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Aerial pathways to resilience: the acceptance of drones in logistics transformation

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Abstract

Amidst the tumultuous backdrop of the COVID-19 pandemic and the ensuing lockdowns, traditional parcel delivery services faced substantial disruptions, grappling with challenges such as delays, heightened demand, and the inherent risk of contact transmission. In contrast, this paper explores the promising prospect of drone delivery services as a resilient and efficient alternative during crises, offering a contactless delivery solution to circumvent the limitations endured by traditional services in times of unprecedented upheaval. This study examines the determinants of consumer acceptance of drone delivery services, focusing on the roles of perceived usefulness, ease of use, and privacy concerns. We collected data from 1,108 Portuguese consumers through an online survey to assess how these factors influence consumer attitudes and intentions toward adopting drone delivery services. Our findings confirm that perceived usefulness is the most significant predictor of both positive attitudes toward and intentions to adopt drone delivery services, underscoring the importance of practical benefits in technology acceptance. Perceived ease of use also positively impacts consumer attitudes and intentions, highlighting the role of usability in facilitating adoption. Conversely, perceived privacy concerns, while negatively affecting attitudes and intentions, do so marginally, suggesting that privacy issues are secondary to the perceived benefits and usability of the service. The study further reveals that the mediation effect of consumer attitudes weakens the relationship between these antecedents and adoption intentions, particularly diminishing the negative impact of privacy concerns. This research not only provides valuable insights for businesses seeking to implement drone package delivery services but also offers a theoretical foundation for future studies in the burgeoning field of innovative logistics solutions. As industries evolve, it is imperative to unravel the complexities of consumer perceptions to foster successful integration and acceptance of cutting-edge technologies.

Keywords Drone delivery service, Supply chain, Perceived ease of use, Perceived usefulness, Perceived privacy concerns

Introduction

During the COVID-19 pandemic, many countries implemented lockdowns and restrictions on movement to prevent the spread of the virus [1, 2]. This had a significant impact on traditional parcel delivery services, which were unable to operate as usual. The limitations of traditional parcel delivery during lockdowns included delays, increased demand, and the risk of contact transmission [3, 4]. However, drones have the potential to provide solutions in times of crisis. In crisis situations, the benefits of utilizing drones for last mile delivery become even more pronounced. Drones can navigate areas that

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are otherwise inaccessible due to natural disasters or other emergencies, ensuring that essential supplies such as food, medicine, and medical equipment reach those in need promptly. For example, autonomous unmanned aerial vehicles (UAVs) have been identified as a dominant option for delivering parcels in rural or disaster-stricken areas, where traditional delivery methods may face significant obstacles [5]. The efficiency and speed of drone deliveries can be life-saving in such scenarios, providing critical aid more quickly than ground-based options. UAVs and autonomous ground vehicles (AGVs) offer distinct advantages and limitations for delivery applications. AGVs excel in ground-based operations with higher payload capacity and energy efficiency but are constrained by road infrastructure and traffic conditions [6, 7]. In contrast, UAVs provide faster, more direct routes with the ability to bypass ground congestion but face challenges such as limited payloads, battery life, and stricter airspace regulations [8, 9]. Both technologies cater to different logistical needs, with UAVs suited for lightweight, time-sensitive deliveries and AGVs for heavier, routine transport.

The adoption of advanced aerial mobility (AAM) in urban and rural communities depends on technological advancements, regulatory frameworks, societal acceptance, and environmental impact [10]. Urban air mobility (UAM), a subset of AAM, focuses on integrating drones and aerial vehicles into metropolitan areas, contrasting with their use in rural settings [11]. This distinction is essential as operational environments significantly affect aerial systems'design, deployment, and regulation. Urban areas demand stringent air traffic management due to higher population densities, while rural regions prioritize long-range capabilities for agriculture and infrastructure tasks. UAM offers solutions to alleviate urban traffic congestion and reduce travel times [12]. Conversely, rural AAM applications often involve aerial photography, mapping, and inspection of infrastructure like power lines [13]. These differences necessitate specialized drone technologies and protocols to meet unique challenges, such as complex airspaces in urban areas or vast distances in rural settings [11].

Drone parcel delivery revolutionizes logistics by introducing direct, autonomous operations that bypass traditional constraints like road infrastructure. This approach reduces delivery times and allows dynamic route adjustments using real-time data, enhancing operational efficiency [14]. However, managing increased aerial traffic and ensuring compliance with safety and privacy regulations are critical challenges [15, 16]. Advanced air traffic management systems and updated regulatory frameworks are essential to coordinate drone movements and address airspace usage, safety, and privacy concerns.

The global market for drone parcel delivery is projected to grow to $13.32 billion by 2028, with North America leading adoption, followed by Europe and Asia–Pacific [17, 18]. Major players, including Amazon, Google, and DHL, along with startups like Zipline and Wing, are driving innovation in last mile delivery [19]. Competition is intensifying as new companies enter the market and expand operations [20]. In Portugal, the drone delivery market is expected to grow by 1.8% annually from 2024 to 2028, reaching $7.6 million in 2028 [21]. Portugal's geography and population density make it well-suited for drone delivery, but regulatory challenges and public perception issues remain barriers to widespread adoption [20, 22].

Key factors influencing consumer attitudes toward drone delivery services include perceived ease of use, usefulness, and privacy concerns. Studies indicate that consumers are less likely to adopt drone services if they perceive them as complex [23]. Perceived usefulness, such as speed and cost-effectiveness, increases adoption likelihood [24]. Privacy concerns, such as data security and potential surveillance, are significant barriers [25, 26]. Companies must design privacy-focused services and effectively communicate these measures to build consumer trust and increase adoption rates [25, 27].

Despite the growing interest in drone parcel delivery, gaps in research remain. There is limited understanding of how perceived ease of use influences attitudes and adoption intentions [28]. Similarly, the relationship between perceived usefulness and intention to adopt drones requires further exploration [29, 30]. Additionally, the impact of privacy concerns on attitudes and intentions is under-researched, despite its importance in the digital age [24]. Addressing these gaps is crucial for developing strategies that increase adoption intentions while mitigating concerns.

This study investigates how perceived ease of use, perceived usefulness, and perceived privacy concerns in relation to the drone parcel delivery service affect Portuguese consumers'attitudes and intentions to adopt this service. To this end, 1108 responses were collected from the Portuguese population.

