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Understanding Behavioral Intention to Use Drone Technology for Sustainable Development: The Facilitating Role of Behavioral Learning Engagement with Instructional Videos

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Abstract

Although drone technology can be regarded as one of the most viable technologies for achieving sustainable development goals (SDGs), individuals are still unaware of its benefits and challenges. During the pandemic, drone technology benefited businesses and communities as a mechanism of sustainable crisis management by minimizing human contact in different environments despite its safety concerns. However, few studies have shown what salient factors influence individuals' intention to use drone technology in the context of sustainable development. Therefore, drawing on the theory of planned behavior (TPB), we investigate individuals' behavioral intention to use drone technology for combatting pandemics while achieving SDGs. We also examine how individuals' learning engagement with instructional videos facilitates their intention. Our findings suggest that only perceived usefulness positively influences individuals' attitudes, which leads to their behavioral intention to use drone technology for SDG-related activity. In contrast, their perceived safety concerns and pandemic helpfulness do not significantly impact the formation of their positive attitudes toward drone technology use. Furthermore, we found that an individual's sustainable development concerns and behavioral learning engagement are likely to play a significant role in facilitating their intention to use drone technology by their attitudes toward them. Based on our findings, this study contributes to the theoretical literature on technology adoption and learning engagement with instructional videos. This study also provides practical insights into how organizations and policymakers promote drone technology for sustainable development through informative and educational campaigns with instructional videos.

Keywords

Drone technology, Sustainable development, Learning engagement, Instructional videos, Behavioral intention

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Introduction

In 2015, the United Nations (UN) proposed 17 sustainable development goals (SDGs). These included affordable clean energy, sustainable cities and communities, and responsible consumption and production among others, with 169 targets and 232 indicators that emphasized peace and prosperity for people and the planet (United Nations, 2015). Since then, various innovations and technologies have played a critical role in pursuing the SDGs by accelerating the developmental progress of human beings and communities and bridging the digital gaps (Bachmann et al., 2022; Berawi, 2019; Wu et al., 2018). For example, data-driven technologies have helped achieve the SDGs by making information more reliable, supporting better decision-making, and optimizing resource allocations (Bachmann et al., 2022). SDGs and their targets can be achieved through and alongside developments in technology, innovation, and breakthrough solutions (Berawi, 2019). During the pandemic, potential technologies, including unmanned aerial vehicles (UAVs), artificial intelligence (AI), and the Internet of Things (IoT), also supported achieving the SDGs by mitigating the dangers of viruses (e.g., minimal human contact, etc.) (Mohsan et al., 2022).

To achieve SDGs such as peacekeeping, combatting poverty, and delivering aid (Rosenthal, 2018), drone technology, commonly known as UAVs, has been widely adopted in diverse fields. Specifically, drone technology advances SDG 13, climate action, by reducing carbon emissions in conservation and commercial agriculture (substituting for heavy vehicles and helicopters) (Wildlife Drones, 2024). Agricultural drones, for instance, help farmers achieve precision farming and combat extreme weather and assist aging farmer populations (Mogili & Deepak, 2018); medical supplies can be delivered to remote locations by healthcare drones (Yaprak et al., 2021); in disaster management, drones can be used to fight against urban and forest fires (Tanzi et al., 2016). Thus, drone technology has been utilized to carry out various sustainable development projects, including forestry management, urban planning, land administration, risk assessment, coastal zone management, infrastructure monitoring, and post-disaster damage assessment (The World Bank, 2017). Drone technology also contributes to sustainable development by performing humanitarian missions, such as search and rescue (Arnold et al., 2020), and enabling zero-emission last-mile delivery for e-commerce companies (Pahwa & Jaller, 2023). Thus, innumerable sustainable development opportunities can be achieved with drone technology.

Although drone technology supports sustainable development applications, many SDG-relevant individuals are still unaware of those applications with their benefits and challenges (Sabino et al., 2022). Furthermore, the factors that encourage individuals

to adopt and use drone technology for sustainable development remains unclear. To void this academic and practical gap, we propose the following research questions: (1) *what salient factors influence individuals' behavioral intention to use drone technology for sustainable development?* and (2) *how can their behavioral intention to use drone technology be facilitated in educational settings?* Drawing on the theory of planned behavior (TPB) in the context of responses to the pandemic, we examine three antecedents—perceived usefulness, pandemic helpfulness, and perceived safety concerns—of individuals' attitudes toward drone technology for sustainable development, along with sustainable development concerns and behavioral learning engagement. In addition, this study examines the role of instructional videos about sustainable development goals (SDGs) in facilitating individuals' intention to use drone technology through their behavioral learning engagements.

