Guangxi Logistics Users' Cognition and Adoption Willingness for Drone Delivery in the Low-Altitude Economy

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Abstract: The low-altitude economy, as a major national strategic initiative, has emerged as a key research focus in the logistics sector, with drone delivery—an innovative logistics model—demonstrating significant potential in improving delivery efficiency and extending service coverage. Based on users' demographic, psychological, and behavioral characteristics in Guangxi, this study conducts an empirical analysis using Structural Equation Modeling (SEM) based on data from 768 valid questionnaires, aiming to identify the determinants of drone delivery adoption among Guangxi users. The findings reveal that perceived usefulness and perceived convenience significantly and positively influence users' intention to use drone delivery. Risk perception heightens anxiety and negatively affects usage intention. Users generally exhibit caution toward adopting drone delivery, while social influence is found to be statistically insignificant.

Keywords: Low-Altitude Economy; Drone Delivery; Usage Intention; Technology Acceptance Model (TAM)

1. Introduction

The advent of the low-altitude economy signifies a profound transformation within the global economic landscape, emerging as a pivotal engine for future growth. Characterized by the commercial utilization of airspace at altitudes traditionally below 300 meters, this burgeoning sector leverages unprecedented advancements in aviation technology, sophisticated digital infrastructure, and proactive regulatory frameworks to unlock substantial economic value. By enabling novel applications and services, the low-altitude economy is fundamentally reshaping traditional industrial paradigms across logistics, transportation, agriculture, emergency response, and urban management. Its development hinges critically on synergistic technological innovation and strategic policy support, fostering environments where efficiency, safety, and scalability can converge.

With in this dynamic sector, drone delivery stands out as a cornerstone application, particularly revolutionizing logistics paradigms. The inherent efficiency and flexibility of unmanned aerial vehicles (UAVs) position them as critical enablers for overcoming persistent geographical barriers – such as challenging terrain, urban congestion, or dispersed rural populations – that traditionally hamper the speed and cost-effectiveness of last-mile delivery. Furthermore, UAVs offer significant potential for optimizing resource allocation, enabling rapid responses in medical supply chains, reducing carbon footprints compared to traditional road freight for certain tasks, and enhancing overall logistical resilience. Recognizing this potential, the sector is experiencing robust growth: China's civilian drone industry exemplifies this trajectory, achieving a substantial market size of approximately 20 billion yuan (RMB) in 2024. Projections indicate an accelerating trend, with the market anticipated to reach approximately 30 billion yuan by 2025, underscoring rapid adoption and commercial scaling. Dominating this landscape, firms like DJI Innovations command a formidable presence, accounting for over 60% of the domestic market share, reflecting both technological leadership and intense market consolidation. Consequently, drone delivery represents not merely an incremental innovation, but a disruptive force with the capacity to redefine global supply chains, driven by the synergistic forces of technological maturation and supportive economic policies within the broader low-altitude ecosystem.

Developed nations including the United States and Germany have initiated policy pilots to advance the early deployment of Urban Air Mobility (UAM) and Advanced Air Mobility (AAM). In parallel, China has explicitly endorsed the development of the low-altitude economy through national policies such as the National Comprehensive Multi-Dimensional Transportation Network Planning Outline and the Innovation and Application Implementation Plan for General Aviation Equipment. Numerous regions have established pilot zones and provided financial incentives[1], offering strategic guidance for the promotion of drone delivery.

As a gateway for China–ASEAN open cooperation, Guangxi's mountainous terrain and diverse urban-rural logistics demands present ideal use cases for drone applications. Drone delivery offers substantial benefits: it can improve delivery timeliness in remote areas by over 50%, reduce logistics costs by 30%, and contribute to a 25% reduction in carbon emissions from logistics operations through electric propulsion[2]. Since the release of the Guangxi Low-Altitude Flight Service Support System Construction Plan in 2021, the region has been actively building an efficient and intelligent low-altitude economic ecosystem. Nevertheless, existing research on the low-altitude economy largely emphasizes technological advancements and industrial chain development, with limited empirical investigation into regional adaptability and user perceptions. Therefore, examining Guangxi logistics users' awareness and willingness to adopt drone delivery not only addresses regional research gaps but also provides empirical evidence to inform policy design and commercial strategies.

