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Public Acceptance of Autonomous Electric Vertical Take-Off and Landing Aircraft: Analysis Based on the Extended Technology Acceptance Model

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Abstract

Urban air mobility (UAM) has been emerging as a promising direction in future transportation. The autonomous electric vertical take-off and landing (eVTOL) aircraft, as the core vehicle enabling urban air transportation, represents a promising technological trend because of its low operational costs and safety advantages. However, though public acceptance of UAM has been widely investigated, the potential users' acceptance of autonomous eVTOL systems remains under-investigated. This research extends the technology acceptance model by incorporating perceived risk and trust factors and explores how it may explain variations in users' acceptance of autonomous eVTOL aircraft. Thus, a survey study was conducted to guide the design and future deployment of autonomous eVTOL aircraft. Based on 412 responses from China, we analysed public acceptance of autonomous eVTOL aircraft using structural equation modeling. The study revealed that perceived usefulness was a primary determinant of potential users' behavioral intention of using autonomous eVTOL aircraft. Further, trust demonstrates significant positive effects on perceived ease of use and perceived usefulness of autonomous eVTOL aircraft. Finally, respondents' income and familiarity with eVTOL technologies can also moderate users' psychological constructs and thus affect their willingness to use autonomous eVTOL aircraft. These insights provide valuable decision-making references for policymakers, eVTOL aircraft manufacturers, and service operators, contributing to both theoretical understanding of innovative transportation technology acceptance and practical implementation of autonomous eVTOL systems.

Keywords

autonomous eVTOL, urban air mobility, technology acceptance, trust, perceived risk

Introduction

Urban air mobility (UAM), as an innovative air transportation system designed for urban and suburban areas, represents an emerging transportation mode that may potentially address urbanization challenges and ground traffic congestion. It aims to provide convenient, economical, and sustainable aerial mobility for both passengers and cargo (*1*). These services encompass emergency medical services, crisis response, aerial tourism, logistics, and daily commuting (*1*, *2*). UAM services can significantly reduce travel times compared with surface transportation and improve accessibility to areas with inadequate transportation services (*3–5*). Thus, UAM transcends traditional transportation modes, forming a transformative transportation ecosystem to complement existing infrastructure. Market analyses reveal substantial global implementation potential for UAM. For example, Morgan Stanley projects the global UAM market to reach $1.5 trillion by 2040 (*6*). It is also estimated that the market potential in over 200 cities worldwide could reach 19 million passenger trips daily by 2050 (*7*).

UAM relies on aerial vehicles, either manned or unmanned, and with different structures (e.g., fixed wings, and multi-rotor such as helicopters and hexacopters). To date, the electric vertical take-off and landing

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(eVTOL) aircraft has been recognized as one of the most promising solutions for UAM. The eVTOL aircraft utilizes electric propulsion with high hovering and cruising performance to reduce carbon emissions and noise pollution (*8–10*). Thus, they are particularly suitable to be deployed in densely populated urban environments. As such, over 1,000 distinct eVTOL aircraft models are being developed globally (*11*). However, despite rapid technological advancement, barriers still exist for eVTOL aircraft implementation, such as the lack of economic viability, regulatory frameworks, operational infrastructure, and social acceptance (*12*). Among these, similar to the implementation of new technologies such as autonomous vehicles (AVs) in surface transportation, the acceptance of eVTOL aircraft by the general public plays a critical role in the successful commercialization of UAM (*13*).

To tackle this challenge, it is necessary to understand potential factors that can shape users' willingness to use eVTOL aircraft. Because of the limitations of the maximum take-off load of eVTOL aircraft, *autonomous* eVTOL aircraft—without the weight of an additional pilot—are believed to be the future of UAM. However, to the best of the authors' knowledge, although public acceptance of UAM has been explored, potential users' attitudes toward autonomous eVTOL aircraft have not been explored (*14–18*). Given that autonomous eVTOL aircraft have specific characteristics that make them different from manned eVTOL aircraft or other AVs in surface transportation (e.g., more severe outcome if a malfunction happens), it is necessary to re-evaluate the factors that can shape users' acceptance of autonomous eVTOL aircraft, along with the weights of each factor.

Thus, in this study, we aim to understand public acceptance of autonomous eVTOL aircraft. Specifically, we adopt an extended technology acceptance model (TAM) framework to formulate research hypotheses. Based on these hypotheses, we designed an online questionnaire targeting *potential* eVTOL aircraft users in China (in contrast to *actual* users, as no commercially running eVTOL aircraft are available in China), where ambitious strategic plans for supporting UAM have been announced. Finally, the hypotheses were validated through structural equation modeling (SEM) analyses. The findings from this study can guide strategies to support the commercialization of autonomous eVTOL aircraft services.

Literature Review

Public Perception of UAM

Previous research has extensively examined public perceptions of UAM. Studies indicate that respondents, in general, show positive attitudes toward UAM, with more positive attitudes being observed when adopting UAM in emergent scenarios (e.g., search and rescue) (*1*, *2*, *19*, *20*). However, safety consistently emerges as the primary public concern (*21*). Specifically, for potential users of UAM, service reliability, efficiency, and acceptance of autonomous technology can significantly influence acceptance of UAM (*22*). Similarly, Goyal R. et al. found that perceived safety, environmental impact, and operational reliability are positively associated with users' confidence in UAM (*23*). For non-users of UAM, acceptance of UAM has been found to be associated with the safety of ground personnel, operational time windows, and flight altitude, and, in general, they prefer a minimal impact of UAM on their daily life (*24*).