The study makes six important contributions. Firstly, this study highlights that the perceived ease of use of the drone delivery service has a positive influence on both consumers'attitudes and adoption intentions. Secondly, the perceived usefulness of the service emerged as a key determinant, showing a significant positive impact on consumer attitudes and intentions. Thirdly, this study indicates that privacy concerns exert a negative influence on both attitudes and adoption intentions toward

drone delivery services. This finding underlines the need to actively address consumers'privacy concerns by implementing robust and transparent measures to protect sensitive data. Fourth, one of the most striking contributions is the finding that, among the factors examined, the perceived usefulness of the drone delivery service has the greatest influence on consumer attitudes and intentions. Fifthly, it is recommended that marketing strategies emphasize the simplicity of use and the practical benefits of the service, highlighting the ease with which consumers can take advantage of the drone delivery service. In addition, introducing transparent and proactive communication strategies and addressing privacy concerns can be crucial to building consumer trust. Finally, it is suggested that companies invest in continuous improvements to the perceived usefulness of the service, incorporating consumer feedback, which can be an effective strategy to boost acceptance and adoption.

Theoretical framework

At the nexus between supply chain resilience and the adoption of drones for parcel delivery lies a crucial intersection, where the well-established theories of planned behavior (TPB), the technology acceptance model (TAM), and the theory of reasoned action (TRA) illuminate the intricate link between individual attitudes and subsequent behavioral intentions. The theory of planned behavior (TPB) provides a theoretical basis for understanding the relationship between supply chain resilience and the acceptance of drones for parcel delivery [31]. TPB expands on the theory of reasoned action, which derives from social cognitive theories. TPB argues that an individual's behavioral intentions are influenced by their attitudes toward behavior, subjective norms, and perceived behavioral control [32–35]. In the context of drone delivery, an individual's attitude toward the use of drones for parcel delivery can significantly influence their behavioral intentions. If individuals consider drone delivery to be faster, cheaper and more efficient, they are more likely to accept it as a viable option [25].

The technology acceptance model (TAM) also provides a relevant framework for understanding the relationship between supply chain resilience and the acceptance of drone delivery [36]. TAM is a widely used model that explains the determinants of technology acceptance and end-user behavioral intention across a wide range of technologies [37]. The model is made up of five constructs: purchase/use intention, attitudes toward use, perceived benefit, perceived risk, and perceived control [23]. In the context of drone delivery, perceived benefits, such as increased efficiency and reduced delivery times, can influence an individual's attitudes toward using drones for parcel delivery. Perceived risks, such as security concerns and privacy issues, can also affect an individual's acceptance of drone delivery [38, 39].

The theory of reasoned action (TRA) also has implications for the acceptance of drones for parcel delivery [31]. TRA posits that an individual's behavioral intention is influenced by their attitudes toward the behavior and subjective norms. In the context of drone delivery, an individual's attitude toward using drones for parcel delivery can be influenced by subjective norms, such as the opinions of family and friends and the social pressure felt to adopt new technologies [25]. By understanding the theoretical underpinnings of the relationship between supply chain resilience and the acceptance of drone delivery, companies and policymakers can develop strategies to promote the adoption of drone delivery services, contributing to a more resilient and efficient supply chain [27, 40].

In the context of this study, the integration of theoretical frameworks such as the TPB, the TAM, and the TRA offers a comprehensive lens for understanding the factors influencing consumer adoption of emerging technologies like drone delivery services. TPB underscores the central role of attitudes in shaping behavioral intentions, emphasizing how positive evaluations can drive adoption. TAM contributes by highlighting how perceptions of ease of use and usefulness not only shape attitudes but also directly affect individuals' intentions to engage with new technologies. Furthermore, TRA provides a foundation for understanding the mediating role of attitudes in the relationship between perceptions and behavioral intentions while also accounting for how negative factors, such as privacy concerns, may adversely affect these dynamics. Collectively, these theories guide the development of nuanced propositions regarding the interplay between cognitive evaluations, emotional responses, and external concerns in shaping technology adoption behaviors.

Developing and formulating hypotheses

Supply chain resilience and the acceptance of drones for parcel delivery

There is a strong relationship between consumers'attitudes toward drone delivery services and their intentions to adopt the service [23, 41]. The consumer attitude reflects a "person's favorable or unfavorable assessment regarding the behavior in question," while consumer intention is a "measure of the strength of one's willingness to exert effort while performing certain behaviors" (Lee, 2009, p. 132). When consumers have a positive attitude toward the service, they are more likely to have positive emotions and intentions to use it [23, 41]. According to Yoo et al. [25], attitude toward drone delivery positively affects the intention to use it. Conversely, a negative attitude toward the service can lead to

negative emotions and intentions to use it. It is, therefore, essential to address consumers'attitudes toward drone delivery services in order to promote their adoption [43]. By identifying and addressing the factors that influence consumer attitudes, service providers can create a positive perception of the service, leading to increased intentions to adopt it.

It is crucial to address consumer attitudes toward drone delivery services when promoting their adoption [23]. With the rise of e-commerce and the growing demand for faster and more efficient delivery options, drone delivery has the potential to revolutionize the delivery sector [44]. However, the success of the service will depend on the willingness of consumers to adopt it. By understanding and addressing the factors that influence consumers'attitudes, service providers can create a positive perception of the service, leading to increased intentions to adopt it.

H1: Consumer attitudes positively influence consumers'intentions to adopt drone delivery services.

Antecedents to accepting drone package delivery services

Perceived ease of use

Perceived ease of use significantly impacts consumer decision-making by influencing perceived value and price sensitivity. When a product or service is easy to use, consumers are more likely to perceive it as valuable, which can enhance their willingness to pay a premium price [45]. This relationship is grounded in the notion that ease of use reduces the cognitive load and effort required to utilize a product, making it more attractive and justifiable even at higher prices. Wilson et al. [46] found that perceived ease of use directly correlates with consumers'loyalty and their readiness to invest more in products they find user-friendly. Additionally, when consumers perceive a product as easy to use, they often equate this with higher quality and reliability, further justifying a higher price point [46].

The correlation between ease of use and purchase speed is another critical aspect of consumer decision-making. Products that are perceived as easier to use tend to expedite the purchasing process, as consumers feel more confident and less hesitant to complete transactions [47, 48]. This speed in decision-making can be attributed to the reduced complexity and enhanced user experience, which minimizes the time spent on evaluating and comparing options. Saoula et al. [47], examining the impact of website design on customer engagement, found that ease of use significantly motivates quicker purchase decisions, underscoring the importance of intuitive design in e-commerce.