This study is organized as follows. We first review the literature on drone technology, sustainable development, and learning engagement. Then, we outline the theory of planned behavior as a theoretical base underlying our research. Based on the literature and theoretical base, we propose our research model and pose our hypotheses regarding what and how salient factors determine individuals' behavioral intention to use drone technology. We discuss the research methodology used in this study and present the empirical results of our Partial Least Squares (PLS) analysis. We conclude by noting the theoretical and practical implications of our findings, the limitations of our study, and directions for future research.

Background

Drone Technology for Sustainable Development

Along with the broad application of drones, drone technology has been improving rapidly and is becoming more user-friendly daily (Hafeez et al., 2022). As a result, it has been widely utilized in various business sectors and their commercialization. According to an industry report (Fact.MR, 2023), the U.S. drone market size is estimated at $11.1 billion in 2022, and reached a market valuation of $82.9 billion by 2023. One specific example of commercial use of drone technology, the global drone delivery service market, has reached a valuation of $359.6 million in 2023 and may significantly increase to $3,090.5 million by 2033 (Fact.MR, 2023). During the pandemic, the role of drone technology rapidly escalated with its growing recognition and acceptance level (Green et al., 2021). Drone technology demonstrated that it could help deliver essential goods, supplies, and services as well as battle the spread of viruses by providing medical supplies, broadcasting environmental and health concerns, spraying

disinfectants, and even improving sustainability more efficiently and effectively while minimizing human contact (Green et al., 2021; Mohsan et al., 2022).

Drone technology offers numerous benefits in achieving sustainable development goals (SDGs) by providing fast and accurate data collection and allowing for efficient monitoring of environmental resources, disaster areas, and infrastructure (Alsamhi et al., 2022). For instance, drone technology can utilize sustainable agriculture practices with precision farming and crop monitoring (Raj et al., 2022), improve energy efficiency by supporting renewable energy development and reducing carbon emissions in transportation (Rodrigues et al., 2022), and aid in wildlife conservation efforts by monitoring and protecting endangered species (Jiménez López & Mulero-Pázmány, 2019). Thus, drone technology has great potential to support sustainable development efforts in various fields, from transportation to environmental conservation and disaster management.

Learning Engagement with Instructional Videos

In educational settings, instructional videos have been widely adopted to teach skills, concepts (Hsia et al., 2021; Kim et al., 2019), and problem-solving techniques (Mayer et al., 2020). As such, learning skills and knowledge from instructional videos simplify and enrich individuals' everyday lives. For example, to prepare dinner for the family, a homemaker can subscribe to a cooking lesson channel and follow along with a demonstration of a famous chef; a retiree can learn how to fix a door and make a bar table from a carpenter YouTuber. Thus, instructional videos primarily facilitate the transfer of knowledge, ideas, concepts, skills, or processes (Seo et al., 2021) while encouraging individuals to improve their performance on hard skills (e.g., spreadsheet use, software development, painting) or soft skills (e.g., intercultural communication, leadership) (Szilárd et al., 2018). Therefore, choosing suitable instructional videos is crucial for enhancing learning performance and engagement in various educational settings (Reimers et al., 2020).

Learning engagement refers to the degree to which an individual is actively involved in the learning process and motivated to achieve learning outcomes (Bouchrika et al., 2021). Engaged individuals are more likely to achieve better learning outcomes and have a more positive learning experience (Awidi et al., 2019; Benbunan-Fich & Hiltz, 2003; Carini et al., 2006). As a logical means for learning effectiveness and satisfaction, learning engagement requires a particular medium, such as technology-mediated learning tools (Hu & Hui, 2012) and instructional videos (Bétrancourt & Benetos, 2018; Walsh et al., 2021). Instructional video-based learning specifically engages individuals on

three levels: cognitive, emotional, and behavioral (Kearsley & Shneiderman, 1998). Cognitive engagement refers to how learners actively process and integrate new information and ideas into their existing knowledge structures. This includes paying attention, generating questions, and applying new information to solve problems (Kew & Tasir, 2021). Emotional engagement refers to the degree to which learners are motivated to learn and have positive feelings toward the learning experience. This includes activities such as expressing interest, enjoyment, and enthusiasm for learning (Dubovi, 2022). Behavioral engagement refers to the degree to which learners participate in learning activities and invest effort in achieving learning outcomes. This includes attending classes, completing assignments, and actively participating in discussions (Sun et al., 2019). Among those learning engagements, we adopted only behavioral learning engagement for this study because we aim to facilitate individuals' actual behaviors in adopting drone technology beyond their cognitive and emotional aspects.

Theory of Planned Behavior

The theory of planned behavior (TPB) has been widely considered one of the main research streams on individuals' attitudes toward behaviors (Eagly & Chaiken, 1993). As an extension of the theory of reasoned action (TRA) (Ajzen & Fishbein, 1980), the TPB holds that an individual's behavioral intention is a function of attitude, subjective norm, and perceived behavioral control (Ajzen, 1991). As described in TRA, attitude refers to an individual's evaluation of performing the behavior, and subjective norm refers to their perception of how other people expect the specific behavior to be performed (Ajzen, 1991). The TPB particularly emphasizes the role of perceived behavioral control, defined as an individual's perception of how easy or difficult it is to perform the behavior (Eagly & Chaiken, 1993). As such, the TPB proposes that most human behaviors are subject to perceived behavioral control as expected deficiencies and obstacles, such as the availability of opportunities, time, and money. (Song et al., 2018).