At the same time, the demographic characteristics of the public can also influence their attitudes toward UAM. For example, individuals with higher receptiveness scores and those with higher incomes show higher acceptance of UAM (*25*, *26*). Further, the public has different preferences for the applications of UAM. For example, intracity transportation is less favored than intercity transportation because of the unfavorable complexity-to-benefits ratios of the former (*27*). In contrast, regular business travel with UAM shows the highest adoption potential (*28*). The cost of adopting UAM also plays a role. For example, research indicates that consumers typically prefer to delay adopting UAM, given the relatively high price at this stage (compared with existing transportation modes), indicating that price reduction strategies may effectively accelerate the initial adoption of UAM (*28*, *29*).

However, previous research focused on UAM in general, but did not differentiate the type of aircraft, the unique characteristics of which may affect acceptance of UAM. The level of automation can fundamentally affect relationships between aerial vehicles and human users, as has been pointed out by Onnasch and has been observed in the driving automation domain (*30*, *31*). This may also be the case when fully autonomous eVTOL aircraft are compared with eVTOL aircraft with other levels of automation.

Extended Applications of TAM in Emerging Transportation Services

TAM has demonstrated robust explanatory power in understanding user adoption of new technologies (*32*). In the transportation domain, TAM and its variants are commonly applied to explain the variations in users' acceptance of AVs. For example, research usually finds that perceived usefulness (PU) and perceived ease of use (PEOU) are positively associated with behavioral intentions (BI) (*33*, *34*). At the same time, trust in and perceived benefits of AVs can also boost users' BI when using AVs, for example, by improving PEOU and reducing perceived risk (PR) (*33*, *35–37*). Further, trust itself can be affected by frequency of usage, knowledge, and learning difficulty, while individuals with higher openness to experience are more likely to trust AVs (*34*, *38*).

Given the similarities between UAM and AVs, the research on AV acceptance may provide some insights. Thus, previous studies adopted the TAM framework and its extension to explore public acceptance of UAM systems. For example, PU, PEOU, social influence, and facilitating conditions were found to increase the BI of using UAM (*14*). At the same time, attitudes, PU, and personal innovation also show significant associations with BI (*15*, *16*). Transport service quality also affects PU and PEOU of UAM (*17*). Research also compared influential factors of users' acceptance of AVs and UAM, and it was found that perceived safety and performance expectations are the determinants of BI for AVs; while social influence and hedonic motivation function are primary factors influencing UAM acceptance (*18*).

However, while extensive research has been conducted into users' acceptance of UAM, the role of TAM or its extension in explaining users' acceptance of autonomous eVTOL systems remains understudied. The combination of autonomy with novel aviation technology integrated into urban aerial environments may present unique psychological barriers and pose distinct challenges to public acceptance.

The Development of Autonomous eVTOL

The advancement in autonomous aerial vehicles drives the commercialization of UAM services (*39*, *40*). Despite increasing acceptance of automation technologies, research on users' or potential users' acceptance of autonomous eVTOL is still relatively uncommon (*19*).

Autonomous eVTOL systems rely on five core technological pillars: high-efficiency electric propulsion, navigation controls, multi-sensor environmental cognition, real-time decision algorithms, and reliable operational redundancies. Similar to driving automation, eVTOL systems can be classified into a six-level autonomy framework, spanning from Level 0 (manual control) to Level 5 (swarm automation) (*41*). Further, two primary pathways have emerged for implementing autonomous technology: 1) a gradual transition from human-piloted to fully autonomous flight, aimed at facilitating early airworthiness certification and commercial deployment; and 2) prioritizing autonomous flight development and certification from inception, designed to achieve broad environmental adaptability (*8*). The latter faces significant challenges related to trustworthiness, certification complexity, and constraints in algorithms. Successful development and implementation require comprehensive testing, substantial cybersecurity investments, and the establishment of interoperability standards (*8*). At the same time, to ensure the sustainability of UAM services, it is necessary to understand the factors influencing users' trust in and acceptance of different types of aerial vehicle and take corresponding countermeasures to guide the social acceptance of new technologies. These factors highlight the critical need to systematically investigate PR of, and trust in, autonomous eVTOL aircraft, on top of treating UAM as a single, uni-dimensional concept.

Theoretical Framework

Building on our literature review, this study extends TAM by incorporating the constructs of trust and PR to explain user acceptance of autonomous eVTOL systems. This extension is particularly relevant given the novel nature of autonomous aviation technology and the unique safety considerations in aerial mobility contexts.

BI, PU, and PEOU

BI is widely recognized as the most significant determinant of actual usage behavior. Given that autonomous eVTOL systems are not yet commercially available, this study employs BI as a predictive indicator of future adoption behavior. At the same time, in the context of autonomous eVTOL, PU reflects the degree to which individuals believe that using the system would enhance their travel efficiency, shorten journey duration, and provide more meaningful benefits than existing transportation alternatives. PEOU represents the perception of how easy it is to use autonomous eVTOL systems, which encompasses aspects such as booking processes, boarding procedures, and overall service accessibility. In line with previous TAM research, PU and PEOU are primary determinants of BI, and PU shows a stronger correlation with BI than PEOU (*14*, *42*, *43*). Furthermore, PEOU serves as a causal antecedent to PU and, thus, PEOU can indirectly influence BI through PU (*32*, *44*). Therefore, we have the following hypotheses:

H1: PU is positively associated with BI to use autonomous eVTOL aircraft.

