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Article

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OPERATIONS, INFORMATION & TECHNOLOGY | RESEARCH ARTICLE

Understanding e-commerce customer behaviors to use drone delivery services: A privacy calculus view

Wei Xie¹, Charlie Chen² and Juthamon Sithipolvanichgul^{2*}

Abstract: Drone delivery is an emerging service at the early adoption stage. It is imperative to understand what it takes for the public to accept such emerging services. This study asks what mechanism influences people's switching intention in e-commerce drone delivery services. A 7 points Likert scale questionnaire were developed after the two rounds of pretest and a total of 83 surveys were collected from a business school in USA. This study applies privacy calculus theory and technology anxiety in innovation to develop a research model. An empirical survey and structural equation modeling analysis with SmartPLS and a consistent PLS algorithm are used to understand the hedging effect of relative advantages of drone delivery services and technology anxiety on the switching intention of e-commerce consumers. Theoretically, this research adds the e-commerce literature, suggesting that people appreciate drone delivery's speed and environmental protection advantages. However, privacy risk severity and vulnerability are not

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PUBLIC INTEREST STATEMENT

Drone delivery is an emerging service for E-commerce for the last mile delivery logistic activities. It is very important for E-commerce companies to understand what it takes for the consumer to accept drone delivery. This study suggest that consumer appreciate drone delivery's speed and environmental protection advantages. However, privacy risk severity and vulnerability are not significant predictors of technology anxiety, negatively impacting switching intention. This study also provided practical contribution to improve the service development of e-commerce company to deliver their products to their customers with the most efficient resources being used.

significant predictors of technology anxiety, negatively impacting switching intention. This study also provided practical contribution to improve the service development of e-commerce company to deliver their products to their customers with the most efficient resources being used.

Subjects: IT Security; Computing & IT Security; Management of Technology

Keywords: Drone delivery; risk; security; technology anxiety

1. Introduction

An unmanned Aerial Vehicle (UAV), commonly known as a drone, is an autonomous aircraft without any human onboard (Austin, 2011). The introduction of militaries-originated drone technology into the civilian domain has been quickly adopted by various industries such as agriculture (Mogili & Deepak, 2018; Pacharavanich, 2022) disaster management (Tanzi et al., 2016), and healthcare (Yaprak et al., 2021). E-commerce industries also envision drones as a promising solution to the challenges associated with last-mile product delivery (C. Chen et al., 2022; Leon et al., 2021; Zhu et al., 2020). The logistic and retail sectors such as DHL, UPS, Amazon and Walmart have invested heavily and start using drones as a last-mile delivery for their products in many areas around the globe. Gartner predicts that by 2026, more than 1,000,000 drones will deliver products to customer household. For example, due to the Covid-19, Amazon (2020) has started pilot-testing their “30 minutes or less Prime Air” drone delivery services to decrease disease transmission during the Covid-19 pandemic. DHL also launched a drone delivery solution in urban areas of China, which reduces the delivery time from 40 to 8 minutes and save delivering cost of up to 80% when compared to regular last mile delivery methods (Goasduff, 2020.) Walmart is planning to reach 4 million US households in Virginia, Texas, Florida, Utah, Arkansas and Arizona and make over 1,000,000 drone delivery packages in 2022 (Guggina, 2022.) As an emerging technology which show great promises in the area e-commerce and logistic, the research on drone delivery is still in its infancy and in a nascent stage, especially in the understanding of its social and behavioral effects. Recent research shows that public has an increasing concern over the safety and security risks of the last mile drone delivery method, e.g., damages to the products and buildings in delivery, privacy invasion, and illegal trespassing and destruction to private properties (Park et al., 2021). These consumers concerns can hinder the development of the last mile drone delivery services by the e-commerce company they remain unexplored. Thus, this study aims to adopt the survey method to collect the data from the potential users of drone delivery services and answer the following two questions. First, are the advantages of delivery speed and environmental protection strong enough to convince the public to switch from regular truck shipping to drone delivery services after understanding the potential privacy risks? Second, how does perceived privacy vulnerability affect users’ technology anxiety, impacting the switching intention? The study has two research objectives. First the study explores the research gap on the consumer behaviors and technological anxiety on an emerging technology such as e-commerce drone delivery. Second, the study results can be used by e-commerce businesses on how to improve their service development in this emerging technology of last mile drone delivery services while understanding the potential negative impact of privacy vulnerability and technology anxiety on the consumer. The following sections comprise with theoretical background and hypothesis building based on past literatures. The following sections will discuss theoretical background and hypotheses. The research methodology and the survey instruments construction will be discussed. Then, the research results, conclusion, limitation, and future recommendations are discussed to conclude the end of the study.

2. Conceptual formation and research hypotheses

Our research asserts that consumers’ switching intention from a standard truck delivery to drone delivery could be a function of the relative advantages of the technology and privacy risks-induced

technology anxiety. The following will review push, pull, and mooring (PPM) and privacy calculus theories to gain insights into the switching behaviors of users. Hypotheses will be proposed to understand the potential impact of key antecedents on the intention of users to switch to drone delivery services.

2.1. Switching intention to drone delivery services based on the push, pull and mooring theory

This study aims to understand the intention of e-commerce users to switch to drone delivery services from traditional truck delivery services. Therefore, it is important to understand the switching intention rather than adoption intention. The push-pull-mooring (PPM) theory asserts that people make migration decisions based on both positive (pull) factors of future locations, and negative factors (push) of staying in current locations (Halfacree & Boyle, 1993). People can also decide whether to switch to a new product or service based on their personal and social contexts (mooring factor; Sun et al., 2021).