Accordingly, the TPB is a theoretical framework for predicting an individual's actual behaviors through their behavioral intentions. It combines three components—attitude toward behavior, subjective norm as social influence, and perceived behavioral control (Ajzen, 1991; Karahanna et al., 1999; Pavlou & Fygenson, 2006). In addition, under the TPB, previous research has studied various attitudinal beliefs as individuals' perceptions to investigate their attitudes in different contexts (Pavlou & Fygenson, 2006; Song et al., 2018; Song & Zahedi, 2005). Thus, the TPB was considered suitable for this study because we aimed to identify and empirically test this set of factors that may

facilitate a user's behavioral intentions to use drone technology for sustainable development.

Hypotheses Development

This study aims to investigate what and how salient factors facilitate the use of drone technology for sustainability development in the specific context of the pandemic. For this, we begin by explaining how three context-specific factors play a critical role in facilitating users' attitudes toward their behavioral intentions. These comprise, perceived usefulness, pandemic helpfulness, and perceived safety concerns. Based on the TPB, sustainable development concerns (as subjective norms) and learning engagement (as perceived behavioral control) also facilitate their behavioral intention. Figure 1 shows our proposed research model, including major theoretical constructs and their hypothesized relationships.

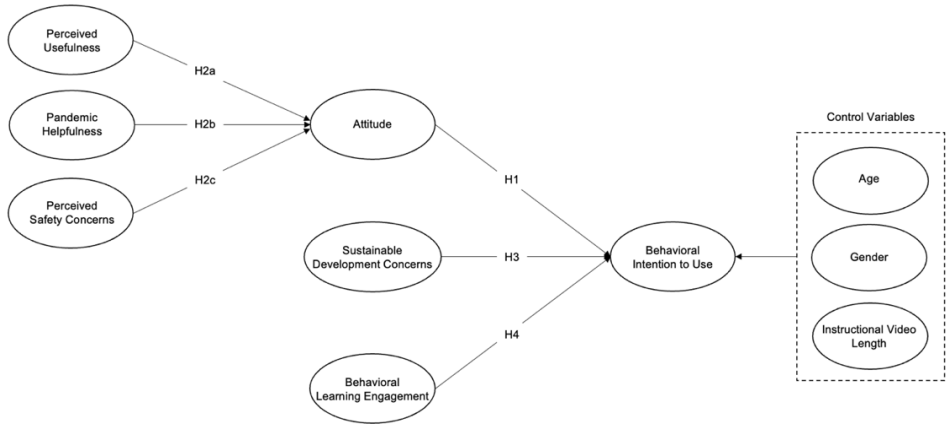

Figure 1 The Proposed Research Model

Source: Developed by the authors.

Attitudes Toward Using Drones for Sustainable Development

To predict an individual's use of new technology, it is essential to understand what factors increase their willingness to adopt and use that technology (Davis et al., 1989b; Pavlou & Fygenson, 2006; Song & Zahedi, 2005). For example, farmers in Germany tend to use agricultural drones more readily when they are aware of the technology and its specific farming applications (Michels et al., 2021). In a sense, drone delivery services are not widely used because most users are unaware of how this innovative service provides them with sustainable benefits. During the pandemic, the public started to pay attention to the sustainable use of drones to achieve sustainable

development goals (Wang & Huang, 2021). To achieve sustainable development goals, it is critical to encourage individuals to have positive attitudes toward using drone technology as early as possible; at the same time, positive attitudes are proven to influence behavioral intentions (Davis et al., 1989a; Pavlou & Fygenson, 2006; Song & Zahedi, 2005). The influence of attitude on behavioral intention has been established in numerous studies (Ajzen, 1991; Mailizar et al., 2021). For instance, prior studies have emphasized the positive relationship between attitude and behavioral intention in various contexts, such as mobile app use (Leon, 2018; Mohd Suki & Mohd Suki, 2017; Yang, 2013), mobile banking (Alalwan et al., 2017), online shopping (Faqih, 2013; Faqih & Jaradat, 2015), drone delivery services (Leon et al., 2021), and autonomous vehicles (Lee et al., 2019). In line with this, Yoo et al. (2018) proposed that individuals' intention toward drone delivery adoption can be determined by their attitude toward using drones for speed and environmental friendliness. Leon et al. (2021) also argued that individuals develop positive attitudes toward drone delivery benefits when they embrace drone technology for business applications. Thus, when examining the relationship between attitude and intention within sustainable development, our proposed model needs to reveal how an individual's positive attitudes toward drone technology increases his or her behavioral intentions. Therefore, we hypothesize that:

Hypothesis 1. *An individual's attitudes toward drone technology are positively associated with his or her behavioral intention to use that technology.*

Attitudinal Beliefs: Perceived Usefulness, Pandemic Helpfulness, and Perceived Safety Concerns

As one of the salient antecedents to attitudes, perceived usefulness has been shown to affect an individual's positive attitudes positively (Davis et al., 1989a; Pavlou & Fygenson, 2006; Song et al., 2018; Song & Zahedi, 2005). For instance, in the context of drone technology use, Yoo et al. (2018) posit that potential drone users might have a more positive attitude toward using it if it is useful. In addition, the benefits of using drone technology in delivery services may be perceived as higher when the technology is useful (Leon et al., 2021). Similarly, individuals are more likely to enhance their positive attitude toward drone technology and its sustainable applications, as they perceive technology as useful in business environments. Hence, this study hypothesizes that:

Hypothesis 2a. *The perceived usefulness of drone technology is positively associated with an individual's attitudes toward that technology.*

Situational factors, such as external factors and environmental contexts, can significantly influence an individual's attitudes toward new technology use (Kemp et al., 2019). For example, an individual's attitudes toward using a new technology may be influenced by such situational factors as the availability of resources, social norms, and cultural factors. Drones were used for food delivery to quarantined people during the pandemic and for surveillance to combat the spread of coronavirus during a pandemic lockdown (Green et al., 2021; Mohsan et al., 2022). Additionally, in crisis circumstances like pandemics, drones were used to rapidly and reliably transport medical-related materials, such as laboratory samples, blood products, vaccines, pharmaceuticals, and even organs for humanitarian aid organizations (Johnson et al., 2021). Thus, drone users are more likely to adopt a positive attitude toward using drones for good when they can see the proven benefits of using drones during a disaster management crisis like the pandemic. Hence, this study considers pandemic helpfulness as a tangible benefit, proposing that:

Hypothesis 2b. *Pandemic helpfulness in using drone technology is positively associated with an individual's attitudes toward that technology.*

Despite the increasing popularity of drone technology and its many benefits, it is a relatively new technology that needs proper regulations and rules. Hence, safety concerns can be defined as any concerns that individuals might feel about the flight of drones and their use for businesses or commercials in various environments (e.g., Khan et al., 2019). An individual's perceived safety concerns in using drone technology can influence his or her attitudes toward drones. Several studies have investigated the relationship between perceived safety concerns and attitudes toward drone technology (Choe et al., 2021; Khan et al., 2019; Stokes et al., 2020). This means that if an individual perceives drones as a safety hazard, they may be less likely to accept and use this technology, which could negatively impact their attitude (Khan et al., 2019). On the other hand, if an individual perceives drones as safe, they may be more accepting of this technology and have a more positive attitude toward it. The more an individual perceives drones as a secure technology to use, the more positive his or her attitudes toward drones will be. Therefore, we propose that:

Hypothesis 2c. *Perceived safety concerns in using drone technology are positively associated with an individual's attitudes toward that technology.*

Sustainable Development Concerns

Subjective norm refers to the perceived social pressure from an individual's social networks to engage in a certain behavior (Ajzen, 1991). This includes the perceived expectations and approval or disapproval of significant others, such as family, friends, and peers; this significantly impacts an individual's behavior and intentions to act. In this study, we employ the concept of sustainable development concerns as subjective norms. Sustainable development refers to a development approach that meets the needs of the present without compromising the ability of future generations to meet their own needs (Verma, 2019; World Commission on Environment and Development, 1987). This includes economic, ecological, social, and cultural concerns in a balanced and integrated manner (Verma, 2019). In sustainable development, subjective norms can be used to understand an individual's behavior and intentions toward sustainable practices, such as recycling (Noh, 2021) and sustainable transportation (Li et al., 2021). Drone technology can be attractive to many individuals because of its relative speed and environmental safety (Kornatowski et al., 2018; Yoo et al., 2018). While drone technology provides benefits by flying the optimal path without using road infrastructure or traffic congestion (Joerss et al., 2016), drone technology is perceived as environmentally friendly by operating on batteries and emitting no carbon (Koiwanit, 2018; Park et al., 2018; Soffronoff et al., 2016). Thus, drone technology will likely be eco-friendly and further sustainability goals (Hwang et al., 2021). Although drone technology has yet to be fully explored for sustainable development, prior studies examined the effects of sustainable development concerns (i.e., bio-spheric values) on ecological viewpoints (Hwang et al., 2021), drone delivery services (Khan et al., 2019), and drone technology adoption (Yoo et al., 2018). Therefore, it is useful to investigate the effects of sustainable concerns on behavioral intention by positing that environmental protection and its sustainability encourage individuals to use drone technology for sustainable development goals. For this reason, we hypothesize that:

Hypothesis 3. *An individual's sustainable development concerns are positively associated with his or her intentions to use drone technology*.