In the context of this study, perceived ease of use was first defined by Davis [49] as the ease or simplicity with which an individual uses a technology. Perceived ease of use refers to the degree to which an individual believes that using a particular technology will be effortless and uncomplicated [50]. In the context of drone delivery services, perceived ease of use can play a significant role in influencing consumers'attitudes and intentions to adopt this service [27]. Silva et al. [51] and Shahzad et al. [52] showed that consumers'perceived ease of use of online drone delivery positively affects their attitudes toward drone delivery services. This positive attitude, in turn, can lead to an increase in word-of-mouth recommendations and willingness to pay more for the service [27]. Therefore, perceived ease of use can be a crucial factor in the adoption of drone delivery services.

Consumer attitudes toward drone delivery services can be positively influenced by perceived ease of use. In other words, if consumers find the drone delivery service easy to use, they are more likely to have a positive attitude toward it [27, 44]. This positive attitude can lead to a greater intention to adopt the service [50].

According to Hwang et al. [53] and Shahzad et al. [52], perceived innovativeness, which is related to perceived ease of use, tends to have a positive influence on attitude toward using drone food delivery services and behavioral intention to use the service. In this way, perceived ease of use can have a direct impact on consumer attitudes toward drone delivery services.

H2: Perceived ease of use positively influences a) consumers'attitudes and b) consumers'intention to adopt drone delivery service.

The relationship between perceived ease of use and consumers'intentions to adopt drone delivery services can be mediated by attitude [27]. In other words, the positive effect of perceived ease of use on consumers'intentions to adopt the service can be explained by the positive attitude consumers have toward the service [50]. According to Mathew et al. [23], Ganjipour, Edrisi [54], Shahzad et al. [52], consumers'attitudes toward drone delivery tend to influence their behavioral intention to use drones positively. It can, therefore, be inferred that perceived ease of use can indirectly influence consumers'intentions to adopt drone delivery services through the mediation of attitude.

H2c: Perceived ease of use positively influences consumers'intentions to adopt drone delivery services when mediated by their attitude.

Perceived usefulness

Perceived usefulness significantly influences consumers'price sensitivity, often altering their willingness to pay. When consumers perceive a product or service as highly useful, they are more likely to justify a higher price point [46]. This relationship is grounded in the value derived from the perceived benefits, which can outweigh cost considerations. Perceived usefulness significantly impacts purchasing decisions, indicating that consumers may overlook higher prices if they see substantial utility [55].

The perceived usefulness of a product or service also plays a critical role in shaping consumers'expectations regarding the speed of delivery. When consumers find a product particularly useful, they tend to desire faster delivery times to maximize its benefits [56]. In online purchasing, the perceived usefulness directly influences consumer satisfaction, which in turn affects their expectations for quick service delivery [57]. The urgency to receive a highly useful product sooner rather than later underscores the importance of perceived usefulness in consumer decision-making. This desire for speed is often linked to the immediate value consumers expect to gain from the product.

In the context of this study, perceived usefulness refers to individuals'belief that using a specific technology will improve the performance of inherent tasks [58]. Previous research has demonstrated that perceived usefulness predicts consumer attitude, boosting its use, particularly in online retail stores [59] as well as your satisfaction and confidence [46]. Perceived usefulness shapes acceptance and intentions to use technologies [50]. In the case of the drone package delivery service, consumers consider this service useful if they perceive that this package delivery experience will be more beneficial [27, 41, 60]. As such, the perceived usefulness of this technology positively affects consumer attitudes [27, 53] and is a determining factor of behavioral intention, as demonstrated by Mathew et al. [23]. In this way, perceived usefulness predicts consumer acceptance of the drone delivery service [27, 50].

H3: Perceived usefulness positively influences (a) consumers'attitudes and (b) consumers'intention to adopt drone delivery services.

The relationship between perceived usefulness and the intention to adopt drone delivery services can be mediated by attitude [53]. When consumers consider drone delivery services to be useful, they develop a positive attitude toward them, which in turn increases their intention to adopt this technology [44, 51, 52]. This mediation effect highlights the importance of attitude as a key factor in shaping the relationship between perceived usefulness and the intention to adopt drone delivery services. By understanding the mediating role of attitude, companies can develop targeted marketing strategies to promote the perceived usefulness of drone delivery services and encourage consumers to adopt this innovative delivery method [61].

H3c: Perceived usefulness positively influences consumers'intentions to adopt drone delivery when mediated by their attitude services.

Perceived privacy concern

Concern about privacy encompasses fears in a specific context about the collection of undue and excessive information, the storage of information in dubious ways, and the sharing and collection of unauthorized data [61, 62]. The systematic literature review study by Luppicini, So [63] on the use of drones for commercial purposes revealed that concerns regarding privacy, ethics, and security surround this technology. Also, Park et al. [64] demonstrated that consumers have a growing concern with the last mile drone delivery method due to the damage that products can cause to infrastructure (for example, buildings) but also due to doubts regarding the invasion of privacy, illegality, and the fragile guarantee of private property. Privacy concerns increase the perceived privacy risk of using drones as they can access individuals'private and sensitive information without consent [61]. Consequently, consumers feel insecure about using drones to deliver parcels for fear that their private information will be shared in an unauthorized manner with third parties, negatively affecting consumers'attitudes toward adopting this service for parcel delivery [65]. Even though consumers associate benefits with drone delivery, they feel discouraged due to concerns about the safety and reliability of this service [15]. In this way, perceived privacy concerns significantly and negatively affect consumers'attitudes and intentions to use this technology [23, 25, 50].

H4: Perceived privacy concerns negatively influence a) consumers'attitudes and b) consumers'intention to adopt drone delivery services.

The negative impact of perceived privacy concerns on consumers'intentions to adopt drone delivery services can be further exacerbated when mediated by their attitudes toward the service [44, 52]. Thus, if consumers have a negative attitude toward drone delivery services due to privacy concerns, they are less likely to adopt the service, even if they consider it advantageous [24].

H4c: Perceived privacy concerns negatively influence consumers'intentions to adopt drone delivery when mediated by their attitude services.

Figure 1 shows the research model and the hypotheses formulated.

Methods

Sample

The sample for this study was collected through an online questionnaire, the link to which was published on social networks (Linkedin and Facebook) and the authors'contact network between January and April 2023. In this way, it is a non-probabilistic sample for convenience. The use of a convenience sample is due to the practicality and viability of execution due to the greater speed and reach in collecting online surveys, allowing access to a greater number of participants located in geographically different areas and the reduced costs in its implementation compared to traditional methods. However, as it is an online questionnaire, we recognize that there may be some demographic biases related to accessibility and inclusion because not all individuals have access to the Internet and social networks, leading to a digital inclusion bias. Furthermore, studies based on online surveys tend to underrepresent older age groups with less digital presence or populations with limited technological skills, leading to sample bias. Consequently, by using a convenience sample collected through an online questionnaire, there may be a lack of representativeness, leading to selection bias and the exclusion of subgroups, problems in generalizing the results, and statistical limitations due to the restricted inference of the results for the entire population.