Grounded in the dynamic evolution of the global low-altitude economy – a transformative paradigm leveraging underutilized airspace beneath approximately 300 meters – this research undertakes a critical investigation into user acceptance mechanisms for drone delivery services within the specific context of Guangxi, China. Recognizing drone delivery as a pivotal technological innovation reshaping last-mile logistics, the study addresses a significant knowledge gap regarding the factors driving user adoption in developing regional economies. To provide a comprehensive theoretical foundation, it innovatively integrates the Technology Acceptance Model (TAM) – focusing on perceived usefulness and ease of use – and the Theory of Planned Behavior (TPB) – emphasizing attitudes, subjective norms, and perceived behavioral control. This synthesized framework forms a robust analytical lens specifically designed to dissect users' cognitive perceptions and multidimensional behavioral intentions associated with this emerging logistics modality. They are expected to yield actionable insights critical for policymakers tasked with refining regional low-altitude economy strategies and regulatory frameworks in Guangxi and analogous regions. Concurrently, logistics enterprises stand to benefit by leveraging these insights to develop differentiated and user-aligned service offerings, enhancing market penetration and operational efficacy. Ultimately, this research seeks to contribute valuable knowledge that facilitates the effective and sustainable integration of drone delivery technologies within the burgeoning broader smart logistics ecosystems, thereby advancing regional economic development and logistical resilience.

2. Theory and Model Selection

The Technology Acceptance Model (TAM), introduced by Davis, was developed within the framework of the Theory of Reasoned Action (TRA) and applied to the domain of information systems to explain individuals' adoption of new technologies[3]. At its core, TAM posits that two key perceptions—Perceived Usefulness (PU) and Perceived Ease of Use (PEOU)—directly influence users' attitudes and behavioral intentions toward technology use. Specifically, PEOU positively affects PU, and both are influenced by external variables such as system design, training, or organizational context.

Building on the original TAM, Venkatesh and Davis proposed an extended version that incorporates social influence constructs—such as subjective norm, image, and perceived voluntariness—as well as cognitive instrumental factors including job relevance and output quality[4]. This enhanced model provides a more comprehensive account of how users form behavioral intentions in organizational and complex technological settings, thereby addressing the limitations of the original TAM in explaining technology adoption beyond individual-level perceptions.

Following TAM, numerous scholars have extended the theoretical framework by incorporating additional determinants such as subjective norm, perceived risk, and facilitating conditions. Researchers have also integrated insights from interdisciplinary theories—including the Diffusion of Innovations (DOI) theory, which emphasizes relative advantage and compatibility, and the Uses and Gratifications (U&G) theory, which focuses on user motivations—to better capture the multifaceted nature of technology adoption. Notably, Venkatesh synthesized eight major technology acceptance models into the Unified Theory of Acceptance and Use of Technology (UTAUT), establishing a comprehensive framework that identifies four core predictors of behavioral intention: performance expectancy, effort expectancy, social influence, and facilitating conditions[5]. This integrative approach significantly enhances the explanatory power of technology adoption models in diverse and emerging technological contexts.

In summary, TAM establishes the foundational understanding of user acceptance by emphasizing core perceptual factors—particularly perceived usefulness and perceived ease of use. UTAUT extends this foundation by incorporating broader contextual and social influences, thereby offering greater explanatory power in complex, real-world technology adoption scenarios. By integrating insights from both frameworks, this study develops a robust theoretical lens through which to examine Guangxi users' cognitive evaluations and behavioral intentions toward drone delivery, particularly within the evolving context of the low-altitude economy.

3. Research Design

3.1 Hypothesis Proposals

As an emerging and rapidly evolving field, the low-altitude economy often leads to ambiguous or hesitant user attitudes and behaviors toward its applications, due to factors such as technological novelty, regulatory uncertainty, and limited public familiarity. Based on the well-established Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT), this study develops an integrated theoretical framework and employs empirical data analysis to investigate the formation mechanisms of users' attitudes and behavioral intentions toward drone delivery services within the regional context of Guangxi. Specifically, the research examines and validates the influence paths of key independent variables derived from TAM and UTAUT—such as perceived usefulness, perceived ease of use, social influence, and facilitating conditions—on usage attitudes and subsequent adoption behaviors. When individuals encounter drone delivery services, their decision-making processes are shaped by a range of cognitive and social factors, including perceived usefulness, perceived convenience, perceived ease of use, and perceived social facilitation, which collectively affect their overall acceptance and willingness to use such innovative delivery solutions. Through theoretical review and deduction, the research hypotheses of this study are presented in Table 1.