Behavioral Learning Engagement as Facilitating Condition

In the TPB, facilitation conditions are critical as the resources and opportunities that can help individuals exhibit a certain behavior (Ajzen, 1991). Facilitation conditions can include access to relevant information, skills, equipment, and supportive social and physical environments. In sustainable development, facilitation conditions have been used to understand the factors that enable or hinder an individual's adoption of

sustainable behaviors, such as energy-efficient practices (Al-Emran & Griffy-Brown, 2023) and sustainable transportation (Shahzad et al., 2022). In this study, we emphasize the role of learning engagement with instructional videos as the facilitating conditions. The purpose of instructional videos is to teach a single, narrow topic or skill in a highly focused manner (Kapp & Defelice, 2019). As such, instructional videos make all the steps into mini-pictures or videos to increase an individual's learning engagement. Individuals are more likely to learn with instructional videos specifically at a behavioral level (Hu & Hui, 2012; Tseng, 2021), which leads to their behavioral intention (Zhou et al., 2022). Thus, this study focuses on the role of behavioral learning engagement rather than cognitive and emotional engagement because our context is related to an individual's use of drone technology in agriculture. Hence, we propose:

Hypothesis 4. *Behavioral learning engagement through instructional videos is positively associated with an individual's intentions to use drone technology.*

Control Variables

We selected the control variables to account for differences among individuals or situations. They include demographic factors such as age and gender, as well as situational factors like instructional video length. As suggested in prior research, we selected those variables in this study because of their potential impact on behavioral intentions.

Research Methodology

Instrument Development

To develop the survey instrument, we employed existing measures with strong content validity in the relevant literature. Then, we adapted and modified them to our research context and domain. All items were anchored by a seven-point Likert scale, as shown in Appendix A. Before the survey was finalized, a draft of the adapted items was reviewed and pretested by a group of six graduate and four undergraduate students, and the items' wording and organization were revised based on feedback to ensure clarity in the context of drone use.

Study Context and Sample

This study delves into the determinants of using drone technology for sustainable development in Thailand. Thailand has experienced a notable increase in drone usage, driven by its perceived effectiveness in optimizing farming and other practices. This trend was especially accentuated during the pandemic when drones were

vital in labor management and crop yield assurance tasks. However, alongside these benefits, concerns about safety and privacy have emerged, significantly influencing individuals' attitudes and intentions regarding drone usage. In addition, in Thailand, where sustainable development is a focal point, integrating drones is seen as a promising approach to address sustainability issues across multiple sectors. Thus, Thailand can be an appropriate context for this study.

A total of 390 participants were selected from among the undergraduate students at a business school in a large university in Thailand. To collect data, we asked participants to randomly select one of four videos about using drones for sustainable development. These videos presented scenarios that described potential future situations related to using drones for sustainable development. Scenarios are not intended to accurately represent the future but rather to highlight key factors that may impact individuals' intentions. The scenario approach prompted participants to consider how they would react in a particular situation (Bishop et al., 2007; Kosow & Gaßner, 2008). An online pilot survey was conducted to fine-tune the survey instruments further. As a result, out of the 390 participants, 224 were finally selected by removing inappropriate and incomplete responses. Table 1 shows a summary of the respondents' demographics.

Table 1 Summary of Respondents' Demographics

Measures	**Frequency**	**Percentage**	**Mean**
Gender			
Male	42	18.8%	
Female	182	81.2%	
Age			
20 years under	189	84.4%	
21-25 years	34	15.2%	
26 years over	1	0.4%	
The average number of instructional videos watched in the course			21.3
The average number of instructional videos in any public sites for the education			15.44
The average time length the instructional video mostly taken			
Less than 5 minutes	28	12.5%	
5-10 minutes	110	49.1%	

Table 1 Summary of Respondents' Demographics (continued)

Measures	Frequency	Percentage	Mean
The average time length the instructional video mostly taken			
11-15 minutes	32	14.3%	
16-20 minutes	6	2.7%	
More than 20 minutes	48	21.4%	
The preferred time length to watch the instructional video			
Less than 5 minutes	56	25%	
5-10 minutes	100	44.6%	
11-15 minutes	35	15.6%	
16-20 minutes	25	11.2%	
More than 20 minutes	8	3.6%	

Source: Author's analysis

Results

Measurement Model

Partial Least Squares (PLS) was used for the data analysis in this study. PLS imposes less stringent requirements than covariance-based approaches in terms of distributions, sample sizes, and measurement scales. We specifically explored the relationships by an extant theory (i.e., TPB) in a relatively new context—the use of drone technology for sustainable development, which has not been examined in the information systems (IS) field with the TPB. Moreover, we combined sustainable development concerns (subjective norms) and instructional video-based behavioral learning engagement (facilitating conditions) in a specific context not considered in the TPB. Hence, PLS can be a suitable analytical method for this study.