The condition for participating in the questionnaire was being Portuguese citizens at least 18 years old. The questionnaire was anonymous, and informed consent was collected from all participants. A pre-test was conducted with 15 participants with different sociodemographic characteristics to assess their understanding of the questions and the average response time. The pre-test results revealed that participants had no difficulty interpreting the questions, and the average response time was 5 min.

From the application of the questionnaires, 1,108 valid responses were obtained. The Portuguese population over the age of 18 reached, in 2022, around 9.1 million inhabitants [66]. If we consider a 95% confidence interval and an error term of 3%, at least 1,067 responses would be needed, making the sample in this study superior.

Regarding the sociodemographic characterization of the participants, 61.4% are female, and 38.6% are male. The average age is 32.1 years old (minimum age of 18 years old and maximum age of 78 years old), with 48.3% being between 18 and 25 years old, 17.6% between 26 and 35 years old, 12.4% between 36 and 45 years old, and 21.7% over 46 years old. Regarding education, 42.9% have secondary education and the remainder complete tertiary education. 22.8% are employees, 9.7% are self-employed, 28.6% are students, and 11.6% are student workers. Regarding monthly net income, 22.4% have

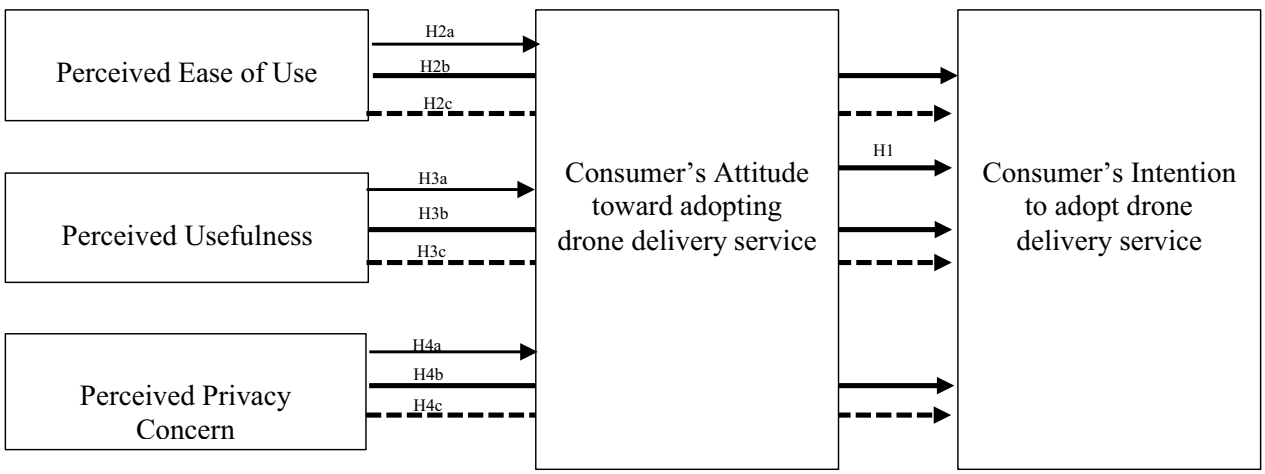

Fig. 1 Research model and hypotheses. Note: direct effects (⟶) and indirect effects (⟶)

no income, 44.9% receive between 761 euros and 1,500 euros, and 19.9% receive more than 1,501 euros monthly.

Measurement of variables

The questionnaire contains six sections adapted from Koh et al. [67]: (i) perceived ease of use of drones for delivery of five items; (ii) perceived usefulness of drones for delivery of five items; (iii) perceived privacy concern with seven items; (iv) consumer attitude toward the adoption of drone delivery services with five items; (v) consumers'intention regarding the adoption of drone delivery services with six items; (vi) questions about the sociodemographic characterization of the participants. The description of the items appears in the questionnaire available in Appendix 1. The items associated with question groups 1 to 5 were measured on a 5-point Likert agreement scale, with 1 strongly disagree to 5 strongly agree.

Data analysis

The data analysis for this study was carried out in four stages. In the first stage, a statistical analysis of the items measuring the constructs included in the research model was carried out using SPSS software (V.25). In the second stage, a factor analysis was implemented. An exploratory factor analysis (EFA) was carried out to divide the items into factors, and a confirmatory factor analysis (CFA) was carried out to assess the confirmatory factor loadings of each item and the reflective nature of the model. The partial least square (PLS) method was used to test the relationships between the constructs included in the research model, using the Smart PLS software. PLS combines factor analysis with the estimation of multiple linear regressions using the ordinary least square method. According to the kurtosis and skewness statistics, the data in this study do not have a normal distribution, and the PLS method does not require this assumption. Thus, PLS is a technique widely used in research for structural equation modeling (structural equation modeling—SEM) due to its flexibility and ability to deal with problems related to data normality, small samples, and complex models with multiple variables. In the third stage, the model obtained after applying the PLS method was assessed in terms of convergence, reliability, and discriminant validity according to the measures proposed by Hair et al. [68]. Therefore, as indicated by Hair et al. [68], for measurement of the convergence and reliability of the model, we use three measures: (i) Cronbach's alpha ($C\alpha > 0.70$); (ii) composite reliability (CR > 0.70), and (iii) average variance extracted (AVE > 0.50). If the values of these coefficients were higher than the reference values, then we can conclude that the model is reliable and convergent. The discriminant validity was tested by the Fornell–Larcker criterion. There is discriminant validity between constructs when the square root of the average variance extracted by a construct must be greater than the correlation between the construct and any other construct. In the last stage, a bootstrapping analysis was carried out using Smart PLS software to estimate the relationships between the constructs predicted in the research model. Bootstrapping analysis is a statistical technique used to evaluate the stability and significance of parameters estimated in models, as in PLS method. In structural equation modeling, bootstrapping helps test the significance of path coefficients, factor loadings, and other metrics. The bootstrapping analysis is commonly applied to validate theoretical models'hypotheses, test parameters'robustness,

Table 1 Descriptive statistics of items

	Mean	Std. deviation
Perceived ease of use (PEU)	3,31	1,167
PEU1	3,21	1,187
PEU2	3,31	1,164
PEU3	3,34	1,19
PEU4	3,48	1,161
PEU5	3,21	1,131
Perceived usefulness (PUSF)	3,17	1,195
PUSF1	3,14	1,178
PUSF2	2,85	1,225
PUSF3	2,88	1,224
PUSF4	3,75	1,115
PUSF5	3,23	1,231
Perceived privacy concern (PPC)	3,79	1,132
PPC1	3,59	1,149
PPC2	3,77	1,151
PPC3	3,82	1,142
PPC4	3,76	1,135
PPC5	3,84	1,109
PPC6	3,83	1,121
PPC7	3,89	1,119
Consumer attitude (CATT)	3,27	1,195
CATT1	3,16	1,206
CATT2	3,3	1,192
CATT3	3,34	1,193
CATT4	3,32	1,198
CATT5	3,22	1,187
Consumer intention (CI)	2,98	1,238
CI1	3,09	1,231
CI2	2,98	1,236
CI3	3,12	1,203
CI4	2,68	1,266
CI5	3,03	1,216
CI6	2,95	1,273

and reliability in exploratory and confirmatory studies and analyze sensitivity in predictive models.