PPM theory has been applied to understanding consumers' switching behaviors when faced with alternative products or services. In the context of switching from a currently adopted technology to a future technology, users are also susceptible to push, pull and mooring factors. For instance, shoppers decide to switch from one mobile to another mobile store because of peer influence (pull force), inconvenience of the current mobile store (push force; Lai et al., 2012), and promotional incentive (mooring force). Another study shows that the decision of users to switch to green transportation from private cars because of perceived environmental threats and inconvenience (push factors), green transport policies and systems (pull factors), and information provision and shifting willingness (mooring factors). PPM theory has also been adopted to investigate the switch intention of users to emerging technologies, such as smartwatch (Bölen, 2020) and traceable agricultural products (Nguyen et al., 2021).

When offered with drone delivery services, e-commerce users have the option of continuing using the current truck delivery service or switching to the novelty services. Drone delivery is another form of green transportation solutions, and the switching intention of users could be susceptible to the influence of various push, pull and mooring factors. However, the current literature primarily emphasizes the early adoption of drone delivery services rather than the switching intention of e-commerce. This study focuses on the use of the PPM theory in understanding factors that can facilitate or inhibit e-commerce consumers' switching behaviors from traditional truck delivery to drone-enabled delivery services.

The current literature uses the PPM theory to examine the switching behaviors of users for such technologies as mobile commerce, green technology, online learning platforms (Xu, Wang, Tai, & Lin, 2021), and augmented/virtual reality (Kim et al., 2020). However, its application to understanding drone delivery practices is limited (Hwang, Lee, Kim, & Sial, 2021). Moreover, majority of current e-commerce customers still prefer truck delivery to drone-enabled delivery practices (Trappe, 2022). We still lack a clear understanding of why majority of e-commerce consumers still resist switching to delivery drones, thus requiring an examination of the phenomena from the switching perspective. This study aims to fill these gaps by understanding:

- (1) *What positive factors contribute to the switching intention of e-commerce customers to drone delivery services?*
- (2) *What negative factors contribute to the switching intention of e-commerce customers to drone delivery services?*
- (3) *Are there mediating factors, such as technology anxiety, on the path from perceived privacy severity and vulnerability to the switching intention of e-commerce customers to drone delivery services?*

We address these questions by investigating e-commerce customers' switching intention to drone delivery services from the privacy calculus perspective.

2.2. Privacy calculus theory and switching intention to drone delivery

E-commerce consumers often conduct a risk-benefit analysis when deciding whether or how much personal information to disclose to online services according to privacy calculus theory (Milne et al., 2004). Most e-commerce customers are cognizant of the dangers of disclosing personal information without sufficient assurance or control of their personal information in the digital context. As such, it is now a common practice for customers to conduct the risk-benefit assessment when allowing firms to access their privacy information.

Under the assumption of rational choice, privacy calculus theory posits that individuals act in ways that maximize expected positive outcomes and minimize expected negative ones (Vroom, 1964). As such, privacy calculus is much like the expected utility hypothesis of game theory. Individuals bet on outcomes that are a function of positive and negative occurrences (Friedman & Savage, 1952). Humans behave in specific ways after assessing each action's advantages and disadvantages. From the privacy calculus perspective, individuals will likely assess the relative advantages and privacy risks of drone delivery services analysis before switching to novelty services.

However, emerging technologies such as drones, can collect customers' privacy information autonomously without the approval of customers. For instance, drones can record photos and collect data throughout neighborhoods while performing delivery missions. Since homeowners have no control of their home airspace, they cannot control their personal life information, such as the number of residents, social activities, and facilities on the premise.

Many e-commerce customers may aware of potential privacy severity and vulnerability issues if their personal information is collected and misused by drones. However, they may not be able to conduct a proper risk-benefit assessment without sufficient technical knowledge. Before drone delivery services are introduced to e-commerce customers, it is imperative to understand the antecedents for their switch intention.

This study proposes two perceived benefits, including delivery speed and environmental protection, and two perceived risks, including privacy vulnerability and severity. Technology anxiety is considered as the mediating factor for the relationships between these two perceived risks and switch intention of e-commerce customers to drone delivery services. The following will center on the discussion of these perceived benefits and risks in relation to the switch intention of e-commerce customers for drone delivery services.

2.2.1. Relative advantages of drone delivery services

Although drone delivery services have privacy risks, many users are attracted to their relative advantages of delivery speed and environmental protection (Kornatowski et al., 2018). Rogers (1983) asserts that the critical driver for diffusion of innovation is the relative advantages of the innovation. Previous research results indicate that the more the perceived advantages, the higher the likelihood of innovation adoption (Agarwal & Prasad, 1998; Vagnani & Volpe, 2017). Studies and surveys suggest that drone delivery provides two significant benefits: delivery speed and environment protection. Customers perceive a faster than standard truck delivery as the main advantage because drones fly the optimal path and are not affected by road infrastructure or traffic congestion (Joerss et al., 2016). In addition, drone delivery is environmentally friendly because drones operate on batteries and thus emit no carbon (Lee et al., 2016; Soffronoff et al., 2016). Many users perceive drone food delivery services are eco-friendly and can help advance sustainability in drone delivery services (Hwang et al., 2021). Accordingly, this study argues that the perceived advantages of speed and environmental protection will pull consumers to switch from standard truck services to drone delivery. Thus, we propose:

H1: the relative advantage of delivery speed increases the switching intention from standard truck delivery to drone delivery.