H2: PEOU is positively associated with BI to use autonomous eVTOL aircraft.

H3: PEOU is positively associated with PU of autonomous eVTOL.

Trust

"Trust" is defined as the belief that an agent can help accomplish personal objectives in uncertain and risky circumstances (*45*). In general, trust can increase BI, either directly or indirectly, through improving PEOU and reducing PR (*17*, *33*). This multi-path mechanism is especially relevant for autonomous eVTOL systems, where the combination of aviation technology and autonomy creates high uncertainty in usability and risk. Given that insufficient trust may lead to disuse of a system, while excessive trust could result in misuse or unrealistic expectations, during the initial market introduction of emerging technologies, such as eVTOL aircraft, potential consumers' trust should be carefully calibrated (*46*). Therefore, the following hypotheses are proposed:

H4: Trust is positively associated with BI to use autonomous eVTOL aircraft.

H5: Trust is positively associated with PU.

H6: Trust is positively associated with PEOU.

H7: Trust is negatively associated with PR.

Perceived Risk (PR)

As a negative predictor of BI, PR represents a subjective assessment of potential negative outcomes associated with autonomous eVTOL systems (*35*, *47*). In a survey on UAM adoption, potential passengers were found to be more concerned with PR than with PU, highlighting the role of PR in the context of aviation (*48*). In our study, PR is modeled as both a determinant of BI and an influencing factor of PU, as there can be a trade-off between the perceived benefits of autonomous eVTOL systems and their potential risks. Therefore, the following hypotheses are proposed:

H8: PR is negatively associated with BI to use autonomous eVTOL aircraft.

H9: PR is negatively associated with PU.

Based on the hypotheses proposed above, a TAM framework for potential users' acceptance of autonomous eVTOL is illustrated in Figure 1.

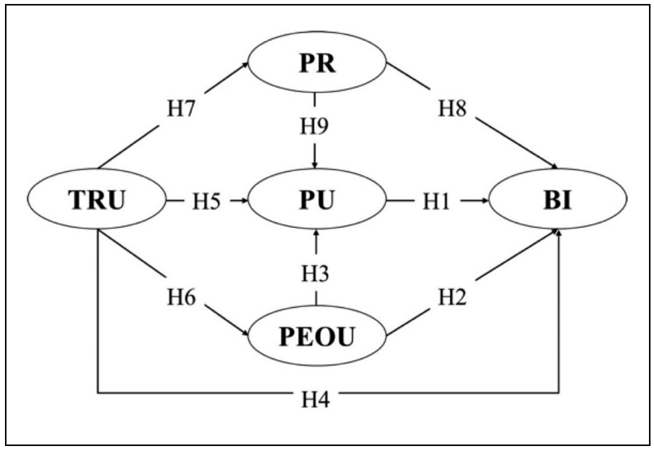

Figure 1. A technology acceptance model framework for users' acceptance of autonomous electric vertical take-off and landing aircraft.
Note: BI = behavioral intention; H = hypothesis; PEOU = perceived ease of use; PR = perceived risk; PU = perceived usefulness; TRU = trust.

Methods

Survey Design

The survey is structured into two parts. The first part gathered demographic information of the respondents, while the second part focused on respondents' acceptance of autonomous eVTOL aircraft. Given that autonomous eVTOL services have not yet been commercialized for general consumers in China, the survey incorporated a two-step approach: initial assessment of familiarity with the technology, followed by the presentation of a manufacturer-produced promotional video (see https://v.qq.com/txp/iframe/player.html?vid = r3554t0o9jb&autoplay = 0&bullet = 0) demonstrating the riding service features and operational characteristics. The video-based introduction ensured that all participants had a basic yet similar understanding of the eVTOL technology before their preferences were assessed. All constructs in the TAM framework were measured using the questions listed in Table 1, with a five-point Likert scale (1 = strongly disagree, to 5 = strongly agree). Further, items were adapted from established scales when necessary and contextualized for autonomous eVTOL applications.

Data Collection

Data collection was conducted through the Tencent Questionnaire Platform (https://wj.qq.com), a prominent Chinese survey website that had collected over 1.7 billion responses as of early 2021, with the number of daily active users exceeding 3 million. The platform has served over 77 million users across more than 80 industries, using paid sampling services to ensure the representativeness of respondents in China (*49*). In total, 500 responses were initially collected, followed by a screening procedures using SPSS based on three criteria: 1) inconsistency in the validation question (inconsistency between age reported in Q3 and age group selected in Q18, seven cases); 2) average response time $\leqslant 2$ s per item (48 cases); and 3) responses showing insufficient variance (below 0.2) across six items measuring trust and PR (33 cases) (*51–53*). This data cleaning process resulted in 412 valid

