding to which reachability and intersection set are

same, are assigned some level. Then, that barrier is removed from further iterations, and same steps are followed until all the barriers are assigned to some level. The research framework is shown in **Figure 1**.



**Figure 1.** Research framework.

#### 4. An Application

A case industry XYZ corporation is the leading airline industry in India's emerging economy. The company was founded in 2006 and is one of Asia's largest airline service providers. The market share of XYZ corporation is 61.6% and has more than 35000 employees. The company is well known for providing quality services to customers and has a state-of-the-art technological infrastructure with a turnover of 10 billion dollars. Also, the company is making strenuous efforts to bring air taxis into the market. The initial route will cover 27 kilometers in just 7 minutes, which usually takes ninety minutes.

Once the barriers were listed using a literature review, experts were asked to validate the barriers. Then, we developed a questionnaire. A pilot survey was conducted to ensure that respondents easily understood the questions. A total of 21 experts were contacted; all the experts had more than 15 years of experience and had a minimum bachelor's degree. The expert details are given in **Table 2**, and SSIM is developed and shown in **Table 3**. MICMAC Analysis is shown in **Figure 2**. Level partitioning is shown in **Figure 3**, where solid line arrows shows direct links, and dashed arrows shows transitive links.

**Table 2.** Expert details.

Expert code	Designation	Years of experience	Qualification
T1	Urban Air Mobility (UAM) Policy Expert	16.8	BTECH
T2	eVTOL Aircraft Design Engineer	17.2	BTECH+MTECH
T3	Aerospace Systems Engineer (Electric Propulsion)	19.2	MBA
T4	Aviation Safety & Certification Specialist	18.7	MTECH
T5	Flight Operations Manager (Advanced Air Mobility)	19.4	MTECH
T6	Civil Aviation Authority Official (UAM/eVTOL Division)	21.5	BTECH
T7	Air Traffic Management (ATM) Specialist	18.4	BTECH
T8	Aviation Regulatory Compliance Expert	17.8	BTECH
T9	Public Policy Advisor – Urban Air Transport	21.3	PhD
T10	Vertiport Infrastructure Planner	16.1	BTECH+MTECH
T11	Smart City & Urban Mobility Planner	18.9	BTECH
T12	Airport Operations & Infrastructure Manager	20.4	PhD
T13	Electrical Grid & Charging Infrastructure Expert	19.8	BTECH+MTECH
T14	Air Taxi Startup Founder / CEO	22.1	BTECH
T15	Advanced Air Mobility Program Director	23.7	BTECH+MBA
T16	Autonomous Systems & AI Specialist (Aviation)	24.9	BTECH
T17	Battery Technology & Energy Storage Expert	21.8	BTECH+MBA
T18	Aviation Economics & Business Model Expert	20.9	BTECH
T19	Environmental Impact & Noise Management Specialist	16.6	BTECH
T20	Public Acceptance & Transportation Behavior Researcher	17.9	BTECH+MTECH
T21	Risk Management & Aviation Insurance Expert	24.1	BTECH

**Table 3.** Self structural-interaction matrix.

Barrier	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	B17
B1	X	O	O	V	V	V	V	A	O	O	O	O	V	O	V	O
B2		X	V	V	V	V	V	A	O	A	O	V	V	O	A	V
B3			O	O	V	A	A	A	O	A	O	O	V	X	A	O
B4				O	V	A	A	A	O	A	O	V	A	O	V	O
B5					A	A	A	O	O	A	O	V	A	A	A	V
B6						A	A	O	O	A	O	A	O	A	A	O
B7							A	A	A	A	O	O	O	A	O	V
B8								A	O	A	O	O	A	A	O	O
B9									V	O	V	O	V	V	O	V
B10										O	O	O	O	O	O	O
B11											A	O	O	O	O	O
B12												O	A	A	O	V
B13													A	A	O	V
B14														A	A	V
B15															A	V
B16																A