We conducted the analyses in two stages—measurement and structural model—using SmartPLS 4.0. First, we conducted the measurement model to test the constructs' sufficient psychometric validity. Then, we also conducted the PLS bootstrap resampling procedure with an iteration of 1000 sub-samples to ensure the stability of the hypothesized relationship in our research model. Table 2 shows the summary of factor analysis for testing the validity of our constructs. As shown in Table 2, the outer loadings of all items are above 0.708, the recommended threshold by Hair et al. (2019). Hence, this result suggests that this model has acceptable item reliability.

Table 2 Summary of Factor Analysis

Construct	Item	Mean	Std.	PU	PH	PSC	ATT	SDC	BE	BI
Perceived usefulness (PU)	PU1	4.13	0.64	0.79						
	PU2	4.14	0.71	0.80						
	PU3	4.38	0.58	0.83						
	PU4	4.29	0.58	0.87						
Pandemic helpfulness (PH)	PH1	4.25	0.88		0.83					
	PH2	4.25	0.75		0.79					
	PH3	3.58	1.14		0.86					
Perceived safety concerns (PSC)	PSC 1	3.77	0.98			0.90				
	PSC 2	3.30	1.35			0.87				
Attitude (ATT)	ATT1	4.46	0.50				0.82			
	ATT2	4.26	0.57				0.90			
Sustainable development concerns (SDC)	SDC 1	4.22	0.64					0.82		
	SDC 2	4.26	0.55					0.82		
Behavioral learning engagement (BE)	BE1	4.45	0.57						0.89	
	BE2	4.34	0.55						0.90	
Behavioral intention (BI)	BI1	4.34	0.53							0.90
	BI2	4.25	0.63							0.79

Source: Author's analysis

We assessed reliability using internal consistency scores with the composite reliability scores. According to Nunally (1978) and Hair et al. (2019), internal consistencies can be satisfactory to good in exploratory research if they range between 0.70 and 0.90; Table 2 shows that composite reliabilities for all constructs are greater than or equal to 0.80. Thus, all constructs in the model exhibit good internal consistency. However, four constructs, such as perceived safety concerns, attitude, sustainable development concerns, and behavioral intention, have relatively lower (below 0.70) but minimally acceptable values, even though Cronbach's alpha may be too conservative (Hair et al., 2019). The square root of each construct's average variance extracted (AVE) can be used for assessing convergent and discriminant validity; it needs to be larger than its correlations with other constructs (Nunally, 1978). As shown in Table 3, all constructs

have an acceptable AVE value (0.50 is higher) for good convergent validity; they also share more variance with their indicators than with other constructs for acceptable discriminant validity. However, the inter-construct correlation between attitude and behavioral intention is relatively high (0.85), even if it is lower than the AVE of each construct.

Table 3 Reliability and Construct Correlations

Construct	CA*	CR*	Inter-construct correlation**						
			PU	PH	PSC	ATT	SDC	BE	BI
Perceived usefulness (PU)	0.89	0.89	**0.82**						
Pandemic helpfulness (PH)	0.83	0.87	0.38	**0.83**					
Perceived safety concerns (PSC)	0.63	0.82	0.15	0.27	**0.84**				
Attitude (ATT)	0.70	0.85	0.54	0.27	0.09	**0.86**			
Sustainable development concerns (SDC)	0.61	0.80	0.56	0.32	0.14	0.69	**0.82**		
Behavioral learning engagement (BE)	0.79	0.89	0.34	0.19	0.09	0.46	0.26	**0.89**	
Behavioral intention (BI)	0.66	0.85	0.58	0.28	0.15	0.85	0.70	0.59	**0.86**

***Note.** CA: Cronbach's alpha, CR: Composite reliability

****Note.** *The diagonal elements (in bold) represent the square root of the AVE.*

Source: Author's analysis

Structural Model

In a PLS structural model, loadings of measures of each construct can be interpreted as loadings in a principal component factor analysis; paths are interpreted as a standardized beta weight in a regression analysis. Figure 2 presents the path coefficients as the estimates obtained from PLS analysis, including control variables. Our proposed model considered control variables such as age, gender, and instructional video's time length. However, none of them affected path weights among the major constructs in the model, such that we excluded the control variables from the PLS testing shown in Figure 2.

