

## **An Assessment of Consumer Acceptance of UAV Delivery Services: An Extended Technology Acceptance Model Approach in Shenzhen, China**

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### **Abstract**

Unmanned aerial vehicle (UAV) delivery offers a promising solution for urban last-mile logistics, but consumer acceptance remains critical to its wider adoption. This study applies an extended Technology Acceptance Model (TAM) to examine consumer acceptance of UAV delivery services in Shenzhen, China. The model includes seven external factors: subjective norms, delivery accuracy, service convenience, perceived price level, self-efficacy, service quality, and UAV delivery service anxiety. Data from 617 valid questionnaires were analyzed using SPSS 29.0 and AMOS 24.0 through descriptive analysis, reliability testing, exploratory factor analysis, confirmatory factor analysis, and structural equation modeling. The results indicate a moderate-to-positive level of acceptance. Overall, 46.84% of respondents expressed positive attitudes toward UAV delivery, while 53.48% preferred it to traditional delivery methods. The measurement model showed satisfactory fit, whereas the structural model showed acceptable absolute fit but marginal incremental fit. Perceived ease of use, subjective norms, delivery accuracy, and service convenience positively affected perceived usefulness, while perceived price level was not significant. Self-efficacy and service quality positively affected perceived ease of use. UAV delivery service anxiety showed a significant positive effect, contrary to H8; therefore, H8 was not supported. Perceived usefulness and perceived ease of use both positively affected behavioral intention. These findings provide context-specific evidence for the extended TAM and practical implications for service providers, platform designers, and policymakers.

**Keywords:** UAV Delivery, Technology Acceptance Model (TAM), Behavioral Intention, Consumer Behavior, Structural Equation Modeling (SEM), Extended TAM

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## 1. INTRODUCTION

Unmanned aerial vehicle (UAV) delivery has emerged as a transformative logistics solution, offering enhanced efficiency, reduced operational costs, and improved distribution flexibility in last-mile delivery. The global UAV market is projected to reach USD 42.8 billion by 2025, while China's logistics UAV sector reached 2.157 billion yuan in 2020, reflecting rapid industrial growth. Shenzhen, as China's leading technology hub and pilot city for UAV delivery, has witnessed large-scale trials by enterprises such as Meituan, with average delivery times reduced to 12 minutes—far faster than traditional ground transport. Despite these technological advancements and market potential, consumer acceptance remains a critical bottleneck for the widespread adoption of UAV delivery (Liu et al., 2020; Yoo et al., 2018). Although prior research has examined the technical feasibility and operational performance of UAV delivery, empirical evidence on consumer acceptance in Chinese urban settings remains limited. In particular, the joint effects of social, service-related, economic, and psychological factors on perceived usefulness, perceived ease of use, and behavioral intention remain underexplored. To address this gap, this study extends TAM with seven context-specific factors and tests the model among consumers in Shenzhen. Subjective norms, delivery accuracy, service convenience, and perceived price level are examined as predictors of perceived usefulness. Self-efficacy, service quality, and UAV delivery service anxiety are examined as predictors of perceived ease of use. Perceived usefulness and perceived ease of use are then examined as predictors of behavioral intention. The study offers a context-specific application and empirical validation of TAM in urban UAV delivery.

## 2. RESEARCH OBJECTIVES

This study aims to comprehensively evaluate the overall acceptance and preference of Shenzhen consumers toward UAV delivery services and identify the key determinants shaping their adoption intentions within an emerging market context. Against the backdrop of insufficient empirical research on consumer psychology in Chinese urban logistics and the limited explanatory power of the classic Technology Acceptance Model (TAM) in capturing context-specific concerns, this research extends the traditional TAM framework by incorporating seven social, service-related, and psychological external variables to systematically examine their effects on perceived usefulness, perceived ease of use, and behavioral intention. The specific objectives are as follows:

- 2.1 To assess the current level of consumer acceptance and the proportion of respondents who prefer UAV delivery to traditional delivery methods in Shenzhen.
- 2.2 To examine how the seven extended variables influence perceived usefulness and perceived ease of use, which subsequently shape behavioral intention.
- 2.3 To assess the reliability and validity of the measurement model and evaluate the fit of the structural model.
- 2.4 To derive context-specific theoretical implications and practical recommendations for UAV service providers, platform designers, and policymakers.