H2: the relative advantage of environment protection increases the switching intention from standard truck delivery to drone delivery.

2.2.2. *Costs of privacy risks*

Drone delivery introduces many possible security risks during the delivery process (Alwateer & Loke, 2020). For example, a drone network is different from traditional wireless networks in that it transmits a more considerable amount of information (Clarke, 2014). Data collected from flying over private properties can end up in the wrong hands. Malicious individuals can also capture unauthorized information (Soffronoff et al., 2016). The private information can be potentially misused to trespass the air of properties. The increased privacy risks can discourage users from switching to drone delivery services (Yoo et al., 2018).

R. W. Rogers (1975) proposed the protection motivation theory (PMT) to address fear. The PMT theory suggests that people will engage in a cognitive appraisal mechanism to evaluate risks for protection when facing threats and risks. During threat appraisal, an individual evaluates the vulnerability and severity of a potential threat. *Vulnerability* refers to the susceptibility to or the likelihood of privacy vulnerability toward drone delivery services. *Severity* speaks of perceived privacy risk intensity toward drone delivery services. Since its introduction, the PMT has been one of the most potent explanatory theories for predicting individuals' intention to engage in protective actions (Anderson & Agarwal, 2010). The current literature on cybersecurity threats (Liang & Xue, 2010), mass media threats (Neuwirth et al., 2000), online risks (Tsai et al., 2016), and mobile health adaptation (Sun et al., 2021) suggests that users' perceived threat can influence their motivation to avoid threats and risks. From the privacy protection motivation perspective, we propose that the privacy vulnerability and privacy risk severity negatively affect switching intention from standard truck delivery to drone delivery. However, the impact is regulated through technology anxiety.

2.3. *The impact of technology anxiety on the intention of users to switch to drone delivery services*

Technology anxiety refers to users feeling nervous, worried, uncomfortable, uneasy, or confused about the adopted technology and its potential negative impact (Hoque & Sorwar, 2017). The adverse effect of anxiety on users' adoption decisions is evident in diverse technologies. For instance, many seniors feel healthcare information technologies (HIT) can assist them in dealing with their chronic health conditions. However, they are reluctant to adopt HIT because they are anxious about its security and privacy issues (Kavandi & Jaana, 2020). Anxiety also negatively influences teachers' and students' decisions to adopt mobile learning (Mac Callum & Jeffrey, 2014) and artificial intelligence (Wang et al., 2021) technologies. The unproven drone delivery service could pose many privacy risks, introducing technology anxiety to potential users. Many users consider drone delivery services dangerous because drones could crash anytime and from anywhere. While users are exposed to the unanticipated safety issue, governmental regulations focusing on protecting user privacy and security are minimal. As such, many users are anxious about adopting drone delivery services.

When offered to use the new emerging technology like drone delivery services, users usually have the choice of either use existing delivery services or switch to the new method of delivery. Switch intention refers to the decision of users to abandon current services and embrace new services (Abdel Hamid Saleh et al., 2015; Bansal et al., 2005). The increased switching intention can result in the attrition of existing users. Therefore, logistics service providers must understand the factors causing the switching intention of users to improve their services. PPM model asserts that users are more likely to switch to an alternative service when they are not satisfied with the existing services. Some e-commerce consumers may feel that existing delivery services i.e. truck

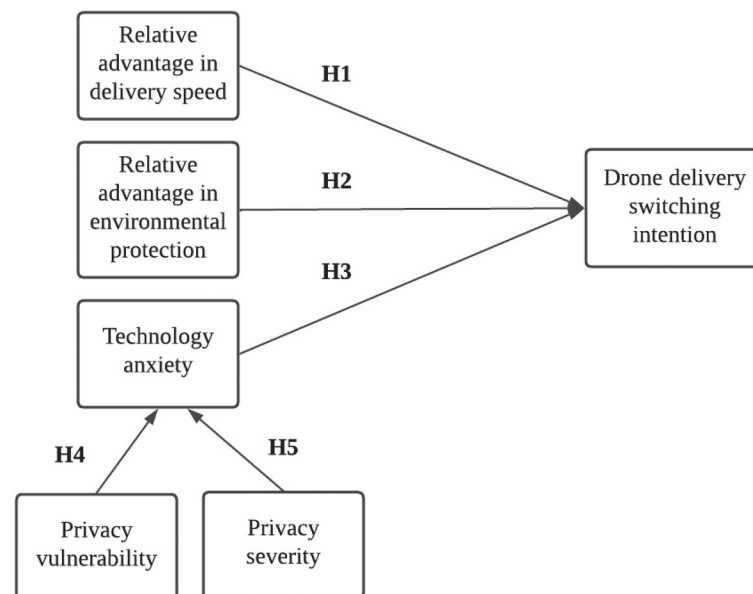
and ocean transportation are either too slow or too costly i.e. air transportation. Also, traditional delivery services have shipping-location limitations. For example, when users reside in a remote location, they cannot receive packages as frequently as they want and will have trouble managing returns of the products. Uncertainty due to weather conditions could be another issue causing shipping delays. Drone delivery services are attractive to many e-commerce customers because they offer relative advantages of speed, convenience, and environmental friendliness (H. Chen et al., 2021; Rai et al., 2022). Despite these benefits, the increased technology anxiety can decrease the intention of users to switch to the novelty service. Thus, we propose:

H3: *technology anxiety* negatively affects switching intention from standard truck delivery to drone delivery.