Results

Descriptive statistics of construct items

Table 1 shows the mean and standard deviation of the items that measure the constructs. Regarding the drivers of consumer attitudes and behavioral intentions regarding the adoption of drones for the delivery of grocery items, what generated the greatest agreement in average terms was perceived privacy concern ($M=$ 3.79), followed by perceived ease of use (M =3.31) and finally perceived usefulness (M 3.17). On average, the items that measure consumer attitude toward adopting drones for parcel delivery generated greater agreement than consumer intention toward this service ($M=$ 3.27 and $M=$ 2.98, respectively).

Factor analysis

In Appendix 2, the results of the EFA and CFA are included. Through the implementation of EFA, the items were divided into six factors, corresponding to the constructs contained in the research model, without excluding any item. The accumulated variance of the five factors is 77.4%, with no factor individually explaining more than 50% of the total variance. The implementation of CFA revealed that all items have high confirmatory factor loadings (> 0.70) and confirmed the reflective nature of the model.

Assessment of the measurement models

The model obtained after applying the PLS logarithm to the research model was evaluated in terms of convergence, reliability, and discriminant validity according to Hair et al. [68]. According to the results obtained (Table 2), the model is convergent and realistic given that the Cronbach's alpha and composite reliability coefficients are higher than the reference value (> 0.70) and the AVE of each construct is higher than 0.50. There is also discriminant validity according to the Fornell–Larcker criterion since the square roots of the AVE (in bold in Table 2) by a construct were higher than the correlation between the construct and any other construct.

Additionally, the model presents a good fit according to the following measures calculated: (i) the goodness-of-fit index (GFI) (0.943; reference value > 0.90); (ii) comparative fit index (CFI) (0.965; reference value > 0.90); (iii) incremental fit index (IFI) (0.922; reference value > 0.90), and (iv) root mean square approximation error (RMSEA) (0.085; reference value < 0).

Research model estimation

Tables 3 and 4 contain the results of the bootstrapping analysis applied to the research model.

Table 2 Reliability, convergence, and discriminant validity

	Ca	CR	AVE	PEU	PUSF	PPC	CATT	CI
Perceived ease of use (PEU)	0.926	0.944	0.773	0.879				
Perceived usefulness (PUSF)	0.894	0.922	0.705	0.717	0.840			
Perceived privacy concerns (PPC)	0.950	0.959	0.772	– 0.190	0.717	0.879		
Consumer attitude (CATT)	0.965	0.973	0.877	0.722	0.756	– 0.105	0.937	
Consumer intention (CI)	0.953	0.963	0.812	0.685	0.779	– 0.136	0.878	0.901

Table 3 Direct effects

	Confidence intervals					
	β	*T*-value	*P*-values	2.5%	97.5%	Hypothesis support
H1: consumer attitude → consumer intention	0.661	20.170	0.000	0.591	0.717	Yes
H2a: perceived ease of use → consumer attitude	0.370	11.501	0.000	0.304	0.432	Yes
H2b: perceived ease of use → consumer intention	0.253	8.431	0.000	0.194	0.311	Yes
H3a: perceived usefulness → consumer attitude	0.487	16.031	0.000	0.427	0.541	Yes
H3b: perceived usefulness → consumer intention	0.594	21.590	0.000	0.541	0.644	Yes
H4a: perceived privacy concern → consumer attitude	– 0.047	2.799	0.005	– 0.081	– 0.015	Yes
H4b: perceived privacy concern → consumer intention	– 0.082	4.649	0.000	– 0.120	– 0.049	Yes

Table 4 Mediating effects

				Confidence intervals		
	Beta	***T*-value**	***P*-values**	**2.5%**	**97.5%**	**Hypothesis support**
H2c: perceived ease of use → consumer attitude → Consumer intention	0.244	9.591	0.000	0.194	0.295	Yes
H3c: perceived usefulness → consumer attitude → consumer intention	0.322	12.464	0.000	0.276	0.375	Yes
H4c: perceived privacy concern → consumer attitude → consumer intention	−0.031	2.708	0.007	−0.055	−0.011	Yes

The results demonstrate that consumers'attitude toward adopting the drone package delivery service positively and significantly affects these consumers'intention to adopt this service ($\beta = 0.661$), confirming hypothesis H1. The perceived ease of use of drone package delivery services positively influences consumers'attitudes and intentions to use these services ($\beta = 0.370$ and $\beta = 0.253$, respectively), confirming hypotheses H2a and H2b. This antecedent influences attitude more positively than the behavioral intention of adopting these parcel delivery services. The perceived usefulness of adopting the drone service for parcel distribution also positively influences consumers'attitudes and intentions to use these services ($\beta = 0.487$ and $\beta = 0.594$, respectively), confirming hypotheses H3a and H3b. However, the perceived usefulness of this service more positively influences the consumer's intention to adopt this service even when compared to the perceived ease of use. Finally, the perceived privacy concern in using these services negatively influences consumers'attitudes and intentions to use these services ($\beta = -0.047$ and $\beta = -0.082$, respectively), confirming hypotheses H4a and H4b.

Table 4 contains the results of the mediating effects of the relationships established in the research model. The perceived ease of use and the perceived usefulness of drone package delivery services positively influence consumers'intention to adopt this service when mediated by consumer attitudes ($\beta = 0.244$ and $\beta = 0.322$, respectively), confirming the hypotheses H2c and H3c. On the contrary, perceived privacy concerns about adopting drone package delivery services negatively influence consumers'intention to adopt this service when mediated by consumer attitudes ($\beta = -0.031$), confirming hypothesis H4c. However, it appears that the relationship between the antecedents of consumers'attitudes toward adopting this parcel delivery service and consumer intention is weakened when mediated by their attitude.