## 3. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

### 3.1 UAV Delivery Services

UAV delivery has evolved from military to civilian applications, emerging as a transformative logistics solution with notable speed and efficiency advantages (Pei et al., 2023). In China, especially Shenzhen, UAV delivery has achieved significant operational gains and market growth (Guo, 2023). Beyond performance benefits, it supports green logistics and emergency response capabilities. However,

adoption is constrained by technical, regulatory, and consumer-related challenges (Tu & Piramuthu, 2024). Existing research overlooks user psychology, creating a critical gap in understanding urban Chinese acceptance.

### 3.2 Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) is a robust framework for explaining technology adoption, focusing on perceived usefulness and ease of use (Marangunić & Granić, 2015). TAM has been widely validated and applied to UAV delivery research, confirming its predictive power (Choe et al., 2021; Fang et al., 2024; Waris et al., 2022). The original TAM lacks context-specific factors relevant to UAV logistics. This study extends TAM by integrating psychological and service-related variables. It aims to examine consumer acceptance of UAV delivery in Shenzhen.

### 3.3 Additional Factors

Drawing on the existing literature and the unique characteristics of UAV delivery services, this study extends the TAM by incorporating seven additional factors: subjective norms, delivery accuracy, service convenience, perceived price level, self-efficacy, service quality, and UAV delivery service anxiety (Figure 1).

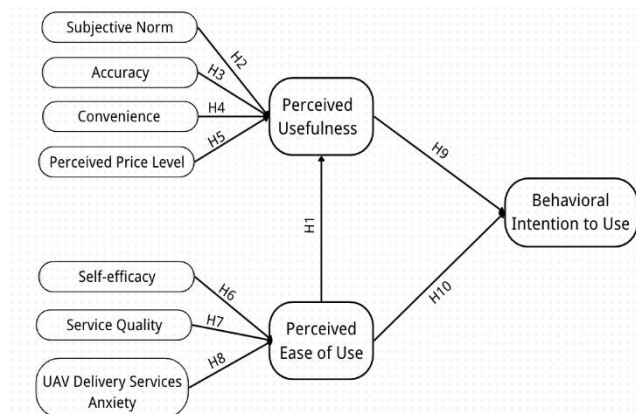


**Figure 1** Conceptual Framework: An Extended Technology Acceptance Model for UAV Delivery Services (Adapted from Davis et al., 1989)

### 3.4 Extended TAM

Subjective norms reflect social pressure to adopt new technologies, shaped by peers and community attitudes. They significantly influence user acceptance in logistics innovations (Waris et al., 2022). Accuracy denotes reliable, on-time and location-specific order fulfillment. It is a core logistics attribute that builds trust and perceived usefulness (Xue et al., 2022). Convenience refers to time-saving and simplified delivery processes. It enhances perceived usefulness by improving efficiency and user experience (Pei et al., 2023). Perceived price level reflects consumers' evaluation of the cost and value of UAV delivery. From a cost–benefit perspective, a higher perceived price may reduce the service's perceived usefulness (Ananth,

2023). However, during the early stage of commercialization, consumers may place greater emphasis on speed, convenience, and service experience than on price. Self-efficacy represents user confidence in using UAV systems. It positively shapes perceived ease of use and adoption intention. Service quality encompasses platform performance, feedback and support. It reduces user burden and improves perceived ease of use (Siswanto et al., 2021). UAV delivery service anxiety refers to concerns about flight safety, payment security, privacy, and technical reliability. Such concerns may increase psychological burden and make the service appear more difficult to use (Tu & Piramuthu, 2024; Wei et al., 2022; Yoo et al., 2018).

### 3.5 Hypothesis Development

Based on TAM and its extended variables, this study proposes ten hypotheses (Table 1), with perceived usefulness and perceived ease of use as core mediators of UAV delivery adoption intention (Choe et al., 2021; Liu et al., 2020; Waris et al., 2022; Yoo et al., 2018). H1: Perceived ease of use has a positive impact on perceived usefulness. H2: Subjective norms have a positive impact on perceived usefulness. H3: Accuracy has a positive impact on perceived usefulness. H4: Convenience has a positive impact on perceived usefulness. H5: Perceived price level has a negative effect on perceived usefulness. H6: Self-efficacy has a positive impact on perceived ease of use. H7: Service quality has a positive impact on perceived ease of use. H8: UAV delivery service anxiety has a negative effect on perceived ease of use. H9: Perceived usefulness has a positive impact on behavioral intention to use UAV delivery services. H10: Perceived ease of use has a positive impact on behavioral intention to use UAV delivery services.