2.4. The impact of privacy vulnerability on technology anxiety about switching to drone delivery services

New technology poses potential privacy risks to users because personal information can be compromised in the data collection, processing, and dissemination processes (Srivetbodee & Igel, 2021). These privacy risks can originate from a lack of ability to safeguard personal information, third-party access, mobile malware, social engineering, or negligence of basic security configurations. Privacy risk levels originate from the likelihood and impact of a potential privacy threat event. Before deciding whether to switch to a drone delivery service, users will assess its privacy vulnerability (likelihood) and privacy severity (impact). Users with high perceived privacy vulnerability are more likely to feel anxious about new technology stealing their own identity (A. Kim & Kim, 2016). Users are more likely to resist adopting the new technology or adopt methods to minimize the likelihood of its occurrence, such as adopting identity theft protection services (Youn, 2009). Many studies have found the causal effect of privacy vulnerability on user anxiety or resistance to various technologies, such as smart homes (Lee, 2020) and social media (Van der Schyff et al., 2020). Drone delivery services can also increase the perceived privacy vulnerability of users, thereby causing an increased level of technological anxiety. Thus, we propose:

Figure 1. Research model.



H4: *privacy vulnerability* positively affects technology anxiety while evaluating whether to switch from standard truck delivery to drone delivery.

2.5. The impact of privacy severity on technology anxiety about switching to drone delivery services

Privacy risk severity refers to the extent of the damage to users resulting from a privacy risk event occurring. Privacy risk severity can explain more variance than privacy risk probability in the perceived risks of online threats (Gerber et al., 2019). When users are uncertain about the severity of personal information losses that the adopted technology can cause, they often feel anxious about using it (Featherman & Hajli, 2016). Although the positive relationship between privacy severity and technology anxiety exist in most situations, a few recent studies show users who are pro-technology, such as Gen Z-ers could be less concerned about their privacy (Bordonaba-Juste et al., 2020; Kurzu, 2017).

Drone delivery services can pose many potential privacy risks. For instance, packages delivered by drones can be mishandled or damaged. Packages with personal information can be in the wrong hands if the delivery drone is hijacked or interfered by weather. Drones can also fly by windows and collect unnecessary and personal information throughout neighborhoods. When users perceive some of these privacy risks are severe, they are more likely to express anxiety toward adopting drone delivery services. Thus, we propose:

H5: *privacy risk severity* positively affects technology anxiety while evaluating whether to switch from standard truck delivery to drone delivery.

The following model (Figure 1) demonstrates the research model for this study with hypotheses.

3. Methodology

3.1. Data collection procedure

This study investigates how the perceived benefits of speed and environment protection offered by drone delivery and the anxiety induced by perceived privacy risks impact switching intention. Due to the emerging service of drone delivery, our experimental study asked the respondents to watch a video about drone delivery first. A scenario refers to a description of a possible future situation, including the path of development leading to that situation (Kosow & Gabner, 2008). Scenarios are not intended to represent a complete description of the future but rather to highlight central elements of a possible future and to draw attention to the key factors. A scenario asks respondents to step into the situation where researchers want them to be and answer the question, “what are you going to do in it” (Bishop et al., 2007).

Structural equation modeling (SEM) with SmartPLS (version 3.3.5) and a consistent PLS algorithm are used to test and analyze the hypotheses of our reflective research model (Hair et al., 2017). Variance-based partial least squares SEM allows us to explore and estimate hypothesized complex predictive relationships between latent constructs (Hair et al., 2017). The advantages of no assumption on normal data distribution and the model convergence on a relatively small sample size fit our proposed exploratory theory (Hair et al., 2017).

We collected our survey data from 83 undergraduate students at a business school from United States (See Table 1). All responses were recorded on a 7-point strongly disagree (1)—strongly agree (7) Likert scale except for the switching intention construct, which has multi-item semantic-differential scales. Different scales within the same survey questionnaire help lower common method bias, as suggested by research (e.g., Heppner et al., 2008; Jordan & Troth, 2020; Podsakoff et al., 2003). In addition, manipulation questions such as speeder trap and attention filter are used to eliminate common method bias further (Arndt et al., 2022; Berinsky et al., 2014; Meade & Craig, 2012; Oppenheimer et al., 2009). In the beginning, a draft of the adapted items

Table 1. Demographics

Demographics	Statistics
Gender	Female = 28 (34%) Male = 55 (66%)
Transportation	YES = 77 (93%) NO = 5 (7%)
Drone proximity	YES = 4 (6%) NO = 78 (94%)
Amazon prime membership	NO = 6 (7%) Had = 14 (17%) YES = 63 (76%)
Neighborhood types	Tight = 27 (32%) Close = 30 (36%) Moderately close = 23 (28%) Distanced = 3 (4%)
Delivery frequency	Average = 1.8/per month
Shopping distance proximity	Average = 7.13 minutes/per month

was reviewed and pretested within a group of students consisting of six graduate and four undergraduate students. The items' wording and organization were revised based on the feedback to ensure clarity in the drone delivery context. Next, an online pilot survey collected 50 responses. The proposed survey instruments were fine-tuned further based on the results from the data collected. At last, the survey questionnaire with 37 items, including questions to capture the demographics of respondents and usage patterns in shopping was finalized. The final online survey was distributed to sophomores in six computer information systems classes for participation. To increase the participation rate, participants can earn 1% of their final grade as their extra credit after successfully completing the survey. The researchers were able to collect 83 valid responses.