Table 1. Questions in the Survey and the Distribution of the Variables

Questions		Variables	Distribution
Demographic questions			
Q1	Gender at birth	Gender	• Female ($n = 260$, 63.11%) • Male ($n = 152$, 36.89%)
Q2	Year of birth	Age (years)	Mean = 30.39 (SD: 8.104, min.: 19, max.: 65) • 18–30 ($n = 123$, 29.85%) • 31–40 ($n = 243$, 58.98%) • 41–50 ($n = 32$, 7.77%) • >50 ($n = 14$, 3.4%)
Q3	Please describe the highest level of education you have received.	Education	• Middle school or below ($n = 10$, 2.43%) • High school ($n = 160$, 38.83%) • Bachelor's degree ($n = 202$, 49.03%) • Master's degree or above ($n = 40$, 9.71%)
Q4	What is your personal pre-tax monthly income range (in CNY)?	Income	• <3000 ($n = 126$, 30.58%) • 3000–12,000 ($n = 204$, 49.51%) • 12,000–25,000 ($n = 61$, 14.81%) • 25,000–35,000 ($n = 8$, 1.94%) • 35,000–55,000 ($n = 3$, 0.73%) • 55,000–80,000 ($n = 4$, 0.97%) • >80,000 ($n = 6$, 1.46%)
Q5	Your current long-term place of residence is located in…	Province	• 31 provinces (sample min. = 2, max. = 68) • Top 3 provinces: Guangdong ($n = 68$, 16.5%), Henan ($n = 37$, 9.0%), Jiangsu ($n = 34$, 8.3%)
Q6	Have you ever traveled by plane or participated in flight activities?	Flight experience	• Yes ($n = 306$, 74.3%) • No but interested ($n = 83$, 20.1%) • No and not interested ($n = 23$, 5.6%)
Q7	How much do you understand autonomous eVTOL aircraft	Familiarity	• Not at all ($n = 47$, 11.41%) • Not very ($n = 58$, 14.08%) • Some ($n = 173$, 41.99%) • Quite ($n = 119$, 28.88%) • Very ($n = 15$, 3.64%)
Related questions of TAM constructs (*32*, *36*)			
	Please watch a video introducing autonomous eVTOLs (https://v.qq.com/txp/iframe/player.html?vid=r3554t0o9jb&autoplay=0&bullet=0) Please rate the following statement about autonomous eVTOLs. (1 = strongly disagree, 5 = strongly agree)		
Q8	I intend to use an autonomous eVTOL aircraft when it becomes available.	Behavioral intention: Cronbach's $\alpha = 0.839$, CR = 0.84, AVE = 0.637	Factor loading: 0.759 Mean: 3.86 (SD: 0.884, min.: 1, max.: 5) • 1 ($n = 4$, 1.0%) • 2 ($n = 21$, 5.1%) • 3 ($n = 106$, 25.7%) • 4 ($n = 178$, 43.2%) • 5 ($n = 103$, 25.0%)
Q9	If the price of autonomous eVTOL aircraft is within my acceptable range, I intend to use it.		Factor loading: 0.805 Mean: 4.15 (SD: 0.827, min.: 1, max.: 5) • 1 ($n = 2$, 0.5%) • 2 ($n = 16$, 3.9%) • 3 ($n = 54$, 13.1%) • 4 ($n = 185$, 44.9%) • 5 ($n = 155$, 37.6%)
Q10	I look forward to using an autonomous eVTOL aircraft in the future.		Factor loading: 0.829 Mean: 4.34 (SD: 0.860, min.: 1, max.: 5) • 1 ($n = 5$, 1.2%) • 2 ($n = 10$, 2.4%) • 3 ($n = 46$, 11.2%) • 4 ($n = 131$, 31.8%) • 5 ($n = 220$, 53.4%)

(continued)

Table 1. (continued)

Questions		Variables	Distribution
Q11	Using autonomous eVTOLs makes my travel more convenient.	Perceived usefulness: Cronbach's $\alpha = 0.864$, CR = 0.872, AVE = 0.695	Factor loading: 0.883 Mean: 4.23 (SD: 0.806, min.: 1, max.: 5) • 1 (*n* = 2, 0.5%) • 2 (*n* = 10, 2.4%) • 3 (*n* = 55, 13.3%) • 4 (*n* = 169, 41.0%) • 5 (*n* = 176, 42.7%)
Q12	Using autonomous eVTOLs can make my travels more efficient or allow me to do other tasks.		Factor loading: 0.850 Mean: 4.26 (SD: 0.806, min.: 1, max.: 5) • 1 (*n* = 2, 0.5%) • 2 (*n* = 9, 2.2%) • 3 (*n* = 55, 13.3%) • 4 (*n* = 161, 39.1%) • 5 (*n* = 185, 44.9%)
Q13	I find the autonomous eVTOLs to be useful for my daily travel.		Factor loading: 0.764 Mean: 3.97 (SD: 0.898, min.: 1, max.: 5) • 1 (*n* = 3, 0.7%) • 2 (*n* = 24, 5.8%) • 3 (*n* = 82, 19.9%) • 4 (*n* = 176, 42.7%) • 5 (*n* = 127, 30.8%)
Q14	I feel that learning to ride an autonomous eVTOL will be easy.	Perceived ease of use: Cronbach's $\alpha = 0.783$, CR = 0.781, AVE = 0.544	Factor loading: 0.775 Mean: 3.47 (SD: 1.042, min.: 1, max.: 5) • 1 (*n* = 16, 3.9%) • 2 (*n* = 57, 13.8%) • 3 (*n* = 123, 29.9%) • 4 (*n* = 149, 36.2%) • 5 (*n* = 67, 16.3%)
Q15	I feel that traveling to my destination by autonomous eVTOL aircraft will be very easy.		Factor loading: 0.754 Mean: 3.97 (SD: 0.967, min.: 1, max.: 5) • 1 (*n* = 8, 1.9%) • 2 (*n* = 24, 5.8%) • 3 (*n* = 78, 18.9%) • 4 (*n* = 163, 39.6%) • 5 (*n* = 139, 33.7%)
Q16	I feel that summoning an autonomous eVTOL aircraft will be very easy.		Factor loading: 0.681 Mean: 3.51 (SD: 1.040, min.: 1, max.: 5) • 1 (*n* = 12, 2.9%) • 2 (*n* = 54, 13.1%) • 3 (*n* = 138, 33.5%) • 4 (*n* = 127, 30.8%) • 5 (*n* = 81, 19.7%)
Q17	Validation question: Please confirm the range of your birth year once again.	Consistency	Mean = 30.39 (SD: 8.104, min.: 19, max.: 65) • 18–30 (*n* = 123, 29.85%) • 31–40 (*n* = 243, 58.98%) • 41–50 (*n* = 32, 7,77%) • $>$50 (*n* = 14, 3.4%)
Q18	The autonomous eVTOL aircraft is dependable.	Trust: Cronbach's $\alpha = 0.913$, CR = 0.914, AVE = 0.781	Factor loading: 0.924 Mean: 3.70 (SD: 0.991, min.: 1, max.: 5) • 1 (*n* = 7, 1.7%) • 2 (*n* = 41, 10.0%) • 3 (*n* = 116, 28.2%) • 4 (*n* = 151, 36.7%) • 5 (*n* = 97, 23.5%)