Discussion and implications

As noted in introduction, this study was partially motivated by the potential of drone deliveries to provide resilience during crises like the COVID-19 pandemic. Indeed, the high perceived usefulness scores we observed suggest that consumers recognize the potential value of drone deliveries in such situations. However, the daily operation of these systems in non-crisis times could lead to the annoyance and privacy concerns hinted at in our results, even if at a low level (privacy concerns negatively impacting attitudes with $\beta = -0.047$). This raises important questions about the trade-offs between maintaining crisis readiness and managing the daily impact of drone systems on citizens'lives. While our study suggests generally positive attitudes toward drone deliveries, it doesn't capture how these attitudes might evolve in the face of constant drone presence in daily life. A significant limitation of our study, and indeed many studies in this field, is the focus on potential users of drone delivery services to the exclusion of non-users such as bystanders, neighbors, and broader communities who may be affected by increased drone traffic without reaping its direct benefits. Our findings showed strong positive relationships between perceived ease of use, perceived usefulness, and both attitudes and intentions to adopt drone delivery services. These factors are primarily relevant to intended users of the service. For non-users, particularly those living near logistics hubs or in drone flight paths, the calculus of acceptance is likely to be different. For instance, while we found that perceived ease of use positively influenced attitudes ($\beta = 0.370$) and intentions to adopt ($\beta = 0.253$), this factor might be irrelevant for non-users who have no intention of using the service but may still be impacted by increased drone traffic in their area. Similarly, the strong positive influence of perceived usefulness on attitudes ($\beta = 0.487$) and intentions ($\beta = 0.594$) may not compensate for the potential nuisance and privacy concerns experienced by non-users. This perspective is crucial because while perceived usefulness and ease of use emerged as strong positive predictors of adoption for users, non-users may be far more sensitive to noise, safety concerns, or potential intrusions into private spaces. Studies from dense urban settings in the USA and Germany have reported heightened public anxiety about overhead flights and personal property rights. Lidynia et al. [69] suggest that when drones appear in

neighborhoods with high population densities, their novelty could rapidly give way to frustration or anxiety, particularly if local residents have no direct say in or benefit from the technology. This also aligns with the findings of Park et al. (2021), who noted growing concerns about last mile drone delivery due to potential damage to infrastructure and invasions of privacy. Consequently, a comprehensive understanding of drone acceptance should integrate safety, noise, and integrity issues, which have been present in public discussions about drone implementation. Although our study did not explicitly measure safety perceptions, it's possible that these concerns are implicitly reflected in the privacy concerns we measured. The negative impact of privacy concerns on attitudes ($\beta = -0.047$) and intentions to adopt ($\beta = -0.082$), while small, hints at underlying anxieties about drone technology that could extend to safety issues. Integrity, both in terms of data protection and the physical integrity of deliveries, is another aspect. The strong positive influence of perceived usefulness on adoption intentions ($\beta = 0.594$) suggests that consumers see value in drone deliveries, but this could be quickly eroded if integrity issues arise. The relative lack of emphasis on non-user perspectives in our findings therefore constitutes a gap that we encourage future research to address, especially given the strong market growth projections for drone deliveries worldwide.

With all these concerns in mind, can there be a flight path to acceptance? Aydin [70] revealed that public perception of drones is influenced by factors that extend well beyond being informed about their benefits and risks. Our results showcase a strong positive relationship between consumer attitudes and the intention to adopt drone delivery services, a finding that aligns with previous research Valencia-Arias et al. [24] and reinforces the fundamental principle in technology acceptance literature that favorable attitudes are necessary for the integration of new technologies into daily life. Central to our findings is the significant influence of perceived ease of use and, more prominently, perceived usefulness on both consumer attitudes and adoption intentions. This observation echoes the work of Waris et al. [27] and is further corroborated by Schmidt, Saraceni [28], who emphasize the role of perceived utility in technology adoption decisions. The implication for service providers is clear: effectively communicating the tangible benefits of drone delivery is essential, positioning the service as a valuable enhancement to consumers'daily lives. Our study also reveals that perceived privacy concerns, while exerting a negative influence on attitudes and intentions, play a relatively minor role compared to the perceived benefits and usability of drone delivery services. This suggests that the advantages of drone delivery, in terms of utility and ease of use, may outweigh privacy apprehensions in consumers'minds. The mediating effect of consumer attitudes on the relationship between privacy concerns and adoption intentions ($\beta = -0.031$) further illustrates the multidimensional nature of technology acceptance, where overall positive perceptions can mitigate specific concerns.

From a more global perspective, the experiences of countries where drone services are already advanced offer instructive parallels and contrasts with our Portuguese findings. Within the Portuguese context, our findings highlight a practical path for companies seeking to deploy drone delivery services in response to unexpected spikes in demand or limitations in ground-based transportation. Yet, these insights extend beyond Portugal. This pattern resonates with studies in India, China, Pakistan, and the USA [23, 25, 27, 30], where willingness to embrace drone technology largely hinges on whether it delivers tangible benefits such as faster service, lowered costs, or greater convenience. In the USA, large e-commerce players have conducted pilot drone programs focusing on residential deliveries, with studies indicating that quick, trackable shipments positively shape user attitudes but spark discontent among non-users when flights become frequent or intrude upon private airspace [25]. Rwanda's success in delivering critical medical supplies via drones has highlighted how usefulness can become the decisive factor in low-infrastructure areas, where roads are limited and the urgency of deliveries is high [71]. Regarding perceived usefulness, both our results and those abroad consistently show that when drone delivery is clearly framed as a solution to pressing logistical issues—such as delayed shipments or high delivery fees—consumers exhibit greater openness to adoption. In Pakistan, for instance, strong functional benefits spark positive attitudes despite initial reticence toward new technology [27], mirroring what we observe among Portuguese respondents. Meanwhile, in China, drone initiatives gain traction primarily when they directly address operational bottlenecks (e.g., package integrity or security) and thereby reinforce the practical value proposition of speed and reliability [30]. Ease of use, or simplicity of operating and receiving deliveries, remains an essential consideration, whether the service is introduced in a high-tech setting like China or a developing market such as Pakistan. These experiences resonate with our own findings that perceived usefulness and ease of use drive consumer acceptance, yet they also underscore that broader acceptance depends on clarifying airspace regulations, addressing non-user apprehensions,

and demonstrating clear public benefit. Our respondents also place a premium on usability: if drones are perceived as complex, the initial curiosity may quickly fade, undermining any gains from convenience or cost savings. Across these regions, transparent communication about how drones work, how deliveries are tracked, and how customer data are managed appears fundamental to converting novelty into everyday acceptance.