**Table 1** Summary of Hypotheses

| Hypothesis | Path                                                 | Expected Direction |
|------------|------------------------------------------------------|--------------------|
| H1         | Perceived Ease of Use → Perceived Usefulness         | Positive           |
| H2         | Subjective Norm → Perceived Usefulness               | Positive           |
| H3         | Accuracy → Perceived Usefulness                      | Positive           |
| H4         | Convenience → Perceived Usefulness                   | Positive           |
| H5         | Perceived Price Level → Perceived Usefulness         | Negative           |
| H6         | Self-Efficacy → Perceived Ease of Use                | Positive           |
| H7         | Service Quality → Perceived Ease of Use              | Positive           |
| H8         | UAV Delivery Service Anxiety → Perceived Ease of Use | Negative           |
| H9         | Perceived Usefulness → Behavioral Intention to Use   | Positive           |
| H10        | Perceived Ease of Use → Behavioral Intention to Use  | Positive           |

## 4. METHODS

### 4.1 Data Collection

This study employed a quantitative cross-sectional survey design to examine consumer acceptance of UAV delivery services in Shenzhen, China. The study population comprised Shenzhen residents from diverse age groups and socioeconomic backgrounds. Data were collected between July and August 2025 using a mixed-mode, non-probability sampling strategy. The online survey was distributed through Google Forms using convenience sampling, while paper-based questionnaires were administered through intercept sampling at selected urban locations in Shenzhen. The questionnaire was developed based on the extended Technology Acceptance Model, and all constructs were measured using a five-point Likert scale ranging from 1 (“strongly disagree”) to 5 (“strongly agree”). After excluding incomplete and internally inconsistent responses, 617 questionnaires were retained for analysis. Before completing the survey, respondents were informed of the study’s academic purpose. For respondents under the age of 18, informed consent was obtained from both the participants and their legal guardians. Participation was voluntary and anonymous, and no personally identifiable information was collected.

### 4.2 Data Analysis

Data analysis was conducted using SPSS 29.0 for descriptive statistics, reliability, and exploratory factor analysis (EFA), and AMOS 24.0 for confirmatory factor analysis (CFA) and structural equation modeling (SEM). First, descriptive statistics were computed to summarize demographic characteristics and response distributions. Second, reliability analysis was performed using Cronbach’s alpha coefficient, with  $\alpha > 0.7$  as the threshold for acceptable internal consistency (Kilic, 2016). Third, exploratory factor analysis (EFA) was conducted with  $KMO > 0.7$  and Bartlett’s test of sphericity ( $p < 0.001$ ) to assess construct validity (Nasidi et al., 2022). Fourth, confirmatory factor analysis (CFA) was applied to evaluate convergent validity factor loadings  $> 0.6$ , composite reliability (CR)  $> 0.7$ , average variance extracted (AVE)  $> 0.5$  and discriminant validity via the Fornell-Larcker criterion (Alavi et al., 2020). Finally, structural equation modeling (SEM) was employed to test the proposed relationships among the extended TAM constructs, with model fit evaluated using  $CMIN/DF < 5$ ,  $RMSEA < 0.08$ ,  $CFI > 0.9$ . Path coefficients and their corresponding significance levels were examined to determine whether each hypothesis was supported. A p-value below 0.05 was used as the criterion for statistical significance. Significance levels were reported as follows: \*\*\*  $p < 0.001$ , \*\*  $p < 0.01$ , and \*  $p < 0.05$ . In addition to statistical significance, the magnitude of standardized path coefficients was considered when interpreting the practical strength of each relationship. Therefore, paths with small coefficients were interpreted as weak effects even when they reached statistical significance.

## 5. RESULTS

### 5.1 Sample Demographics

A total of 617 valid responses were analyzed. As shown in Table 2, respondents aged 18–49 accounted for 80.07% of the sample, while 70.51% held a bachelor's degree or above. These figures describe the demographic composition of the sample and do not establish differences in acceptance across demographic groups.