(continued)

Table 1. (continued)

Questions		Variables	Distribution
Q19	The autonomous eVTOL aircraft is reliable.		Factor loading: 0.869 Mean: 3.65 (SD: 0.989, min.: 1, max.: 5) • 1 (*n* = 8, 1.9%) • 2 (*n* = 42, 10.2%) • 3 (*n* = 126, 30.6%) • 4 (*n* = 148, 35.9%) • 5 (*n* = 88, 21.4%)
Q20	I can trust the autonomous eVTOL aircraft.		Factor loading: 0.856 Mean: 3.67 (SD: 1.009, min.: 1, max.: 5) • 1 (*n* = 10, 2.4%) • 2 (*n* = 43, 10.4%) • 3 (*n* = 110, 26.7%) • 4 (*n* = 158, 38.3%) • 5 (*n* = 91, 22.1%)
Q21	Autonomous eVTOL aircraft would lead to a financial loss for me.	Perceived risk: Cronbach's α = 0.793, CR = 0.796, AVE = 0.569	Factor loading: 0.620 Mean: 2.89 (SD: 1.009, min.: 1, max.: 5) • 1 (*n* = 42, 10.2%) • 2 (*n* = 89, 21.6%) • 3 (*n* = 172, 41.7%) • 4 (*n* = 90, 21.8%) • 5 (*n* = 19, 4.6%)
Q22	Autonomous eVTOL aircraft might not perform well and create problems.		Factor loading: 0.782 Mean: 3.22 (SD: 0.923, min.: 1, max.: 5) • 1 (*n* = 19, 4.6%) • 2 (*n* = 57, 13.8%) • 3 (*n* = 178, 43.2%) • 4 (*n* = 132, 32.0%) • 5 (*n* = 26, 6.3%)
Q23	Using autonomous eVTOL aircraft would be risky.		Factor loading: 0.844 Mean: 3.43 (SD: 0.963, min.: 1, max.: 5) • 1 (*n* = 12, 2.9%) • 2 (*n* = 53, 12.9%) • 3 (*n* = 142, 34.5%) • 4 (*n* = 154, 37.4%) • 5 (*n* = 51, 12.4%)

Note: AVE = average variance extracted; CNY = Chinese yuan; CR = composite reliability; eVTOL = electric vertical take-off and landing; max. = maximum; min. = minimum; SD = standard deviation; TAM = technology acceptance model.

responses from 31 provinces in China, which is sufficient for Covariance Based SEM analysis (*54*). The average time to complete the questionnaire (including watching the video) was 180 s, with a standard deviation (SD) of 81 (min: 94, max: 644).

Data Analyses

Data analyses were conducted using two statistical software packages: SPSS for data cleaning and reliability analysis (Cronbach's α), and AMOS for validity assessment and path analysis. In the analysis, we first provided descriptive statistics about the distribution of valid responses and the characteristics of the respondents. Then, a structural equation model was constructed to test the proposed hypotheses in our framework, following the methodology in Yao et al. (*44*).

First, we evaluated the measurement model using confirmatory factor analysis from three aspects, that is, reliability, convergent validity, and discriminant validity, to ensure the measurement quality before proceeding to structural analysis. Specifically, the internal consistency reliability was assessed through Cronbach's α and composite reliability (CR), the convergent validity was evaluated through factor loadings (FL) and average variance extracted (AVE), and the discriminant validity was assessed by comparing the square root of AVE (SAVE) with inter-construct correlations (*66*).