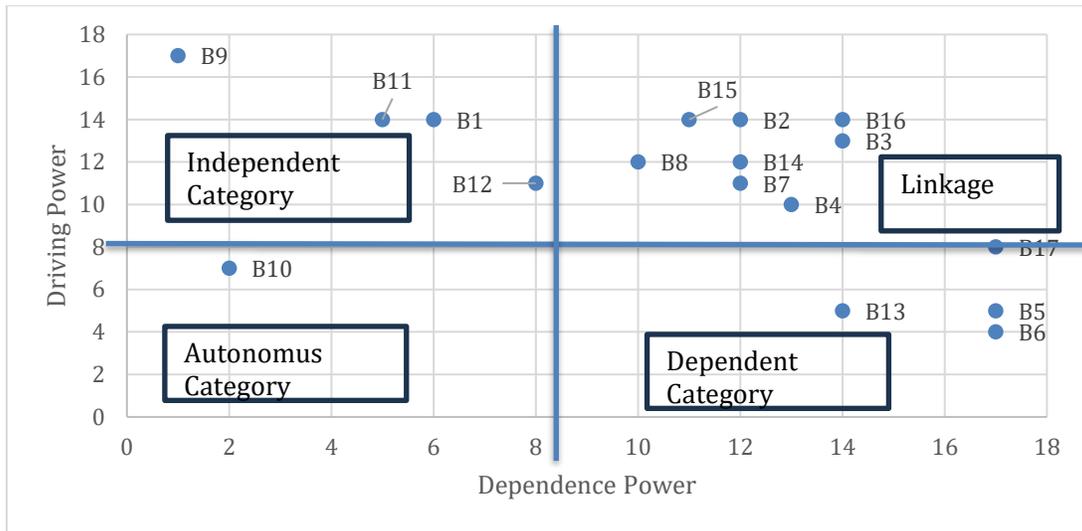


Figure 2. MICMAC analysis.