**Table 2** Selected Demographic Characteristics of Respondents (N = 617)

| Item      | Option                              | Frequency | Percent |
|-----------|-------------------------------------|-----------|---------|
| Age       | Less than 18 years old              | 64        | 10.37%  |
|           | 18-29 years old                     | 297       | 48.14%  |
|           | 30-49 years old                     | 197       | 31.93%  |
|           | 50 years old and above              | 59        | 9.56%   |
| Education | High school and below               | 182       | 29.50%  |
|           | Bachelor                            | 312       | 50.57%  |
|           | Master's degree candidate and above | 123       | 19.94%  |

Overall, 53.48% of respondents preferred UAV delivery to traditional delivery methods. Nearly half reported limited knowledge of UAV operation, while 38.74% demonstrated relatively high familiarity. These findings describe preferences and familiarity within the sample; demographic differences in acceptance were not statistically tested.

### 5.2 Exploratory Factor Analysis and Reliability Analysis

The results of the study showed that the Cronbach's alpha values of all factors ranged from 0.716 to 0.879 (Table 4), which were all higher than the generally accepted threshold of 0.70, confirming the internal consistency and reliability of the constructs (Kilic, 2016). The constructs were measured and analyzed using exploratory factor analysis (EFA) with principal component analysis and varimax rotation. The ten extracted factors, corresponding to the study's constructs, accounted for 73.54% of the total variance, exceeding the acceptable threshold of 60%. In addition (Table 3), the KMO statistic was 0.766, and Bartlett's test of sphericity was significant ( $\chi^2 = 5477.222$ ,  $df = 351$ ,  $p < 0.001$ ), indicating that the variables were suitable for factor analysis (Nasidi et al., 2022). Since all factor loadings exceeded 0.50, the constructs demonstrated adequate convergent validity. In Table 4, the average variance extracted (AVE) values range from 0.52 to 0.78, surpassing the recommended threshold of 0.5, confirming sufficient variance explanation. Additionally, the composite reliability (CR) values range from 0.72 to 0.88, all above

the 0.7 threshold, indicating strong internal consistency among the items. Discriminant validity was also supported because the square root of each construct's AVE exceeded its correlations with the other constructs, in accordance with the Fornell–Larcker criterion. The measurement model demonstrated satisfactory fit, with CMIN/DF = 1.936, RMSEA = 0.042, GFI = 0.928, NFI = 0.903, CFI = 0.950, and AGFI = 0.902. These results support the reliability and convergent validity of the measurement model.

**Table 3** KMO and Bartlett's Test of Sphericity

|                                                  |                    |          |
|--------------------------------------------------|--------------------|----------|
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. |                    | 0.766    |
| Bartlett's Test of Sphericity                    | Approx. Chi-Square | 5477.222 |
|                                                  | df                 | 351      |
|                                                  | Sig.               | <.001    |

**Table 4** Convergent Validity and Alpha

| Variate                           | Item | Estimate | AVE  | C.R. | Alpha |
|-----------------------------------|------|----------|------|------|-------|
| Subjective Norm: SN               | SN3  | 0.67     | 0.60 | 0.81 | 0.805 |
|                                   | SN2  | 0.93     |      |      |       |
|                                   | SN1  | 0.69     |      |      |       |
| Accuracy: A                       | A2   | 0.87     | 0.68 | 0.81 | 0.807 |
|                                   | A1   | 0.78     |      |      |       |
| Convenience: C                    | C2   | 0.72     | 0.56 | 0.72 | 0.716 |
|                                   | C1   | 0.78     |      |      |       |
| Perceived Price Level: PPL        | PPL2 | 0.90     | 0.78 | 0.88 | 0.879 |
|                                   | PPL1 | 0.87     |      |      |       |
| Self-efficacy: SE                 | SE3  | 0.69     | 0.54 | 0.77 | 0.768 |
|                                   | SE2  | 0.88     |      |      |       |
|                                   | SE1  | 0.61     |      |      |       |
| Service Quality: SQ               | SQ3  | 0.68     | 0.55 | 0.78 | 0.780 |
|                                   | SQ2  | 0.87     |      |      |       |
|                                   | SQ1  | 0.66     |      |      |       |
| UAV Delivery Service Anxiety: ANX | ANX3 | 0.63     | 0.56 | 0.79 | 0.781 |
|                                   | ANX2 | 0.92     |      |      |       |
|                                   | ANX1 | 0.67     |      |      |       |
| Perceived Usefulness: PU          | PU3  | 0.67     | 0.56 | 0.79 | 0.781 |
|                                   | PU2  | 0.91     |      |      |       |
|                                   | PU1  | 0.64     |      |      |       |
| Perceived Ease of Use: PEU        | PEU3 | 0.66     | 0.52 | 0.77 | 0.767 |
|                                   | PEU2 | 0.77     |      |      |       |
|                                   | PEU1 | 0.74     |      |      |       |
| Behavioral Intention to Use: BI   | BI3  | 0.70     | 0.54 | 0.77 | 0.766 |
|                                   | BI2  | 0.86     |      |      |       |
|                                   | BI1  | 0.62     |      |      |       |