Next, SEM analysis was performed to calculate the standardized coefficients for each factor. The goodness-of-fit of the measurement model was evaluated using absolute, incremental, and parsimony fit indices. The absolute fit indices included the chi-square/degrees of freedom ratio ($\chi 2$/df) to assess overall fit while

Table 2. Results of the Path Analysis

Paths	Hypothesis	Estimate	Standard error	Critical ratio	p-value
PU→BI	H1	0.543	0.084	6.461	<0.001
PEOU→BI	H2	0.53	0.075	0.703	0.482
PEOU→PU	H3	0.405	0.07	5.774	<0.001
TRU→BI	H4	0.154	0.059	2.613	0.009
TRU→PU	H5	0.361	0.054	6.662	<0.001
TRU→PEOU	H6	0.537	0.051	10.611	<0.001
TRU→PR	H7	-0.36	0.056	-6.418	<0.001
PR→BI	H8	0.029	0.042	0.699	0.485
PR→PU	H9	-0.055	0.039	1.395	0.163

Note: BI = behavioral intention; PEOU = perceived ease of use; PR = perceived risk; PU = perceived usefulness; TRU = trust.

accounting for model complexity, the goodness-of-fit index (GFI) to evaluate the proportion of variance accounted for by the estimated population covariance, and the root mean square error of approximation (RMSEA) to estimate the parsimony-adjusted fit. The incremental fit indices are utilized to assess model fit relative to a baseline model, including the normed fit index (NFI) and comparative fit index (CFI). The parsimony fit measures included the parsimony GFI (PGFI), parsimony NFI (PNFI), and adjusted GFI (AGFI), which adjust for model complexity and penalize overly complex models. Finally, based on the validated measurement model, the pathway analyses were conducted to validate the hypotheses in our framework.

Finally, to investigate the relationships between demographic characteristics and technology acceptance variables, we conducted Spearman correlation analysis between the demographic variables and the latent variables using SPSS, with the values of the latent variables being calculated as the mean scores of their corresponding observed variables (*44*).

Results

Descriptive Statistics of the Responses

The final samples included 63.11% responses (n = 260) from female respondents and 36.89% (n = 152) from male respondents, who had an average age of 30.39 years (range: [18, 65], SD = 8.1). Table 1 provides a more detailed split of the respondents, based on their age range, education level, monthly income, and self-reported familiarity with autonomous eVTOL technology.

In addition, we also noticed that over 68% of respondents expressed positive BI toward autonomous eVTOL aircraft. PU-related items all received high ratings, with particularly strong agreement for efficiency benefits (mean = 4.26, SD = 0.806). Trust-related items also received moderately positive ratings (ranging from 3.65 to 3.70). Finally, ratings for PEOU and PR showed balanced distributions between agreement and disagreement, reflecting the diversity in public acceptance of autonomous eVTOL aircraft.

Measurement Model Assessment

Both Cronbach's α and CR exceeded 0.78 across all constructs (Table 1), well above the recommended threshold of 0.7 (*55*). This indicates high internal consistency among measurement items within each construct, supporting the stability and dependability of the measurement instruments. At the same time, FLs demonstrated robust item-to-construct relationships, with all values exceeding 0.6, indicating good representation of their respective constructs (*55*). Similarly, AVE values for all constructs exceeded 0.5, confirming that each construct explained over 50% of the variance for its indicator, demonstrating good discriminant validity (*56*, *57*).

Discriminant validity is assessed by comparing SAVE with inter-construct correlations (*55*). All SAVE values exceed their respective bivariate correlations with other constructs, demonstrating adequate discriminant validity and confirming that each construct captures phenomena unique from other constructs in the model.

Next, in general, all fit indices demonstrated overall goodness-of-fit of the model (*58*). Specifically, as for the absolute fit indices, the χ^2/df ratio value of 2.706 was below the recommended upper limit of 3; the GFI value of 0.935 and AGFI value of 0.904 both exceeded the lower limit of 0.9; and the RMSEA value of 0.064 was well below the 0.08 upper limit. Similarly, the incremental fit measures (NFI = 0.94, CFI = 0.961) and parsimony fit measures (PGFI = 0.631, PNFI = 0.725) all exceeded their respective lower threshold values.

Path Analysis

As shown in Table 2 and visualized in Figure 2, six out of nine hypotheses were supported. Specifically, PU was a strong predictor of BI, supporting H1; PEOU was

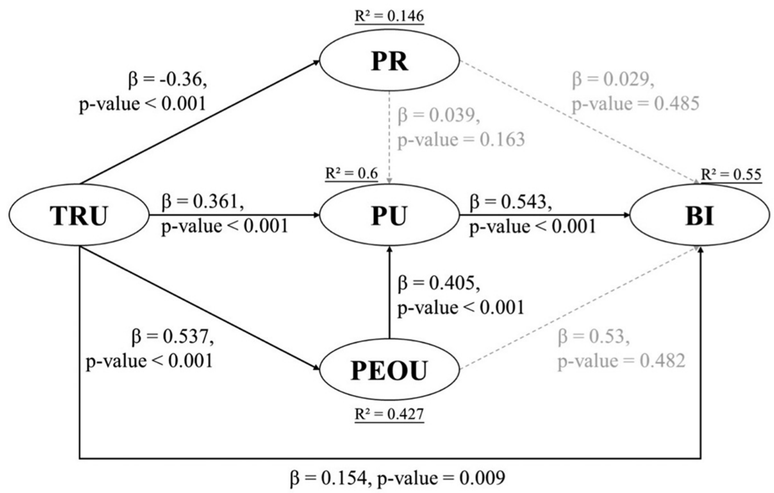

Figure 2. Visualization of the significant paths. (The grey paths are non-significant.)
Note: BI = behavioral intention; PEOU = perceived ease of use; PR = perceived risk; PU = perceived usefulness; TRU = trust.