3.2. Survey instruments

The constructs in this study were measured using items adapted from previously validated studies (Table 2). We adopt three semantic items from Bansal et al. (2005) to gauge the dependent variable switching intention to drone delivery using likelihood. For example, respondents were asked to rate the chance of switching to drone delivery, such as "the likelihood that you would switch from truck delivery to drone delivery." There are four items each to measure the attitude of respondents towards the advantages of speed and the environmental protection offered by drone delivery. These items were initially designed to test the emerging technology diffusion process (Moore & Benbasat, 1991). Extant research has applied them to various technology-enabled service contexts such as mobile banking (e.g., Al-Jabri & Sohail, 2012). Technology anxiety was adapted from Lee and Yang (2013). We removed the three reverse coded items after the first round of the pilot study due to the inconsistent survey results. Research indicates that reverse-worded items failed to prevent response bias and contaminated data due to respondent inattention and confusion (Sonderer et al., 2013). The perceived privacy risk constructs are developed from the protection motivation theory's perceived vulnerability and severity which were tested in information systems security compliance studies (Ifinedo, 2012; Vance et al., 2012).

4. Results and discussion

4.1. Measurement model

The measurement model estimates the accuracy of variables (measurement items), the relationships between the measured variables, and the latent constructs they represent. This involves

Table 2. Constructs and items

Construct	Code	Items	Reference
Relative advantage in speed	AdvS1	Drone delivery is a speedy way to deliver orders	Al-Jabri and Sohail (2012)
	AdvS2	Drone delivery allows me to receive orders quickly	Moore and Benbasat (1991)
	AdvS3	Drone delivery is useful in shortening the order delivery time	Moore and Benbasat (1991)
	AdvS4	Drone delivery gives greater control over the speed of my delivery	Moore and Benbasat (1991)
Relative advantage in environment protection	AdvEn1	Drone delivery is a green way to deliver orders	Al-Jabri and Sohail (2012)
	AdvEn2	Drone delivery allows me to receive orders in a more environmentally friendly way	Moore and Benbasat (1991)
	AdvEn3	Drone delivery is a less carbon dioxide emitting delivery method	Moore and Benbasat (1991)
	AdvEn4	Drone delivery gives me greater control to protect the climate	Moore and Benbasat (1991)
Privacy vulnerability	PrivVul1	My private information is vulnerable to security breaches if I use drone delivery	Ifinedo (2012)
	PrivVul2	My private sphere is subject to security vulnerability if I use drone delivery	Vance et al. (2012)
	PrivVul3	Privacy violation to my data could occur at drone delivery.	Vance et al. (2012)
	PrivVul4	Trespassing my privacy sphere is likely if I use drone delivery.	Vance et al. (2012)
Privacy risk severity	PrivRskS1	Protecting my private information in drone delivery is important	Vance et al. (2012)
	PrivRskS2	Threats to the security of my private information in drone delivery is harmful	Vance et al. (2012)
	PrivRskS3	In terms of security risks in drone delivery, the vulnerability of my private information is low	Vance et al. (2012)
	PrivRskS4	Loss of private data from hacking in drone delivery is a serious problem for me	Vance et al. (2012)
Technology anxiety	Tanxi1	I will avoid using drone delivery because it is unfamiliar to me	Lee and Yang (2013)
	Tanxi2	I have difficulty understanding most technological matters of drone delivery	Meuter et al. (2003)

(Continued)

Table 2. (Continued)

Construct	Code	Items	Reference
	Tanxi3	I feel apprehensive about using technology	Meuter et al. (2003)
	Tanxi4	Drone delivery terminology sounds like confusing jargon to me	Meuter et al. (2003)
	Tanxi5	I hesitate to use drone delivery for fear of making mistakes I cannot correct	Meuter et al. (2003)
Switch intention to drone delivery	SI1	Rate the likelihood that you would switch from truck delivery to drone delivery: Unlikely—Likely	Bansal et al. (2005)
	SI2	Rate the probability that you would switch from truck delivery to drone delivery: Improbable—Probable	Meuter et al. (2003)
	SI3	Rate the chance that you would switch from truck delivery to drone delivery: No chance—Certain	Meuter et al. (2003)

Table 3. Items' loadings

Items	EP	SPD	PRS	PRV	SI	ANX
EP1	0.849					
EP2	0.916					
EP3	0.811					
EP4	0.827					
SPD1		0.861				
SPD2		0.905				
SPD3		0.884				
SPD4		0.81				
PRS1			0.87			
PRS2			0.903			
PRV1				0.82		
PRV2				0.838		
PRV3				0.846		
PRV4				0.858		
SI1					0.963	
SI2					0.957	
SI3					0.938	
ANX1						0.736
ANX2						0.832
ANX3						0.807
ANX4						0.812

Table 4. Construct reliability and validity

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
EP	0.874	0.886	0.913	0.726
SPD	0.888	0.896	0.923	0.749
PRS	0.728	0.738	0.88	0.786
PRV	0.874	0.963	0.906	0.707
SI	0.949	0.949	0.967	0.908
ANX	0.809	0.811	0.875	0.636

Table 5. Fornell-Larcker criterion discriminant validity

	EP	SPD	PRS	PRV	SI	ANX
EP	0.852					
SPD	0.314	0.865				
PRS	0.268	0.235	0.886			
PRV	0.257	0.19	0.623	0.841		
SI	0.388	0.489	0.069	0.055	0.953	
ANX	−0.192	0.125	0.297	0.307	−0.16	0.798

assessing and evaluating items' loadings, construct's composite reliability, convergent and discriminant validity, and overall measurement model fit.