Earlier, we have observed that the drone delivery market size is expected to reach 13.32 billion dollars by 2028. Such projections should be balanced with a realistic assessment of the challenges involved in widespread implementation. Our findings of strong positive attitudes toward drone delivery services suggest a receptive market. However, the observed gap between positive attitudes and actual adoption intentions may hint at potential barriers to implementation. Focusing on the Portuguese context, we have examined consumer attitudes toward drone delivery services in a general context, but we recognize that acceptance and implementation of these services are likely to vary significantly across different environments and applications. The urban–rural divide and the distinction between societal and consumer-oriented services present particularly important contexts for consideration. In urban areas, the perceived usefulness of drone deliveries might be tempered by concerns over privacy, noise pollution, and air traffic congestion. A public opinion study across multiple EU cities confirmed that residents were more worried about noise pollution and midair conflicts when drones operate over crowded neighborhoods [72]. As Luppicini, So [63] highlighted, privacy and security concerns are paramount in discussions about commercial drone use. While our findings showed only a marginally negative impact of privacy concerns on attitudes and adoption intentions, these concerns might be amplified in densely populated urban environments as the reality of widespread drone use becomes apparent. Also, our results don't tell us at what point the concentration of drones in the sky becomes unacceptable to urban communities. Understanding these acceptance limits is important for determining the viability of drone delivery as a widespread service, which is particularly relevant given the high initial investment required for drone delivery infrastructure. Future research should expand to include the perspectives of non-users, particularly in urban environments where the externalities of drone delivery services are likely to be most pronounced. Conversely, in rural contexts, the perceived usefulness of drone deliveries may be considerably higher compared to urban environments. Our study identified perceived usefulness as the most significant predictor of both attitudes toward and intentions to adopt drone delivery services. In rural areas, where traditional delivery methods often face efficiency and cost challenges, the advantages offered by drone deliveries are likely to be more pronounced. In these settings, drones might provide timely and cost-effective delivery solutions for essential goods, addressing the limitations of traditional services. Empirical evidence from various international settings reinforces how population density, infrastructure, and local needs affect drone uptake. For instance, health-focused drone projects in countries such as Rwanda and Ghana have demonstrated that the time to deliver medical products can be significantly reduced, lowering some delivery intervals from hours to minutes, leading over 30 countries to follow the way and currently apply the technology in either pilot studies or established delivery networks [71]. Conducting on-site field trials and collecting region-specific data from both urban and rural participants would help quantify how exactly population density, infrastructure constraints, and noise sensitivity affect drone acceptance. Designing follow-up studies that segment respondents by location or settlement size could also offer richer insights into how perceived usefulness might dominate in rural areas while privacy or noise concerns intensify in highly populated urban environments.

Although privacy concerns occupy a secondary position, they remain important. In Portugal, our findings suggest that privacy issues are less critical than the direct advantages of drones. Similar trends appear in India and the USA [23, 25], where users are largely willing to overlook certain privacy drawbacks if drone services are seen to significantly reduce delivery time or costs—although ongoing data protection measures are key to sustaining trust over the long term. Regulatory interventions can play a decisive role in minimizing anxieties: adopting transparent data protection policies, enforcing no-fly zones near sensitive locations, and standardizing drone surveillance protocols may help sustain consumer trust. In European contexts, the general data protection regulation (GDPR) imposes specific requirements on data handling, which could mitigate public apprehensions. In non-European settings such as the USA or Japan, where regulations can differ substantially, companies and authorities might need more proactive communication strategies. Beyond users, non-users exposed to frequent drone traffic may express heightened privacy concerns or societal safety anxieties, as illustrated by reports from late 2024 New Jersey drone sightings. Regulatory frameworks need to strike a delicate balance between harnessing the potential benefits of drone deliveries, as

evidenced by high perceived usefulness in our study, and protecting community interests and safety. This balance is decisive for ensuring public acceptance and the long-term viability of drone delivery systems. Policies should be designed to consider the perspectives of both users and non-users, particularly in urban planning and zoning decisions. This inclusive approach can help mitigate potential conflicts and ensure that the implementation of drone delivery services doesn't disproportionately impact certain communities. Our findings carry important implications for both private and public stakeholders. From a business standpoint, highlighting how drones can solve persistent customer pains—such as delayed orders or the need for contactless delivery—may enhance their perceived value among intended users. Companies can design marketing campaigns that not only showcase fast, reliable delivery but also demonstrate intuitive interfaces and seamless user experiences, thereby reinforcing ease of use. In terms of privacy concerns, companies can further adopt communication strategies that clarify data collection and storage policies, the use of encryption, adherence to no-fly zones near sensitive locations (such as schools or hospitals), and the implementation of data anonymization techniques to protect individual identities. Leveraging these findings, firms could pilot drone delivery services in targeted regions—such as remote areas where improved logistics are critical or urban districts keen on cutting-edge services—generating localized success stories that could be scaled over time. Consumers, for their part, may need ongoing education on how drones function, what safeguards exist, and how these technologies can improve their quality of life, particularly in contexts like remote healthcare or same-day package delivery. Such transparent dialogue could alleviate undue fears and demonstrate that drones have benefits beyond convenience, potentially mitigating worries over surveillance or intrusion.

Policymakers, meanwhile, bear responsibility for establishing clear regulatory frameworks that address community concerns regarding continuous overflight, noise thresholds, and possible violations of private property. Coordination with local authorities and community groups can help ensure that both users and non-users have a voice in determining no-fly zones and operational guidelines, thus fostering a more inclusive environment for drone deliveries. There is a pressing need for guidelines on traffic management, noise, and privacy that draw on robust research and stakeholder consultation, allowing technological innovation to proceed without sacrificing public confidence. Policymakers should also be mindful of equitable access, which may require incentives for serving underserved areas or rules ensuring fair pricing across different regions. We consider these aspects to converge on one key concern: market design and regulation. Policy decisions about market entry and exit barriers, airspace rules, noise limits, safety standards, insurance, and compensation frameworks will significantly influence both the net present values and the internal rates of return for drone delivery investments. By timely addressing these policy implications, policymakers may create a regulatory environment that fosters innovation in drone delivery services while safeguarding public interests and promoting widespread access to the benefits of this technology.