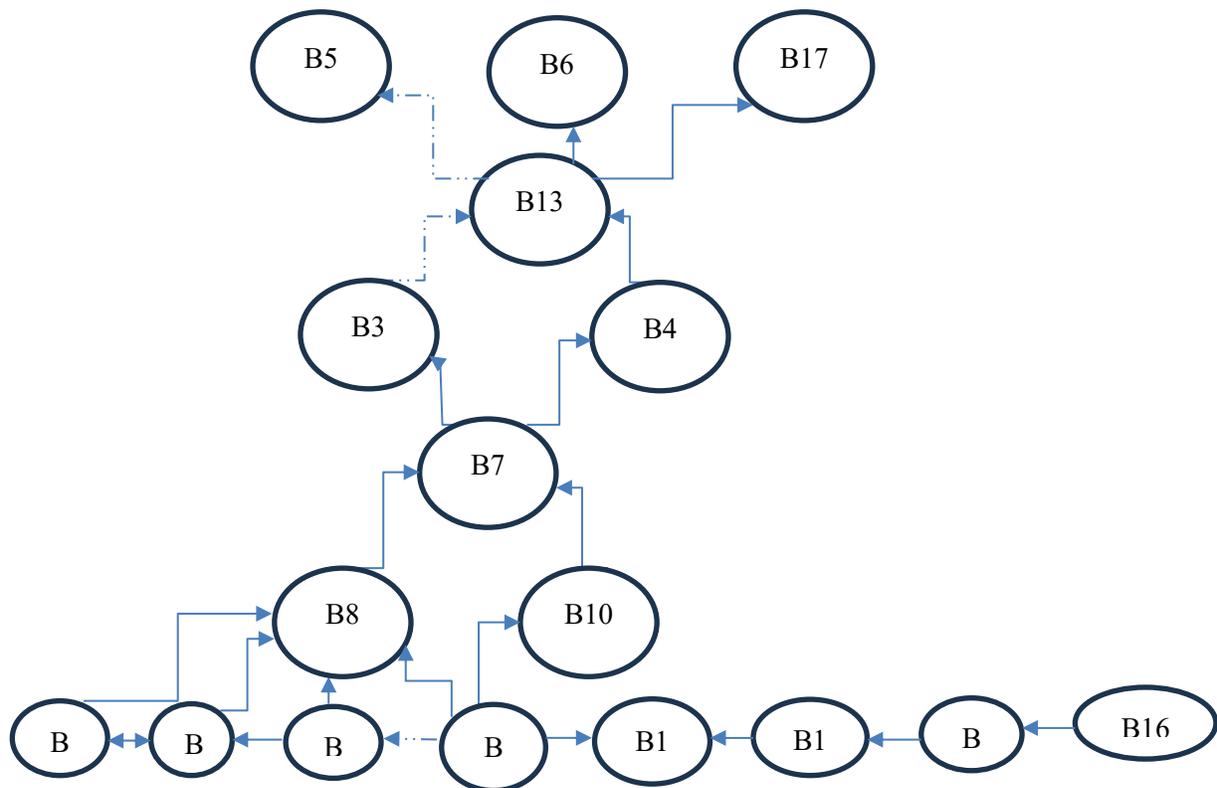


Figure 3. Level partitioning.

## 5. Discussion and Analysis of ISM-Based Model

The ISM Model used in the presented study helps to develop a structural hierarchical framework for analyzing barriers to adopting air taxis. Since integration of air taxis with other transport systems is subject to complexities, a multi-layered structural framework can help to understand the nitty-gritty and causal relationship among the anticipated barriers.

Fragmented stakeholder system (B5), absence of operational standards (B6), and awareness of tech literacy (B17)—barriers are positioned at the top of the hierarchy, which implies high dependence and low driving power. These are outcomes, not causes. Their placement suggests that unless foundational and institutional readiness is established, interventions targeting user behavior will likely yield limited results. Several studies have emphasized the importance of algorithmic transparency, pilotless demo acceptability, and pricing psychology in shaping user adoption of AI-based systems (Kim et al., 2022). These are organizational and human-centered constraints that represent institutional inertia and capability gaps. The absence of coordination across aviation authorities, urban development bodies, and innovators delays systemic alignment, a challenge mirrored in earlier mobility innovations like EVs and technology integration. Also, poor tech literacy among users and stakeholders hinders air taxi adoption.

A critical insight from the ISM model is the bridge role played by Lack of Environmental Risk Communication (B13), situated at the second level. This variable links foundational technology and regulation to downstream public behavior. Its classification as a dependent variable with strong links to environmental and human-centric factors underscores its systemic relevance. Insufficient risk assessment surrounding environmental impacts—noise, emissions, land use—leads to misperceptions and social rejection. Therefore, effective risk analysis is a critical conduit between infrastructural progress and community legitimacy. Since environmental monitoring depends heavily on real-time data, it needs to be taken care of with utmost care. Also, it is a matter of fact that risks pertaining to data impact the environmental assessment credibility. Also, due to the high cost of advanced technological systems, organizations usually take a step back to go for cost-intensive environmental risk assessments.

At the third level, we find Cybersecurity and Data Vulnerability (B3) and High Capital Investment (B4) high in driving and dependence power; hence, they are classified as linkage variables. These barriers are especially sensitive to the lower-layer enablers and, in turn, exert influence on organizational and environmental readiness. The threat of cyberattacks on autonomous aerial vehicles and their associated digital infrastructure poses security risks and affects public trust (Rice et al., 2022). Likewise, the capital-intensive nature of UAM infrastructure demands not just a large investment but a favorable cost-recovery ecosystem, which remains elusive in low-income segments.

Limited urban mobility synergy (B7) is positioned at the fourth hierarchy level. While regulatory and technological levers influence these, their implementation determines the systemic viability of air taxis in urban ecosystems. The lack of clear SOPs, route algorithms, and ATC integration mechanisms impedes safe fleet operations. Similarly, disconnects between first-mile/last-mile systems and UAM corridors reinforce a "technology-island" problem, where air taxis operate in silos without syncing with metro, bus, or EV networks.

The barriers placed as the foundational layer of the structure are placed at the fifth layer, such as risk-averse organizational culture (B8) and Urban density and space constraints (B10). The required conditions for air taxis include standardized vertiport architecture, electromagnetic shielding protocols, and integration with digital traffic systems. These conditions remain undefined in the Indian context. Another critical dimension

of environmental unpredictability posing operational uncertainty is due to India's diverse climatic zones. It ranges from dense fog to high wind variability (Tripathi et al., 2022).