Table 3 provides us with a snapshot of operationalized items' loadings. The first pilot study has insignificant loadings for two items of the perceived privacy risk severity and one item of technology anxiety; thus, they were removed.

As Nunnally (1978) suggests that composite reliability should be 0.7 or higher for a construct to demonstrate adequate reliability. Convergent validity refers to the extent to which items for each construct are related and measures the same construct, evaluated by average variance extracted (AVE). A larger than 50% variance in each construct is suggested (J.F. Hair et al., 2009). As shown in Table 4, all metrics are at a 0.000 significant level, indicating that all items are free from random measurement errors and consistent in measuring what they suppose to measure.

In contrast, the discriminant validity ensures that variables of each construct are not interrelated and only measure their associated constructs. It can be evaluated using a Fornell-Larcker criterion and a heterotrait-monotrait ratio of correlations (HTMT) in SmartPLS. The Fornell-Larcker values (square root of every AVE), reported in bolded font and the diagonal of the correlation

Table 6. Model statistics & hypotheses results

Model path statistics	Path coefficients	Hypothesis supported?	P values
EP -> SI	0.216	Yes	0.039
SPD -> SI	0.443	Yes	0.000
ANX -> SI	−0.174	No	0.103
PRV -> ANX	0.199	No	0.153
PRS -> ANX	0.173	No	0.321

Table 7. Bootstrapping test result

HTMT Intervals	Original Sample (O)	Sample Mean (M)	LL 2.50%	UL 97.50%
AdvSpeed -> AdvEnv	0.35	0.356	0.121	0.612
Intention -> AdvEnv	0.419	0.415	0.174	0.622
Intention -> AdvSpeed	0.527	0.522	0.316	0.686
PrivacyRskS -> AdvEnv	0.343	0.357	0.132	0.617
PrivacyRskS -> AdvSpeed	0.282	0.315	0.116	0.529
PrivacyRskS -> Intention	0.094	0.172	0.021	0.147
PrivacyVul -> AdvEnv	0.297	0.318	0.117	0.537
PrivacyVul -> AdvSpeed	0.224	0.259	0.102	0.42
PrivacyVul -> Intention	0.097	0.166	0.034	0.124
PrivacyVul -> PrivacyRskS	0.769	0.77	0.552	0.93
TAnxiety -> AdvEnv	0.221	0.269	0.095	0.43
TAnxiety -> AdvSpeed	0.151	0.221	0.063	0.193
TAnxiety -> Intention	0.181	0.235	0.072	0.313
TAnxiety -> PrivacyRskS	0.378	0.403	0.158	0.607
TAnxiety -> PrivacyVul	0.31	0.33	0.159	0.504

matrix (Table 5), are larger than the corresponding off-diagonal correlations among any pair of latent constructs (Fornell & Larcker, 1981), indicating suitable discriminant validity.

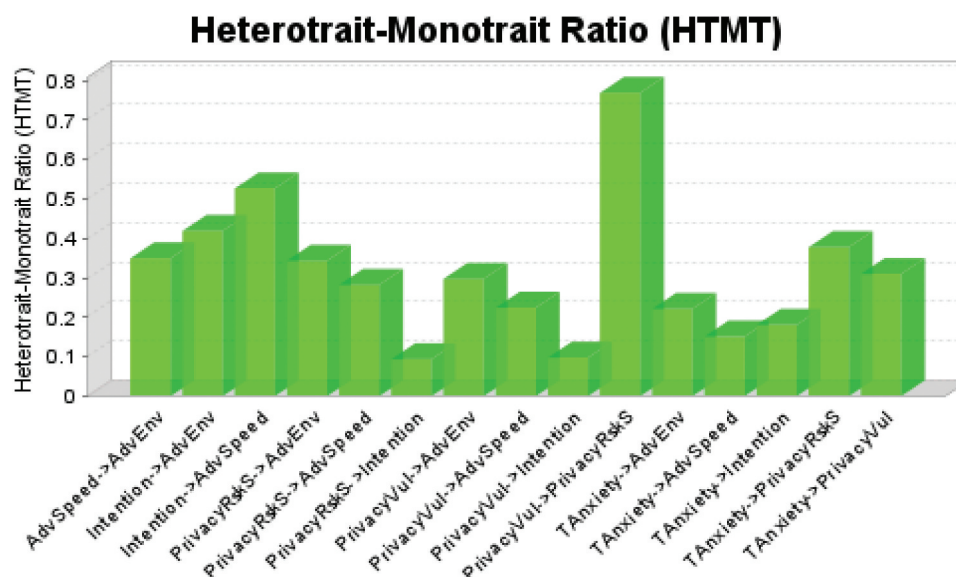
To further ensure high discriminant validity, we further calculated heterotrait-monotrait (HTMT) ratio and Q-square value. Henseler et al. (2015) proposed the heterotrait-monotrait (HTMT) ratio of the correlations, calculated as the mean value of the item correlations across constructs relative to the (geometric) mean of the average correlations for the items measuring the same construct (Hair et al., 2019). High HTMT values indicate discriminant validity issues. Henseler et al. (2015) propose a conservative threshold value of 0.85 (and less) for structural models with conceptually less similar constructs. The HTMT values of this study are all smaller than 0.85, indicating permissible discriminant validity.