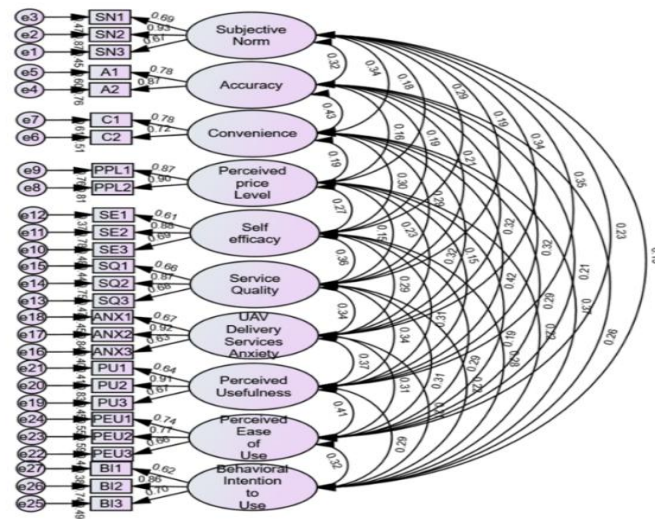


**Figure 2** Model diagram of confirmatory factor analysis

### 5.3 Hypotheses Testing

The SEM results are presented in Table 5. Using the 95% confidence criterion, a p-value less than 0.05 indicates a significant effect. The structural model yielded a CMIN/DF value of 3.253 and an RMSEA value of 0.055, indicating acceptable absolute fit. However, the CFI value of 0.865 and the TLI value of 0.849 were below the conventional threshold of 0.90. Therefore, the overall model fit should be interpreted as mixed rather than robust, and the structural estimates should be interpreted with appropriate caution. Of the ten hypotheses, eight were supported. H5 was not supported because the effect of perceived price level was not statistically significant, whereas H8 was not supported because the significant coefficient was opposite to the hypothesized direction. Perceived ease of use had a significant positive effect on perceived usefulness ( $\beta = 0.341$ ,  $p < 0.001$ ). Subjective norms ( $\beta = 0.202$ ,  $p < 0.001$ ), service convenience ( $\beta = 0.203$ ,  $p < 0.001$ ), and delivery accuracy ( $\beta = 0.110$ ,  $p = 0.004$ ) also positively affected perceived usefulness. However, the effect of delivery accuracy was relatively weak. Perceived price level had no significant effect on perceived usefulness ( $\beta = 0.014$ ,  $p = 0.700$ ); therefore, H5 was not supported. Self-efficacy ( $\beta = 0.181$ ,  $p < 0.001$ ) and service quality ( $\beta = 0.192$ ,  $p < 0.001$ ) positively affected perceived ease of use. UAV delivery service anxiety had a significant positive effect on perceived ease of use ( $\beta = 0.224$ ,  $p < 0.001$ ). However, because the observed direction was contrary to the negative relationship proposed in H8, the hypothesis was not supported. Finally, perceived usefulness ( $\beta = 0.214$ ,  $p < 0.001$ ) and perceived ease of use ( $\beta = 0.267$ ,  $p < 0.001$ ) both positively affected behavioral intention.