Airspace management (B1), Regulatory and Legal Ambiguity (B9), Noise Pollution and Public Opposition (B11), and climate vulnerability (B12) lie at the foundational level, which are low in dependence but high in driving power. Lack of clear comprehension of propulsion process, battery range, and reliability impacts technology acceptance. Moreover, the presence of regulatory policies and technological guidance impacts investors' trust (Alqahtani & Kumar, 2024). The noise pollution and public opposition (B11) also act as a foundational challenge, directly impacting political and planning momentum. Previous research has found that low engagement and information asymmetries lead to public opposition to drone corridors or vertiports rather than inherent resistance to technology (Goyal et al., 2021). Thus, its location at the foundation of the ISM structure is validated as a critical initiation of ripple effects in public policy and communication.

ISM-based model analysis helps organizations to examine multiple layers of causality, technological, and regularity aspects that lay the cornerstone for achieving organizational coherence, sustainability, and user acceptance. Therefore, the analysis reveals how anticipated barriers do not function in isolation, but rather have strong interconnections with other barriers.

Policy makers and strategic planners must formulate standard regulatory policies, including traffic management and working protocols, that help the organizations in the quick adoption of air taxis. Since air taxis require a lot of investment and are at very early stages of deployment, proper research and development are required for smooth operationalization. On a societal level, a well-funded public communication strategy, along with pricing innovations like demand-based tariffs or public-private operating models, will be essential for achieving fair and widespread adoption.

## 5.1 Theoretical Implications

The identified barriers are supported by the TOEH framework and add significantly to the available scholarly literature by developing a structure and systematic hierarchical framework for analyzing air taxi adoption barriers. Using ISM and MICMAC approaches, the presented study unpacked the layered causality and analyzed the contextual relationships of barriers in the case of emerging economy perspectives. Managers can use the presented model to analyze the cascading impact of various influential variables impacting air taxi adoption; therefore, rather than testing them in silos, the combined impact can be better visualized.

Second, integrating ISM with MICMAC introduces a system thinking perspective that improves theorizing on barrier propagation in emerging economies. Moreover, unlike linear models, this approach shows that independent variables, like regulatory ambiguity and effective airspace management, inhibit adoption directly and impact middle-level barriers, including infrastructure planning and transformation. It further facilitates the need to view UAM adoption as a systematic, layered, and multi-stakeholder transformation instead of a user-technology transaction.

Lastly, identifying communication-related variables such as environmental risk perception (B13) and tech literacy (B17) as bridge constraints contributes to theories of technology legitimacy and innovation diffusion in high-stakes mobility ecosystems. These findings also expand diffusion theory by illustrating how legitimacy gaps are not found just on the demand side but emerge from weak upstream coordination between technology, policy, and communication systems.

## 5.2 Practical Implications

From a managerial standpoint, the ISM-based barrier structure offers a practical roadmap for prioritizing policy and investment decisions in air taxi implementation. At the policy and regulatory level, decision-makers must first address foundational drivers: regulatory ambiguity (B9) and airspace management (B1). It is necessary to establish regulatory sandboxes, define standards, and clarify liability for AI-enabled operations to provide the legal scaffolding for UAM investments (Alqahtani & Kumar, 2024). Regulatory clarity will also allow faster innovation cycles and more predictable infrastructure planning. At the organizational and ecosystem level, the study identifies the need for centralized governance mechanisms to reduce stakeholder fragmentation (B5). Government bodies should enable city-level UAM task forces comprising representatives from civil aviation, municipal planning, eVTOL manufacturers, and digital traffic management. These multi-stakeholder arrangements can jointly evolve SOPs, route-mapping norms, and public transit integration. Such convergence will accelerate operational readiness and prevent duplication of efforts and jurisdictional conflicts. Adopting air taxis requires significant investment; therefore, managers must explore public-private partnership options. Moreover, to raise awareness among citizens, localized demos can be conducted to build public trust.

## 6. Conclusion, Limitations and Scope Future Work

In the proposed study, the barriers to air taxi adoption in India are systematically examined using the TOEH framework, along with ISM and MICMAC analyses. Among the 17 contextual barriers identified, some are as follows: B2 (low technology readiness levels), B1 (poor airspace management), B5 (fragmented stakeholder ecosystems), B16 (affordability issues), and B15 (low public trust in automation). The ISM hierarchical model demonstrates that technological immaturity (B2) and airspace management (B1) are at the bottom of the hierarchy and have a great deal of power to influence other variables, such as a risk-averse organizational culture (B8). Also, obstacles such as concerns about safety and trust in automation are characterized by low dependence but high driving power, underscoring the value of interventions at a higher level. By combining structure with behaviour, this work provides a new analytical framework for understanding UAM proliferation in developing markets. The findings provide valuable lessons for policymakers, aviation regulators, and entrepreneurs to set the policy agenda and overcome systemic inertia in embracing air mobility transformation in India.