Table 3. Correlation Analysis Results

	BI		PU		PEOU		TRU		PR	
Variable	r	*p*	r	*p*	r	*p*	r	*p*	r	*p*
Age	0.045	0.4	0.047	.3	0.085	0.09	0.043	0.4	−0.034	0.5
Education	0.064	0.2	−0.003	.9	0.026	0.6	0.050	0.3	−0.004	0.9
Income	**0.167**	0.001	**0.174**	<0.001	**0.119**	0.02	**0.106**	0.03	0.051	0.3
Familiarity	**0.174**	<0.001	**0.292**	<0.001	**0.269**	<0.001	**0.356**	<0.001	−0.082	0.096

Note: BI = behavioral intention; PEOU = perceived ease of use; PR = perceived risk; PU = perceived usefulness; TRU = trust.
The bolded texts indicate significant results ($p < 0.05$).

positively associated with PU, supporting H3; and trust showed a strong positive association with BI, PU, and PEOU, supporting H4, H5, and H6, respectively. At the same time, trust was negatively associated with PR, supporting H7.

Finally, the model demonstrated that our constructs can largely explain the BI of using autonomous eVTOL aircraft, with R^2 of 0.55 for BI, 0.6 for PU, 0.427 for PEOU, and 0.146 for PR, all exceeding the recommended threshold of 0.1 (*59*). The particularly high R^2 of PU and BI suggested that these two constructs have a strong influence on public acceptance of autonomous eVTOL aircraft.

Acceptance and Demographic Characteristics

The analysis revealed significant correlations between demographic characteristics and acceptance factors, as shown in Table 3. Specifically, income level was positively associated with BI, PU, PEOU, and trust. At the same time, the familiarity level of autonomous eVTOL aircraft was also positively correlated with BI, PU, PEOU, and trust. However, neither age nor education level showed significant correlations with any constructs ($p > 0.05$). Similarly, PR demonstrated no significant associations with any demographic characteristics, suggesting factors other than demographic variables may influence PR, for example, technology belief and initial trust (*44*). This deserves further investigation.

Discussion

Through a survey study with 412 valid samples, we investigated how social-psychological factors affect potential users' acceptance of autonomous eVTOL aircraft—a promising form of future UAM transportation—based on an extended TAM model.

Implications from the Extended TAM Model

First, the findings validate the efficacy of the extended TAM framework in the context of autonomous eVTOL aircraft. Specifically, the model demonstrated substantial explanatory power for a technology not yet commercially available in China (R^2 values ranging from 0.146 to 0.600). This indicates that the extended TAM models can provide insights into the acceptance of anticipated technologies.

Concerning the identified structure of the extended TAM, first, in line with previous research on users' acceptance of AVs and supporting H1, we found that PU still played a vital role in explaining the variations in BI, indicating that the utilitarian and functional advantages are the top considerations for potential eVTOL aircraft users (*33*, *34*). Further, some other psychological factors can affect BI through PU. For example, a PEOU-PU-BI relationship chain was identified, indicating that, although the direct impact of PEOU on BI was non-significant (violating H2), PEOU can indirectly affect BI through PU (supporting H3).

Thus, future eVTOL aircraft manufacturers and service providers should prioritize the functional benefits of eVTOL aircraft and deploy them in scenarios where they can play a unique role, for example, in time-sensitive scenarios where they can seamlessly integrate with existing transportation systems. Policymakers can also focus on high-congestion corridors where UAM offers substantial advantages, and prioritize vertiport placements and intermodal connections that maximize utility benefits.

Further, in line with our expectations and supporting H4, H5, H6, and H7, we identified trust as a fundamental prerequisite for acceptance of autonomous eVTOL aircraft. Specifically, trust was positively associated with multiple TAM model constructs, including BI, PU, PEOU, and PR. These findings are not surprising, as trust was found to be a core concept in the domain of driving automation (*34–36*). The particularly strong relationship between trust and PEOU suggests that confidence in autonomous systems can significantly influence users' expectations of interaction complexity, especially with a system that they have never used before, which may further increase their chance of using such a system in the future.

Thus, manufacturers should design systems that support trust formation through transparent operational interface design, for example, by providing ambient awareness systems and multi-sensory feedback (*60*). Service providers should consider a free first trial or progressive experience offerings (from virtual simulations to short trial flights) for users to build up trust in eVTOL aircraft, similar to what has been conducted in the AV domain (*13*, *61*). Policymakers should consider forcing strict performance-based safety certification with transparent testing protocols and standardized emergency response systems to increase potential users' confidence in eVTOL aircraft.

Finally, violating H8 and H9 and being different from research in aviation or AV domains, we found that the PR failed to affect PU or BI of adopting autonomous eVTOL aircraft (*35*, *47*). In general, our respondents had a relatively low PR of autonomous eVTOL aircraft, potentially because only those who were confident in the future development of eVTOL aircraft or UAM would be interested in answering an eVTOL-aircraft-related survey.