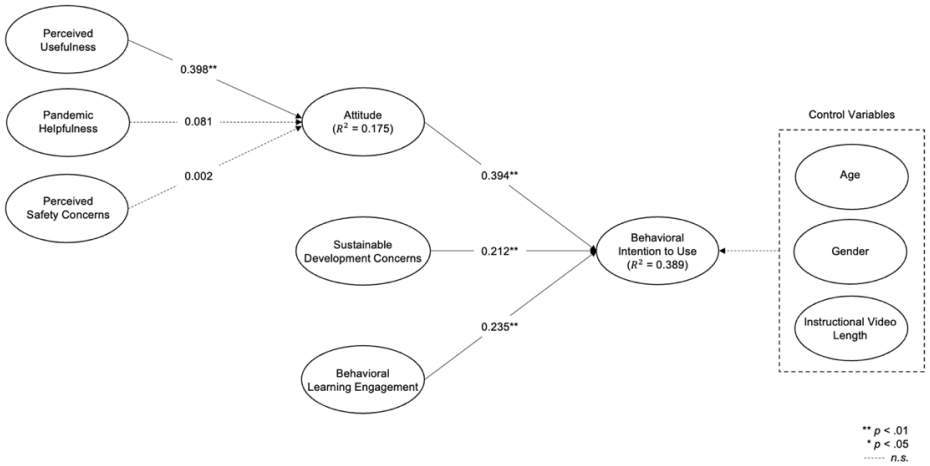

Figure 2 The Estimated Model: PLS Results

Source: Author's analysis

First, Hypothesis 1 assessed that an individual's behavioral intention to use drone technology for sustainable development would positively influence his or her attitude. Our hypothesis was supported by the PLS results. Attitude accounts for 38.9 percent of the variance in behavioral intention with sustainable development concerns and behavioral learning engagement. Thus, our results showed that attitude, sustainable development concerns, and behavioral learning engagement have a reasonable power to explain individuals' behavioral intention to use drone technology for sustainable development.

Second, Hypothesis 2 predicted that three attitudinal beliefs (perceived usefulness (H2a), pandemic helpfulness (H2b), and perceived safety concerns (H2c)) would be positively related to an individual's attitudes. Our results partially supported H2. As shown in Figure 2, individuals' attitudes were significantly and positively affected by perceived usefulness, not by pandemic helpfulness and perceived safety concerns. Also, the low R^2 value (R^2 = 0.175) indicated that the three attitudinal beliefs we considered in this study only explain a small amount of variance in individuals' attitudes when they intend to use drone technology for sustainable development.

Third, our PLS results supported both Hypotheses 3 and 4; that is, the influences of sustainable development concerns (H3) and behavioral learning engagement (H4) on behavioral intention to use drone technology for sustainable development. As noted, those constructs explain the variance in behavioral intention with individuals' attitudes.

Discussion

This study aims to explore the salient factors influencing individuals' behavioral intention to use drone technology for sustainable development as well as the facilitating process of learning engagements with instructional videos. For this, based on the TPB in our context, we adapted the model by (1) adopting *perceived usefulness* from Davis's 1989 Technology Acceptance Model (TAM) in addition to our contextual factors (e.g., pandemic helpfulness and safety concerns), (2) regarding sustainable development concerns as subjective norms because there is social pressure from society and communities, and (3) adopting behavioral learning engagement as a control factor in TPB. First, our results suggest that only perceived usefulness positively relates to individuals' behavioral intentions to use drone technology for sustainable development. These findings are consistent with previous research that has shown that the perceived usefulness of technology is a key determinant of individuals' intention to use it (Davis, 1989), even in the context of drone technology. Second, we found that sustainable development concerns play a significant role in increasing individuals' behavioral intentions in accordance with their attitudes. This finding is consistent with previous research showing that individuals' environmental attitudes are positively related to their willingness to engage in pro-environmental behaviors (Kaiser et al., 1999). Third, our study emphasized the role of behavioral learning engagement through instructional videos as an essential factor in facilitating individuals' behavioral intentions. This finding shows that instructional videos can be an effective tool in facilitating individuals' learning engagements (Walsh et al., 2021), which leads to their intention to use drone technology, particularly in educational settings.

Theoretical Implications

From a theoretical standpoint, this study contributes to the literature on new technology adoption for sustainable development by examining the factors influencing individuals' behavioral intention to use drone technology. Our study contributes explicitly to the theory of planned behavior (TPB) by providing empirical evidence on the factors that influence individuals' behavioral intentions to use drone technology in the context of sustainable development. However, although we conjecture that pandemic helpfulness (i.e., the usefulness of drone technology in combating pandemics) and perceived safety concerns can be important factors in individuals' behavioral intentions to use drone technology for sustainable development, their significances were not supported in this study. These results are inconsistent with prior studies, given that safety concerns have been identified as a significant barrier to the adoption of drone technology (Sah et al.,

2021). We conjecture that this result may be because study participants were students and had limited experience in using drone technology for sustainable development in real situations; therefore, they may have had less concern about safety issues and pandemic situations. Nonetheless, we conjecture that those situational factors may still be critical to understanding our context (the use of drone technology during the pandemic) under the theoretical basis of TPB. Moreover, this study contributes to the TAM literature by confirming perceived usefulness as a salient factor influencing individuals' attitudes toward their behavioral intention to use drone technology in the context of sustainable developments.