The contribution of this study is a comprehensive structural analysis of the barriers to air taxi adoption; however, some limitations should be acknowledged. The manner in which the ISM-MICMAC methodology is employed relies on expert judgment, which can lead to subjective considerations. The model identifies but does not measure influence. Since this study is limited to the Indian context, direct generalization to other geographic areas cannot be inferred from the existing results. However, the model developed in this work provides a replicable template that may be used in future research to explore whether similar or dissimilar barriers, and their assessment, emerge in other countries.

Future research should statistically test the proposed hierarchical model using empirical techniques such as structural equation modelling (SEM) or fSQCA. Moreover, for future research, various perspectives on socio-technical systems and institutional theory can be analyzed, which will help policymakers and decision-makers better understand air taxi adoption. Comparative research across a range of developing and developed countries might further explore the generalizability and applicability. In addition, considering an end user's perspective through surveys or experimental simulations would improve the likelihood of adoption. For future scope, additional work on precise cost-benefit trade-offs, real-time public attitudes, and policy responsiveness can be undertaken.

### Conflicts of Interest

The authors declare no conflict of interest.

### Acknowledgments

The authors declare that this work did not receive any financial support that could have affected its results. The authors are grateful to the anonymous reviewer and the Editor for the insightful comments to help improve the quality and presentation of this paper.

### AI Disclosure

The author(s) declare that no assistance is taken from generative AI to write this article.

### References

- Ahmed, S.S., Fountas, G., Lurkin, V., Anastasopoulos, P.C., Zhang, Y., Bierlaire, M., & Mannering, F. (2024). The state of urban air mobility research: An assessment of challenges and opportunities. *IEEE Transactions on Intelligent Transportation Systems*, 26(2), 1375-1394.
- Al Haddad, C., Chaniotakis, E., Straubinger, A., Plötner, K., & Antoniou, C. (2020). Factors affecting the adoption and use of urban air mobility. *Transportation Research Part A: Policy and Practice*, 132, 696-712. <https://doi.org/10.1016/j.tra.2019.12.020>.
- Alnoor, A., Abbas, S., Sadaa, A.M., Chew, X., & Bayram, G.E. (2025). Navigating the power of blockchain strategy: Analysis of technology-organization-environment (TOE) framework and innovation resistance theory using PLS-SEM and ANN insights. *Technological Forecasting and Social Change*, 214, 124044. <https://doi.org/10.1016/j.techfore.2025.124044>.
- Alqahtani, H., & Kumar, G. (2024). Efficient routing strategies for electric and flying vehicles: a comprehensive hybrid metaheuristic review. *IEEE Transactions on Intelligent Vehicles*, 9(9), 5813-5852.
- Altouq, S. (2024). *Resilient power and propulsion system design for eVTOL aircraft*. Doctoral Thesis, University of Strathclyde. <https://stax.strath.ac.uk/concern/theses/rn301211g>.
- Baum, M.S. (2021). *Unmanned aircraft systems traffic management: UTM*. CRC Press. Boca Raton.
- Bauranov, A., & Rakas, J. (2021). Designing airspace for urban air mobility: a review of concepts and approaches. *Progress in Aerospace Sciences*, 125, 100726. <https://doi.org/10.1016/j.paerosci.2021.100726>.
- Bhaduri, E., & Choudhury, C.F. (2026). Shifting skies: a cross-country investigation of evolution of public perception toward urban air mobility through Twitter (X) discourse. *Journal of Air Transport Management*, 132, 102950. <https://doi.org/10.1016/j.jairtraman.2025.102950>.
- Budde, D., Hinkelbein, J., & Boyd, D.D. (2021). Analysis of air taxi accidents (2004-2018) and associated human factors by aircraft performance class. *Aerospace Medicine and Human Performance*, 92(5), 294-302.
- Cohen, A., & Shaheen, S. (2024). *Advanced air mobility: opportunities, challenges, and research needs for the state of california (2023-2030)*. Research Report, Institute of Transportation Studies, University of California, pp. 1-54. <https://doi.org/10.7922/G2JH3JJC>.
- Di Vito, V., Dziugieli, B., Melo, S., Ten Thije, J.T., Duca, G., Liberacki, A., & Witkowska-Konieczny, A. (2025). Integrating urban air mobility into smart cities: a proposal for relevant use cases in the next decades. *Aircraft Engineering and Aerospace Technology*, 97(1), 2-12. <https://doi.org/10.1108/AEAT-03-2024-0087>.
- Dohale, V., Ambilkar, P., Kumar, A., Mangla, S.K., & Bilolikar, V. (2023). Analyzing the enablers of circular supply chain using Neutrosophic-ISM method: lessons from the Indian apparel industry. *The International Journal of Logistics Management*, 34(3), 611-643. <https://doi.org/10.1108/IJLM-05-2022-0174>.
- Dubai Civil Aviation Authority [DCAA]. (2023). *[Dubai air mobility roadmap / relevant publication]*. Government of Dubai. <https://dcaa.gov.ae/>.