Conclusion

The integration of drone delivery services into our logistics systems represents a transformative shift with far-reaching implications for urban and rural landscapes, consumer behavior, and supply chain resilience. This study explores the influence of perceived ease of use, perceived usefulness, and perceived privacy concerns of the drone parcel delivery service on Portuguese consumers'attitudes and intentions of adopting this service. Our findings highlight the significant positive influence of perceived usefulness and ease of use on consumer attitudes and intentions to adopt drone delivery services. This underscores the importance of effectively communicating the tangible benefits of drone deliveries to the public. At the same time, the relatively minor impact of privacy concerns, while noteworthy, suggests that the perceived advantages of drone deliveries may outweigh potential apprehensions in consumers'minds. However, our findings also point to the need for a more comprehensive approach to studying drone acceptance. Future research should include both user and non-user perspectives to capture a more holistic view of societal acceptance. Explicitly measuring safety concerns and noise pollution perceptions would provide a more complete picture of potential barriers to acceptance. Also, investigating acceptance thresholds in different contexts, such as urban versus rural environments and consumer versus societal services, would offer valuable insights for targeted implementation strategies. Moreover, expanding this research across different national settings and regulatory frameworks—including non-European regions—would clarify how cultural norms, legislation, and infrastructure readiness affect drone delivery acceptance,

thereby providing a global perspective on its future development and commercial viability.

This study has certain limitations that warrant acknowledgment. Despite the large number of responses, the use of a non-probabilistic convenience sampling technique means that our sample may not be fully representative of Portuguese consumers. However, the number of subsamples in the bootstrapping analysis was increased to reduce potential biases in the results. Using bootstrapping analysis using the partial least square method to estimate the relationships between variables is essential to minimize biases in studies with non-probabilistic samples, providing more robust and reliable inferences. This analysis allows us to compensate for sampling limitations by allowing a better estimation of variability, increasing the precision of the coefficients and providing more realistic confidence intervals. In future studies, given the disadvantages of convenience sampling, four alternatives or strategies can be adopted to minimize its impacts and improve the representativeness and validity of studies. First, simple random sampling involves randomly selecting participants from a defined population, ensuring that all have the same probability of inclusion. This can be done by using random number generators or lottery methods to select participants from a complete target population list. Second, stratified sampling, where the population is divided into subgroups based on relevant characteristics (such as age, gender, or location) and participants are randomly selected from each stratum proportionately: (i) define the key demographic or behavioral criteria relevant to the study, (ii) collect a list of potential participants and divide them into strata before applying random selection within each group to ensure proportional representation. Third, snowball sampling involves asking initial participants to nominate others who fit the research criteria. Start with a small group of relevant participants who meet the study criteria. Then, request that they refer others within their network who also fit the research requirements, allowing the sample to grow progressively. Fourth, online randomized sampling uses digital platforms that recruit participants randomly or based on criteria representative of different subgroups. Utilize survey platforms or social media advertisements that employ randomized selection techniques to reach diverse participants. Pre-screening filters can be used to ensure that the final sample includes a balanced representation of different demographic and behavioral segments. Furthermore, it would be interesting to introduce sociodemographic characteristics (gender, age, education, and professional status) of the participants as moderate variables into the proposed research model as well. Also, our measurement of key constructs, while based on established scales, could be refined. We used three antecedents (perceived ease of use, perceived usefulness, and perceived privacy concerns) to explain consumer attitudes and intentions toward drone delivery services. However, the items used to measure these constructs, particularly perceived usefulness, could be made more specific to the context of drone deliveries. For instance, future studies could include more concrete items related to reduced delivery time, cost savings, and convenience to measure perceived usefulness. In future studies, it would be interesting to use other antecedents such as the acceptance of the technological characteristics of drone services, the characteristics of the tasks of these services, and the perception of improvement that this service could offer in terms of the companies'supply chain. It would be important to address privacy concerns more broadly. In a future analysis, we intend to better distinguish different dimensions of privacy concerns, specifically addressing the risks of data collection and storage, surveillance, and intrusion; drone flight paths; and property rights. The study assesses perceptions and intentions regarding using drones for deliveries since this delivery system does not yet exist in Portugal. As such, the acceptance of the hypotheses may not fully capture consumer behavior in the real world since, in practice, the participants in the study sample have not yet experienced this service. Through a questionnaire and a focus group, it would be interesting to evaluate the intention of Portuguese distribution companies to adopt this service to deliver their orders and explore how this service could make their supply chains more efficient and resilient.

Appendix: 1

Questionnaire available at https://drive.google.com/file/d/1uE2kwEWYNfqah5ODTTqCZ_hb0QsRh20j/view?usp=sharing.

Appendix: 2 EFA and CFA results

Set of items	Factors						
	1	2	3	4	5		
	PEU	PUSF	PPC	CATT	CI	Communality	Confirmatory factor loads
Perceived Ease of Use (PEU)							
PEU1	0.741					0.749	0.903
PEU2	0.751					0.811	0.908
PEU3	0.781					0.817	0.855
PEU4	0.785					0.759	0.846
PEU5	0.751					0.793	0.880
Perceived usefulness (PUSF)							
PUSF1		0.800				0.730	0.853
PUSF2		0.751				0.870	0.892
PUSF3		0.757				0.868	0.894
PUSF4		0.712				0.748	0.717
PUSF5		0.747				0.742	0.830
Perceived privacy concern (PPC)							
PPC1			0.768			0.751	0.729
PPC2			0.828			0.800	0.885
PPC3			0.870			0.866	0.922
PPC4			0.839			0.840	0.917
PPC5			0.847			0.844	0.916
PPC6			0.803			0.763	0.881
PPC7			0.781			0.757	0.885
Consumer attitude (CATT)							
CATT1				0.877		0.819	0.925
CATT2				0.868		0.828	0.934
CATT3				0.887		0.855	0.953
CATT4				0.881		0.843	0.945
CATT5				0.875		0.822	0.924
Consumer intention (CI)							
CI1					0.899	0.860	0.924
CI2					0.788	0.700	0.865
CI3					0.890	0.851	0.939
CI4					0.730	0.636	0.811
CI5					0.877	0.829	0.933
CI6					0.864	0.817	0.927

Abbreviations

UAV	Autonomous unmanned aerial vehicles
AAM	Advanced aerial mobility
UAM	Urban air mobility
TPB	Theory of planned behavior
TAM	Technology acceptance model
TRA	Theory of reasoned action
PEU	Perceived ease of use
PUSF	Perceived usefulness
PPC	Perceived privacy concerns
CATT	Consumer attitude
CI	Consumer intention

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Author contributions
JML and SG conceived the core idea of the manuscript and conducted empirical studies, analyzed the data, and drafted the manuscript. TT helped with the literature review and discussion. All authors have read and approved the manuscript.

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Availability of data and materials
The data that support the findings of this study are available from the corresponding author, upon reasonable request.

Declarations

Ethics approval and consent to participate
Written consent was obtained from all the participants involved in the study.

Consent for publication
We attest to the fact that all authors have contributed significantly to the work, have read the manuscript, attest to the validity and legitimacy of the data and their interpretation, and agree for publication this manuscript in the Future Business Journal.

Competing interests
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