The overall standardized root mean square residual (SRMR) measures the model's residual discrepancies between observed and hypothesized correlations. Our 0.08 is at par with the suggested cut-off values (Byrne, 2016; Hu & Bentler, 1999; Kline, 2011), demonstrating a good fit (McDonald & Ho, 2002).

4.2. Structural model and hypotheses testing

The structural model estimation includes assessing the multicollinearity, significance, and relevance of construct relationships and model fit in R^2 and F^2 (effect size). For the multicollinearity assessment, the variance inflation factor (VIF) ranges from 1.081 to 1.633 for all the variables

Figure 2. A pictorial representation of the HTMT result of bootstrapping.



(items) used in the model, much smaller than the suggested cut-off value of 5, indicating admissible correlations among variables (Ringle et al., 2015).

Table 6 provides the psychometric structural model results, including the standardized path coefficients for each hypothesized relationship and R^2 values for exogenous constructs. A significant indicator for each path coefficient and endogenous variable is also presented in parentheses. As we can see from the results, two out of five hypotheses are supported. The relationships between two privacy risk constructs and technology anxiety are not significant. Technology anxiety also does not significantly negatively impact the switch intention of users to drone delivery services. R^2 represents the variance explained in each endogenous construct, measuring the model's predictive accuracy.

The rule of thumb for moderate model fit in social science is 0.3–0.5 (Chin, 1998; Falk & Miller, 1992; Hair et al., 2011). The insignificant paths and R^2 introduce an interesting phenomenon yet to be investigated. The hypothesized reason contributes to the composition of respondents who are younger generations in this study. Younger generations born and grew up with technologies are less concerned about privacy than older generations. If future studies can verify this hypothesis, it will provide direct evidence to support speculations on how technologies shape human behaviors.

The mediation effects of technology anxiety on the path from perceived severity and perceived vulnerability to switching intention were tested using the bootstrapping methodology (Shin, 2020). Bootstrapping significant level is set at 5% for the calculation. All HTMT values at 95% UL are smaller than 0.85 and significant. Table 6 presents LL and UL for all the correlations (Table 7). A pictorial representation of the result of bootstrapping of SmartPLS is also presented on Figure 2. Q-square measures the predictive relevance of the model and endogenous constructs. Q-square value larger than 0 indicates the model is relevant and well-constructed (Fornell & Larcker, 1981).

5. Implications, future research, and limitations

This study adopts the push, pull and mooring and privacy calculus theories to examine the relative influence of positive and negative factors on the intention of users to switch to drone delivery services. The relative advantages of drone delivery services in speed and environmental protection are positive factors examined in this study. On the other hand, this study asserts that users'

technology anxiety caused by privacy risk vulnerability and severity can negatively discourage users' intention to switch to drone delivery services.

The findings of this study highlight that speed and environmental protection have a significant positive influence on users' switch intention. The importance of relative advantages for the diffusion of innovation (Rogers, 1995) is further extended to the context of drone delivery services. However, users are not receptive to the negative influence of technology anxiety. The increased privacy risk severity and vulnerability do not exhibit a significant negative influence on the increase of technology anxiety either. This finding corroborate previous studies on the direct influence of privacy risk severity and vulnerability on information privacy concerns or anxiety for varying technologies, such as cloud services (Bordonaba-Juste et al., 2020). Our finding is particularly relevant to potential users of drone delivery services because they are the Millennial generation, who appreciate more about technology-related aspects than information security related issues (Bordonaba-Juste et al., 2020). Users in this study tend to pay more attention to their relative advantages than potential privacy risks for drone delivery services, regardless of severity and vulnerability levels. These major findings offer theoretical and practical implications.

5.1. Theoretical implications

One major theoretical implication is the design and development of a research model purposely to provide insights into the switching behaviors of potential e-commerce users for drone delivery services. The research model integrates two theories: PPM and privacy calculus theories. The switching intention variable from PPM theory is used as the dependent variable to understand the switching behavior of the public for drone deliveries. The novelty delivery service has distinctively relative advantages over traditional transportation methods: speed and environmental protection. These two factors are critical relative advantages for the diffusion of innovative drone delivery services. A previous study shows a strong correlation between these two factors and the intention to adopt drone delivery services (Yoo et al., 2018). This study extends the previous study and affirms their positive impact on the switching behaviors of users.

Users have varying anxiety levels when confronted with new technology (He & Freeman, 2010). Privacy concerns or anxiety can influence users' risk perception toward using new technologies, such as mobile technologies (Tay et al., 2021). This study shows that many users are also anxious about using drone delivery services after understanding their related privacy and security risks. This study further asserts that the anxiety of using drone delivery services can originate from the privacy risk vulnerability and severity. Although the finding shows otherwise, the integrated research model allows us to assess the joint effect of relative advantages and anxiety triggered by privacy risks on the switching behaviors of users for drone delivery services. The finding indicates that users are more concerned about whether drone delivery services can live up to their promise in speed and environmental protection rather than potential privacy risks. Users are willing to take privacy risks and tolerate anxiety in exchange for speedy and environmentally friendly drone delivery services. Thus, our study provides theoretical insights for research on novelty drone delivery services.