- Eve (2022). *Blade and Eve announce strategic partnership to expand Urban Air Mobility in India*. Eve Air Mobility Press Release. <https://ir.eveairmobility.com/news-events/press-releases/detail/19/blade-and-eve-announce-strategic-partnership-to-expand>.
- Federal Aviation Administration [FAA]. (2023). *Innovate28: FAA's advanced air mobility implementation plan*. U.S. Department of Transportation. <https://www.faa.gov/innovate28>.
- Ferrão, I.G., Espes, D., Dezan, C., & Branco, K.R.L.J.C. (2022). Security and safety concerns in air taxis: a systematic literature review. *Sensors*, 22(18), 6875. <https://doi.org/10.3390/s22186875>.
- Garrow, L.A., German, B.J., & Leonard, C.E. (2021). Urban air mobility: a comprehensive review and comparative analysis with autonomous and electric ground transportation for informing future research. *Transportation Research Part C: Emerging Technologies*, 132, 103377. <https://doi.org/10.1016/j.trc.2021.103377>.
- Gonçalves, J., Ferreira, F.A., Milici, A., & Ferreira, N.C. (2025). Value-focused thinking and interpretive structural modeling in the development of resilience-enhancing initiatives in SMEs. *Strategic Change*. <https://doi.org/10.1002/jsc.2617>.
- Goyal, R., Reiche, C., Fernando, C., & Cohen, A. (2021). Advanced air mobility: demand analysis and market potential of the airport shuttle and air taxi markets. *Sustainability*, 13(13), 7421. <https://doi.org/10.3390/su13137421>.
- Hagspihl, T., Kolisch, R., & Schiffels, S. (2025). Planning an airport shuttle network with air taxis using choice-based optimization. *OR Spectrum*, 1-35. <https://doi.org/10.1007/s00291-024-00801-y>.
- Hande, U.Y.A.R., & Aslan, A. (2026). Redesigning rural space through smart ecotourism villages: a model proposal based on TOE theory. *Cities*, 168, 106465. <https://doi.org/10.1016/j.cities.2025.106465>.
- Kim, Y.W., Lim, C., & Ji, Y.G. (2022). Exploring the user acceptance of urban air mobility: extending the technology acceptance model with trust and service quality factors. *International Journal of Human-Computer Interaction*, 39(14), 2893-2904. <https://doi.org/10.1080/10447318.2022.2087662>.
- Krylova, M. (2022). *Urban planning requirements for the new air mobility (UAM) infrastructure integration*. Master Thesis. Frankfurt University of Applied Sciences. <https://doi.org/10.13140/RG.2.2.22025.11364>.
- Liu, Y., & Gao, C. (2024). Assessing electric vertical take-off and landing for urban air taxi services: key parameters and future transportation impact. *Sustainability*, 16(11), 4732.
- Lou, S., Yao, C., & Zhang, D. (2025). How to promote green innovation of high-pollution firms? A fuzzy-set QCA approach based on the TOE framework. *Environment, Development and Sustainability*, 27(2), 4911-4935. <https://doi.org/10.1007/s10668-023-04107-x>.
- Mahashabde, A., Wolfe, P., Ashok, A., Dorbian, C., He, Q., Fan, A., & Waitz, I.A. (2011). Assessing the environmental impacts of aircraft noise and emissions. *Progress in Aerospace Sciences*, 47(1), 15-52. <https://doi.org/10.1016/j.paerosci.2010.04.003>.
- Ministry of Civil Aviation [MoCA]. (2021). *Drone Rules 2021*. Government of India. <https://civilaviation.gov.in/>.
- Ministry of Housing and Urban Affairs [MoHUA]. (2022). *Annual Report 2022-23*. Government of India. <https://mohua.gov.in/upload/uploadfiles/files/2688HUA-ENGLISH-19-4-2023.pdf>.
- Ministry of Land, Infrastructure and Transport [MOLIT]. (2022). *K-UAM Roadmap*. Government of South Korea. <https://www.molit.go.kr/>.
- Naveen, P., Antony, M.P., Ramasamy, B.V., Sah, D.K., & Maheswar, R. (2024). Unlocking the potential: how flying taxis will shape the future of transportation. *Sustainability*, 16(24), 10795. <https://doi.org/10.3390/su162410795>.
- NITI Aayog. (2021). *Reforms in Urban Planning Capacity in India*. Government of India. <https://niti.gov.in/sites/default/files/2021-09/UrbanPlanningCapacity-in-India-16092021.pdf>.