Table 1. Research Hypotheses

Hypothesis	Content
H1	Perceived Usefulness has a positive impact on Usage Attitude
H2	Perceived Convenience has a positive impact on Usage Attitude
H3	Perceived Ease of Use has a positive impact on Usage Attitude
H4	Perceived Social Facilitation has a positive impact on Usage Attitude
H5	Perceived Risk has a negative impact on Usage Attitude
H6	Users' Self-Efficacy has a positive impact on Usage Attitude
H7	User Trust has a positive impact on Usage Attitude

3.2 Scale Selection and Questionnaire Design

This study integrates core constructs from the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT), incorporating perceived usefulness, perceived ease of use, effort expectancy, and social influence as key predictors of user acceptance. Measurement items for TAM constructs were adapted from established scales in prior research[3, 6] , with contextual adjustments based on recent studies in the Chinese context[7]. UTAUT constructs were measured using validated items from Abbad[8] and Jain[9]. Self-efficacy and trust were assessed using scales developed by Wang[10] and Yang[11], respectively. Behavioral intention to use drone delivery was measured using a scale adapted from Zhu and Fu [12], which itself draws on the foundational work of Venkatesh[5]. The questionnaire begins with a brief description of the research context, followed by screening items to assess respondents' prior awareness of drone delivery services. Only those who reported some level of familiarity were directed to complete the main survey. Demographic information was collected at the end.

3.3 Pre-Survey

A pre-survey was conducted to evaluate the questionnaire's clarity, reliability, and feasibility.

Participants were recruited from Guilin and its surrounding regions, with a focus on individuals familiar with drone delivery or interested in technological innovations. A total of 98 usable responses were collected. Internal consistency was assessed using Cronbach's alpha, and exploratory factor analysis (EFA) was performed to examine construct validity. Based on the pre-survey results and the rule of ten, the target sample size for the main survey was set at 800.

4. Data Collection and Data Analysis

4.1 Formal Survey and Data Validation

The data collection process for this study was meticulously designed and implemented to ensure both the relevance and quality of the responses. The questionnaire was developed and disseminated using the professional online survey platform "Wenjuanxing". To secure a diverse and representative sample of respondents, the survey was distributed through multiple channels, including social media platforms such as WeChat, referrals within personal and professional networks, and on-site invitations where participants could scan a QR code to access the questionnaire. This multi-pronged approach facilitated extensive reach across different demographic segments within Guangxi. The data collection phase spanned 43 days, after which an initial pool of 807 responses was gathered. To guarantee the validity and reliability of the data for subsequent analysis, a rigorous screening procedure was applied. This involved excluding questionnaires from respondents who indicated no prior knowledge of drone delivery services, as their responses would lack the necessary contextual understanding. Additionally, responses with excessively short completion times—suggesting inattentive or random answering—along with those originating from duplicate IP addresses, were removed as part of the data cleaning process. Following these exclusions, a total of 768 valid questionnaires were retained, resulting in a high valid response rate of approximately 95.2%, which provides a robust empirical foundation for the findings of this study.

4.2 Reliability and Validity Tests

The results showed that the Cronbach's α value of each variable was greater than 0.75, the KMO (Kaiser-Meyer-Olkin) value was 0.761, and the significance level was less than 0.000. These results indicate that the data has good reliability and its validity meets relevant standards, making it suitable for further data analysis. Second, to further explore the correlation between variables, Python was used to conduct a correlation analysis. The results revealed that all variables had a significant correlation ($p < 0.05$), confirming the suitability of the data for subsequent Structural Equation Modeling (SEM) testing.

4.3 Test of Hypothetical

To further validate the proposed model, Python was used to construct the SEM, and the Generalized Least Squares Structural Equation Modeling (GLS-SEM) method was adopted for data calculation to verify the relationships between variables in the model. All goodness-of-fit indicators met the required standards. Through calculation, the validation results of the hypothetical paths were obtained, as shown in Table 2. Additionally, a mediating effect test was conducted, with the results presented in Table 3.