**Table 5** Results of Hypotheses Testing (Note: \*\*\*  $p < 0.001$ , \*\*  $p < 0.01$ , \*  $p < 0.05$ )

| Hypothesis  | Estimate | C.R.  | p-value | Decision      |
|-------------|----------|-------|---------|---------------|
| H1: PEU→PU  | 0.341    | 5.617 | ***     | Supported     |
| H2: SN→PU   | 0.202    | 4.129 | ***     | Supported     |
| H3: A→PU    | 0.110    | 2.882 | 0.004   | Supported     |
| H4: C→PU    | 0.203    | 3.765 | ***     | Supported     |
| H5: PPL→PU  | 0.014    | 0.385 | 0.700   | Not supported |
| H6: SE→PEU  | 0.181    | 3.672 | ***     | Supported     |
| H7: SQ→PEU  | 0.192    | 3.936 | ***     | Supported     |
| H8: ANX→PEU | 0.224    | 4.278 | ***     | Not supported |
| H9: PU→BI   | 0.214    | 3.550 | ***     | Supported     |
| H10: PEU→BI | 0.267    | 3.941 | ***     | Supported     |

## 6. Discussion and Conclusion

This study empirically investigates consumer acceptance of UAV delivery services in Shenzhen using an extended Technology Acceptance Model (TAM) with seven social, service-related, economic, and psychological variables, based on 617 valid responses. The study provides context-specific evidence on the application of the extended TAM to UAV delivery in a major Chinese city. The measurement model demonstrated satisfactory reliability and validity, whereas the structural model showed acceptable absolute fit (RMSEA = 0.055) but marginal incremental fit, as the CFI (0.865) and TLI (0.849) were below the conventional threshold of 0.90; therefore, the structural results should be interpreted with appropriate caution. Perceived usefulness ( $\beta = 0.214$ ,  $p < 0.001$ ) and perceived ease of use ( $\beta = 0.267$ ,  $p < 0.001$ ) significantly increased behavioral intention, with perceived ease of use exerting the stronger direct effect and positively influencing perceived usefulness. This finding is consistent with the core assumptions of TAM and prior research on UAV delivery adoption (Davis et al., 1989; Waris et al., 2022). Subjective norms and service convenience positively affected perceived usefulness, while delivery accuracy had a significant but relatively weak effect, suggesting that consumers may regard accurate delivery as a basic service requirement rather than a distinctive advantage. Perceived price level did not significantly affect perceived usefulness ( $\beta = 0.014$ ,  $p = 0.700$ ); therefore, H5 was not supported. This finding contrasts with Jasim et al. (2022), who reported that price sensitivity significantly influenced behavioral intention toward drone food delivery services. The difference may be attributable to variations in construct operationalization and market context: Jasim et al. examined price sensitivity as a direct antecedent of behavioral intention among Malaysian consumers, whereas the present study assessed perceived price level as an antecedent of perceived usefulness in Shenzhen. At the current stage of commercialization, Shenzhen consumers may place greater emphasis on convenience, delivery speed, usability, and service reliability than on price. Nevertheless, this interpretation remains tentative because actual delivery fees and respondents' exposure

to promotional pricing were not measured. However, this interpretation remains tentative because actual delivery fees and respondents' exposure to promotional pricing were not measured in this study. Self-efficacy and service quality positively affected perceived ease of use, indicating that user confidence and reliable platform support can reduce perceived difficulty. Contrary to the hypothesized negative relationship, UAV delivery service anxiety had a significant positive effect on perceived ease of use ( $\beta = 0.224, p < 0.001$ ); therefore, H8 was not supported. This unexpected result may indicate that concerns about flight safety, payment security, and privacy can coexist with perceptions of operational ease. Respondents who are more familiar with UAV delivery may understand how the service operates while remaining aware of its potential risks (Wei et al., 2022; Yoo et al., 2018). Nevertheless, this interpretation is exploratory, and future studies should revalidate the anxiety scale and examine the effects of prior experience and technology familiarity. The theoretical contribution of this study lies in its context-specific extension and empirical validation of TAM rather than in the development of a fundamentally new theory. From a practical perspective, UAV service providers should simplify ordering, tracking, and collection procedures, improve service reliability and customer support, and communicate safety and privacy measures clearly (Kellermann et al., 2023; Tu & Piramuthu, 2024; Wei et al., 2022). Policymakers should also strengthen regulations concerning flight safety, data protection, service liability, and consumer rights. The study is limited by its cross-sectional design, non-probability sampling strategy, single-city setting, marginal structural-model fit, and unexpected anxiety result. Future studies should adopt longitudinal, cross-regional, and subgroup-based designs to further validate the proposed relationships.

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