- Pak, H., Asmer, L., Kokus, P., Schuchardt, B.I., End, A., Meller, F., & Wendt, K. (2025). Can Urban Air Mobility become reality? Opportunities and challenges of UAM as innovative mode of transport and DLR contribution to ongoing research. *CEAS Aeronautical Journal*, 16(3), 665-695.
- Papenfuss, A., Stolz, M., Riedesel, N., Dunkel, F., Ernst, J.M., Laudien, T., & Schuchardt, B. (2025). Experiencing urban air mobility: how passengers evaluate a simulated flight with an air taxi. *CEAS Aeronautical Journal*, 16(3), 789-807. <https://doi.org/10.1007/s13272-025-00823-4>.
- Raza, W., Renkhoff, J., Ogirimah, O., Bawa, G.K., & Stansbury, R.S. (2025). Advanced air mobility: Innovations, applications, challenges, and future potential. *Journal of Air Transportation*, 33(2), 169-187. <https://doi.org/10.2514/1.D0440>.
- Reimer, F., Herzig, J., Winkler, L., Biedermann, J., Meller, F., & Nagel, B. (2025). Applied design thinking in urban air mobility: creating the airtaxi cabin design of the future from a user perspective. *CEAS Aeronautical Journal*, 16(3), 957-972.
- Rice, S., Winter, S.R., Crouse, S., & Ruskin, K.J. (2022). Vertiport and air taxi features valued by consumers in the United States and India. *Case Studies on Transport Policy*, 10(2), 500-506. <https://doi.org/10.1016/j.cstp.2022.01.010>.
- Rohrmeier, K., Wei, W., & Ison, D. (2025). Decoding the vertiport: planning for urban air mobility. *Journal of Planning Literature*, 41(1), 24-34. <https://doi.org/10.1177/08854122251314481>.
- Roy, S., Ali, S.M., & Alghababsheh, M. (2025). Integrated fuzzy total interpretive structural modeling and partial least squares structural equation modeling to understand resource efficient circular supply chains. *Annals of Operations Research*, 355(1), 355-389. <https://doi.org/10.1007/s10479-025-06607-7>.
- Sadrani, M., Adamidis, F., Garrow, L.A., & Antoniou, C. (2025). Challenges in urban air mobility implementation: a comparative analysis of barriers in Germany and the United States. *Journal of Air Transport Management*, 126, 102780. <https://doi.org/10.1016/j.jairtraman.2025.102780>.
- Senthilnathan, V.P., Singaravelu, M., Rajendran, S., & Srinivas, S. (2025). A clustering-metaheuristic-simulation approach to determine air taxi operating site location. *Transportation Research Interdisciplinary Perspectives*, 29, 101330, <https://doi.org/10.1016/j.trip.2025.101330>.
- Shkera, A., & Patankar, V. (2025). Understanding the factors that influence active travel frequency for walkable neighborhoods: insights from a metropolitan city in India. *Applied Mobilities*, 10(3), 352-378.
- Spühler, F., Siebenrock, K., Terekhov, I., & Mattfeld, D.C. (2025). A framework for ranking potential cities for implementing emerging urban mobility technologies: a case study for eVTOL aircraft. *Journal of Urban Mobility*, 7, 100102. <https://doi.org/10.1016/j.urbmob.2025.100102>.
- Takacs, A., & Haidegger, T. (2022). Infrastructural requirements and regulatory challenges of a sustainable urban air mobility ecosystem. *Buildings*, 12(6), 747. <https://doi.org/10.3390/buildings12060747>.
- Tepylo, N., Straubinger, A., & Laliberte, J. (2023). Public perception of advanced aviation technologies: a review and roadmap to acceptance. *Progress in Aerospace Sciences*, 138, 100899. <https://doi.org/10.1016/j.paerosci.2023.100899>.
- Tian, Y., Wan, L., Han, K., & Ye, B. (2018). Optimization of terminal airspace operation with environmental considerations. *Transportation Research Part D: Transport and Environment*, 63, 872-889. <https://doi.org/10.1016/j.trd.2018.06.018>.
- TomTom. (2023). *TomTom Traffic Index 2023: Global congestion trends*. TomTom International BV. <https://www.tomtom.com/traffic-index/>.
- Tornatzky, L.G., & Fleischer, M. (1990). *The processes of technological innovation*. Lexington Books. California, USA.