Second, drone delivery literature has identified and evaluated the two relative advantages of speed and environmental protection as the primary reasons for drone delivery adoption for users (Yoo et al., 2018). Most prior studies on drone delivery generally regarded privacy and security risks as two antecedents for the slow adoption of the novelty services, such as blockchain (Toufaily et al., 2021) and mobile payment (Johnson et al., 2018) services. However, this study offers an integrative framework to examine the relative influence of these positive and negative factors on users' attitudes toward switching to drone delivery services. More importantly, this study includes technology anxiety as the intermediating variable to assess whether Gen Z-ers who care less about privacy risks will change their switching behaviors. Our study showed that technology anxiety's intermediating effect is strong even though it does not significantly influence switching behaviors. The intermediating effect is much stronger than the direct influence of privacy risk severity and vulnerability on

technology anxiety. These findings offer additional insights into the importance of using technology anxiety or other intermediating variables to develop more robust research models in the drone delivery field.

5.2. Practical implications

There are three major implications for practitioners. First, perceived faster delivery speed is the primary reason for the decision of users to switch to drone delivery services. Although environmental protection benefit is also essential for the switching decision, users consider the relative advantage of speed is two times more important than environmental protection. E-commerce vendors should focus on improving the delivery speed to convert users who are used to traditional shipping methods to drone delivery services.

Second, many users consider environmental protection another significant benefit of drone delivery service, even though it is not as crucial as faster delivery than traditional delivery services. Our study shows that about 1/5 of the subjects in this study are intended to switch to drone delivery services because of the secondary benefit. An increasing number of users value the ability of drone delivery to reduce environmental impact and road congestion (Borghetti et al., 2022). When offering drone delivery services, e-commerce vendors can use campaigns or other approaches to promote these services by emphasizing their environmental friendliness and operational sustainability.

Third, the present study investigates the relative influence of privacy risk severity and vulnerability on the technology anxiety of users. Although users are more concerned about privacy risk severity than vulnerability regarding the adoption of drone delivery services, these two factors did not have a significant influence. This finding corroborates previous studies that Gen Zers' are more willing than previous generations to give up their privacy to achieve personal and financial goals (Schlee et al., 2020). Instead, technology anxiety can potentially mediate the influence of these two factors on the switching decision of users for drone delivery services. This finding adds additional insights to the current literature on using technology anxiety as a moderating factor for technology adoption (Cebeci et al., 2019). The commonly accepted idea is that people with higher technology anxiety tend to see the negative aspect of new technology and avoid using it.

E-commerce vendors may want to continue to explore the mediating variable and investigate factors that can reduce the mediating impact of technology anxiety. For instance, users often adopt emotion- and communication-focused strategies to cope with online privacy risks (Cho et al., 2020). E-commerce vendors may want to formulate public relationship and communication strategies that connect potential users to the sustainable benefits of drone delivery services. Such communication strategies can help lower anxiety levels of using drone delivery services.

5.3. Limitations and future research directions

Our findings warrant careful interpretations because they have some limitations. First, the target participants are active users of e-commerce sites. Although these samples are representative and effective at understanding the switching behaviors of users for drone delivery services, all participants are Gen Zers. Gen Z-ers share common characteristics (McMahan, 2020); for instance, they are digital natives and never feel the world is a safe place to live. Many are entrepreneurial and prefer contactless service, except for security seeking (Kim et al., 2021). Thus, the findings can be better generalizable to Gen Z users than users in other age groups.

Second, 82 subjects participated in the study. The present study adopts SmartPLS to run the path analysis because it has fewer restrictions on sample size. SmartPLS needs to meet the "10 times" rule of thumb to have a more robust power than other techniques at a small sample size (Chin, 1998). In other words, the minimum sample size needs to be at least ten times the largest of two possibilities: (1) the construct with the largest number of indicators, or (2) the largest number of independent variables impacting the dependent variable (Marcoulides & Saunders, 2006). A few constructs in the research model have four indicators and three independent variables impacting

the dependent variable. Thus, it is imperative to have at least 40 samples to run the path analysis using SmartPLS. Although our study exceeds the minimum sample size, larger sample size and a more diversified sample can increase the power effect and generalizability of the findings.

Third, information system literature has found that many factors contribute to technology anxiety. These factors include experiences, age, gender, personality trait, and social-economic background. Drone delivery is a novelty service. All subjects surveyed in this study have no prior experiences. This study neither collects demographic information nor assesses its potential influence on technology anxiety. Future research may want to improve the survey design to include demographic variables that can potentially impact the decision of users to switch to drone delivery services.

Fourth, the extant literature shows that prior experiences with a new technology or service negatively correlate with technology anxiety (Fagan et al., 2004). Increased experience can potentially lead to a diminution in technology anxiety (McInerney et al., 1994). Future research can invite subjects with prior drone delivery experience to participate in the study. Thus, a comparative analysis can be conducted to assess whether prior experiences of using drone delivery services can impact the following relationships: privacy risk severity and vulnerability has a significant influence on technology anxiety, thereby impacting the decision of users to switch to drone delivery services.

The novelty of the present study opens opportunities for researchers to integrate different areas of study to understand the adoption behaviors of users for drone delivery services. For practitioners, drone delivery services are still at the early adoption stage. They can use the findings of this study to design, improve and implement drone delivery services and apps to convert users from traditional to drone delivery services.

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