Table 2. Results of Hypothesis Testing

Hypothesis	Path Relationship	Path Coefficient	p-value
H1	Perceived Usefulness → Usage Attitude	0.111	0.011
H2	Perceived Convenience → Usage Attitude	0.141	0.009
H3	Perceived Ease of Use → Usage Attitude	0.117	0.024
H4	Perceived Social Facilitation → Usage Attitude	-0.002	0.96
H5	Perceived Risk → Usage Attitude	0.095	0.036
H6	User Trust → Usage Attitude	0.076	0.046
H7	User Self-Efficacy → Usage Attitude	0.120	0.001

The results indicate the following: Perceived Usefulness has a significant positive impact on Usage Attitude (H1 is supported); Perceived Convenience has a significant positive impact on Usage Attitude (H2 is supported); Perceived Ease of Use has a significant positive impact on Usage Attitude (H3 is supported); Perceived Social Facilitation has no significant positive impact on Usage Attitude (H4 is not supported); Perceived Risk has a significant negative impact on Usage Attitude (H5 is supported); User Trust has a significant positive impact on Usage Attitude (H6 is supported); User Self-Efficacy has a significant positive impact on Usage Attitude (H7 is supported). Regarding the mediating effects: Perceived Usefulness, Perceived Convenience, and Perceived Risk exhibit a full mediating effect on Usage Attitude; Perceived Ease of Use and Perceived Social Facilitation show no mediating effect on Usage Attitude; User Trust and User Self-Efficacy demonstrate a partial mediating effect on Usage Attitude.

Table 3. Results of Mediating Effect Test

Independent Variable	Direct Effect	Indirect Effect	95%(Percentile) Confidence Interval	Total Effect
Perceived Usefulness	0.006	0.012	[-0.001, 0.040]	0.018
Perceived Convenience	0.027	0.016	[-0.005, 0.045]	0.043
Perceived Ease of Use	0.030	0.011	[-0.001, 0.036]	0.041
Perceived Social Facilitation	0.116	0.002	[-0.008, 0.013]	0.118
Perceived Risk	0.068	0.013	[-0.002, 0.038]	0.080
User Trust	0.097	0.009	[-0.000, 0.028]	0.106
Self-Efficacy	0.079	0.012	[-0.000, 0.028]	0.091

5. Conclusions and Recommendations

Users' perceptions of drone delivery—including Perceived Usefulness, Perceived Convenience, Perceived Ease of Use, Self-Efficacy, and Perceived Trust in Service Providers—all exert a significant positive impact on their Usage Attitude. In contrast, Perceived Risk demonstrates a notable negative effect on Usage Attitude, highlighting the importance of mitigating risk-related concerns in user adoption. Notably, users' Perceived Social Facilitation does not exhibit a statistically significant positive influence on Usage Attitude, a finding that aligns with earlier hypothesis testing outcomes. Building upon these conclusions, the following recommendations are proposed to foster the application and development of drone delivery within the logistics sector:

Logistics enterprises should place greater emphasis on promoting the usefulness of drone delivery by clearly illustrating its advantages in delivery timeliness and operational efficiency through the presentation of quantitative data and real-world implementation cases. At the same time, companies are encouraged to streamline delivery workflows and simplify operational requirements to elevate the overall perception of convenience among users.

In terms of enhancing Perceived Ease of Use, it is essential to provide comprehensive operational guidance through the development of clear and accessible instructional materials that can be distributed via digital platforms. Such efforts contribute to reducing the technical and cognitive barriers that users may face when engaging with drone-based delivery systems.

To address users' Perceived Risk, it is critical to establish robust safeguard mechanisms that encompass compensation protocols for potential losses and reliable real-time monitoring of delivery operations. By transparently communicating these risk management strategies, enterprises can alleviate user apprehension and build a stronger sens of security.

Furthermore, logistics providers should strive to improve service quality and cultivate a professional brand image to reinforce user trust. Initiatives may include partnerships with established logistics entities to enhance credibility, as well as the implementation of end-to-end order tracking systems that offer users full visibility over the delivery process.

Enterprises are also advised to maintain consistent engagement with user feedback by establishing structured communication channels and refining services based on collected insights. Such user-centered improvements can holistically strengthen positive attitudes toward drone delivery.

Finally, relevant stakeholders should concentrate on optimizing critical aspects of the drone delivery ecosystem. By reinforcing service reliability, strengthening user communication, and steadily building a positive public reputation, the industry can effectively boost user acceptance of drone-assisted logistics. These measures will not only infuse innovation into the logistics landscape but also help the sector better align with evolving consumer expectations, thereby facilitating the broader integration and sustainable development of drone delivery models in diverse logistics scenarios.

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