- Tripaldi, F., Vianello, S., & Bianchi, N. (2025). Emerging trends in urban air mobility: an extensive review. *Energies*, *18*(6), 1426. <https://doi.org/10.3390/en18061426>.
- Tripathi, M., Mandal, M., & Wadhwa, R. (2022). Air taxis: a technological breakthrough to beat the traffic woes. *Communications of the Association for Information Systems*, *50*(1), 13. <https://doi.org/10.17705/1CAIS.05013>.
- Vongvit, R., Maeng, K., & Lee, S.C. (2024). Effects of trust and customer perceived value on the acceptance of urban air mobility as public transportation. *Travel Behaviour and Society*, *36*, 100788. <https://doi.org/10.1016/j.tbs.2024.100788>.
- Wang, K., & Qu, X. (2023). Urban aerial mobility: Reshaping the future of urban transportation. *The Innovation*, *4*(2), 100392. <https://doi.org/10.1016/j.xinn.2023.100392>.
- Yan, Y., Wang, K., & Qu, X. (2024). Urban air mobility (UAM) and ground transportation integration: a survey. *Frontiers of Engineering Management*, *11*(4), 734-758. <https://doi.org/10.1007/s42524-024-0298-0>.
- Yoo, J., Choe, Y., & Rim, S.-i. (2022). Risk perceptions using urban and advanced air mobility (UAM/AAM) by applying a mixed method approach. *Sustainability*, *14*(24), 16338. <https://doi.org/10.3390/su142416338>.
- Zhang, H., Huo, J., Chen, C., & Liu, Z. (2025). A composite transportation network design problem with land-air coordinated operations. *Transportation Research Part C: Emerging Technologies*, *171*, 104967. <https://doi.org/10.1016/j.trc.2024.104967>.
- Zhao, Y., & Feng, T. (2024). Strategic integration of vertiport planning in multimodal transportation for urban air mobility: a case study in Beijing, China. *Journal of Cleaner Production*, *467*, 142988.
- Zhong, Y., Chen, Z., Ye, J., & Zhang, N. (2025). Exploring critical success factors for digital transformation in construction industry—based on TOE framework. *Engineering, Construction and Architectural Management*, *32*(6), 4227-4249.
- Zhyriakov, D., Ptak, M., & Sawicki, M. (2025). Urban air mobility, personal drones, and the safety of occupants—a comprehensive review. *Journal of Sensor & Actuator Networks*, *14*(2), 39. <https://doi.org/10.3390/jsan14020039>.