The Heterogeneity of the Populations

We also observed the influence of demographic characteristics on potential users' acceptance of eVTOL aircraft. Specifically, income level was positively associated with key acceptance constructs (BI, PU, PEOU, and trust), suggesting that economic factors can affect users' acceptance of eVTOL aircraft. This is possibly because of the expected high price of eVTOL aircraft travel. At the same time, technology familiarity also exhibited positive correlations with these constructs, similar to how mental models affect users' attitudes toward AVs (*62*). This finding extends previous TAM research by highlighting the crucial role of prior technology exposure in fostering acceptance of novel autonomous systems. In summary, the sector of the Chinese population inclined to use eVTOL aircraft is primarily defined by two core attributes: higher income levels and greater technology familiarity. Further, though not revealed in the path analysis, a higher portion of respondents were female, indicating that females might be more interested in this new technology than males.

Thus, manufacturers and service providers should implement progressive exposure strategies to enhance potential users' understanding of the eVTOL aircraft, and develop differentiated product strategies targeting various market segments. At the same time, policymakers need to develop inclusive regulatory frameworks that ensure potential users' access across income levels while maintaining safety standards.

Insights from Comparisons with prior UAM studies

Contrasting our autonomous eVTOL findings with prior UAM research reveals several noteworthy divergences. While earlier UAM studies consistently emphasize perceived safety/risk as a salient determinant of intention, this study indicates that, instead, PU is the dominant driver of BI for autonomous eVTOL aircraft, with PEOU exerting only an indirect effect via PU (*47*, *48*). It is likely that, without real-world deployment, the variation in users' PR is small, or respondents may find it difficult to map PR directly to their own usage. This is especially the case for fully autonomous eVTOL aircraft, which is different from the experience in existing commercial aviation. Thus, a weaker association between PR and BI was observed. Second, trust, as a unique influential social-psychological factor for autonomous systems, supersedes acceptance factors by shaping multiple core constructs simultaneously and mitigating PR, underscoring the centrality of calibrated trust for fully autonomous aerial systems, similar to what has been observed in driving automation studies (*33*, *36*). In addition, income and technology familiarity emerge as robust correlates across acceptance constructs, whereas age and education show limited associations, which suggests early autonomous eVTOL aircraft adopters can be characterized more by economic readiness and technological familiarity than by the sociodemographic factors typically reported in UAM-related surveys (*2*).

Limitations and Future Work

Several limitations of this study should be acknowledged. First, all responses were collected at a single time point, limiting the ability to examine how acceptance factors evolve as autonomous eVTOL technology progresses from concept to commercial implementation. Future longitudinal studies tracking attitude changes across technology development stages would provide a richer understanding of acceptance dynamics. For similar reasons, as autonomous eVTOL aircraft are fast evolving, we did not focus on how specific types or features of them can affect users' acceptance, but focused on the influence of social-psychological factors on autonomous eVTOL technologies in general. Additionally, the research relies on self-reported intentions rather than observed behaviors, potentially introducing social desirability bias. As eVTOL aircraft services become available, studies incorporating actual usage behaviors will strengthen the validity of our conclusions. Laboratory simulations, virtual reality experiences, or controlled demonstration flights in future research would provide more ecologically valid responses. Furthermore, we did not control for gender or the balance of other demographic information in the study. Though this may provide more information about the sector of the population that is more interested in eVTOL technologies, the results might be biased toward a specific group. Future research, with balanced demographic information, may be needed to validate our findings. Finally, we only considered a limited number of potential influential factors. For example, we omitted the regional effect, given the multidimensionality of the region factor (e.g., region might be related to both educational level and weather conditions). Further research is needed to better understand other factors that may shape potential users' trust in eVTOL aircraft.

Conclusion

This study examined public acceptance of autonomous eVTOL technology through an extended TAM incorporating trust and PR constructs. Analysis of survey data from 412 respondents validated the proposed theoretical framework, identifying PU as the primary determinant of BI. Further, trust was recognized as a foundational factor positively associated with BI, PU, and PEOU, while negatively associated with PR. This multi-pathway influence of trust highlights its crucial role in shaping users' acceptance of future autonomous aerial mobility. Notably, heterogeneity of the population was observed, with technology familiarity and income level strongly correlating with constructs of the TAM model.

In summary, based on the findings from our study, efforts of the stakeholders can affect each other dynamically: the design of eVTOL aircraft by the manufacturers can affect service capabilities; regulatory frameworks can influence manufacturer priorities; and service providers' feedback can shape both eVTOL product development and regulations. Thus, only by coordinating efforts from the stakeholders and recognizing the unique characteristics of aerial autonomous mobility can the distinctive challenges identified in our model be effectively addressed.

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Author Contributions

The authors confirm contribution to the paper as follows: study conception and design: H. Li, Y. Yang, D. He; data collection: H. Li, Y. Yang; analysis and interpretation of results: H. Li, Y. Yang; draft manuscript preparation: H. Li, D. He. All authors reviewed the results and approved the final version of the manuscript.

Declaration of Conflicting Interests

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Ethics Approval

This study was approved by the Human and Artifacts Research Ethics Committee at the Hong Kong University of Science and Technology (Guangzhou) (HKUST(GZ)-HSP-2024-0084).

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Data will be made available on request by contacting D. He.

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