Second, we underscore the importance of sustainable development concerns in individuals' behavioral intentions to use drone technology in our contexts. This finding is consistent with previous research showing that individuals' environmental attitudes are positively related to their willingness to engage in pro-environmental behaviors (Kaiser et al., 1999). In the TPB, "subjective norm refers to an individual's attitude that follows other referents who think that certain behaviors should or should not be performed" (Song et al. 2018, p. 481). Thus, the subjective norm can be implemented by social influence; therefore, we extended the concept of the subjective norm to individuals' sustainable development concerns because sustainability has been regarded as one of the most critical social normative beliefs in prior studies (Goldsmith et al., 2015; Wang & Lin, 2017).

Third, this study contributes to the education literature by highlighting the role of learning engagement with instructional videos in facilitating individuals' intention to use drone technology for sustainable development. As stated, behavioral learning engagement refers to the degree to which individuals participate in learning activities and invest effort in achieving learning outcomes (Sun et al., 2019). Instructional videos are critical in facilitating individuals' behavioral learning engagement (Shen, 2024; Tseng, 2021; Walsh et al., 2021), leading to change in their future intended behaviors (e.g., drone technology). We suggest that instructional video can be an effective learning tool to encourage individuals to use and adopt new technology by facilitating their learning engagements. Thus, in educational settings and our specific context, learning engagement through instructional videos can significantly facilitate individuals' intentions and related behaviors when individuals adopt new technology (e.g., drone technology).

Practical Implications

From a practical standpoint, this study provides insights into how organizations and policymakers promote drone technology for sustainable development. Highlighting

the perceived usefulness and pandemic helpfulness of drone technology, organizations may facilitate individuals' use of it despite their security concerns. This can be achieved through informative and educational campaigns such as appropriate instructional videos. Thus, instructional videos can effectively provide individuals with the necessary knowledge and skills (Lin & Yu, 2023; Shen, 2024), facilitating individuals' use of drone technology for sustainable development while combatting pandemics (Mohsan et al., 2022; Oigbochie et al., 2021) and environmental challenges (Bayomi & Fernandez, 2023; Dinko & Nyantakyi-Frimpong, 2023). Thus, this study also contributes to educators in using instructional videos as an effective educational tool to enhance an individual's intention to adopt new technology with a higher level of behavioral learning engagement.

Limitations and Future Research

The limitations of this study have implications for future research in this area. First, this study focused on a specific country, Thailand. We explained why Thailand can be an appropriate context for this study; nonetheless, there needs to be more generalizability due to its exclusive focus on Thailand. To broaden the applicability of the findings, future research should consider replicating this study in countries, such as the United States, which experiencing a parallel surge in demand for drone applications because cultural differences can influence the adoption of mobility technology services, including drones and autonomous vehicles (Zhang & Kamargianni, 2023). Given the substantial influence of cultural factors on technology adoption, further investigations should explore how these cultural nuances impact individuals' attitudes and intentions toward using drone technology for sustainable development.

Second, as a result of our analyses, this study had a relatively lower Cronbach Alpha value (see Table 3). However, this result does not indicate that our analysis is immediately put into question (Bernardi, 1994). We conjectured two possible reasons for low Cronbach's Alpha values as being due either to the low number of survey questions (Tavakol & Dennick, 2011) or the statements' inability to accurately reflect participants' perception of safety and sustainable development concerns (e.g., Dunn et al. 2014). Another reason may have been because our study context, Thailand, had a more collective culture, meaning that study participants may have had held culturally different interpretations (Chang et al., 2013) regarding perceived safety concerns, sustainable development, and behavioral intention. Hence, we encourage future research to validate the reliability of this study by increasing the number of survey questions, manipulating the survey statements regarding safety and sustainable development concerns, or testing in different cultural or application contexts.

Third, our methodological approach has a limitation. While this study builds its argument upon existing theories and concepts, there is an opportunity for a more robust research design. Including a mixed-method research approach, which integrates both qualitative and quantitative data, can yield more comprehensive and conclusive results. This approach would facilitate a more holistic understanding of the factors influencing drone adoption for sustainable development while mitigating potential biases and limitations associated with a single-method approach.

Concluding Remark

This study provides valuable insights into the factors influencing individuals' behavioral intention to use drone technology for sustainable development. The study highlights the importance of promoting the perceived usefulness and pandemic helpfulness of drone technology and providing instructional videos that enhance individuals' learning engagement toward sustainable development applications. The study also demonstrates the significant role of sustainable development concerns and behavioral learning engagement in increasing individuals' behavioral intention to use drone technology. While the study has limitations, it provides a foundation of how individuals can be motivated to use emerging technology, such as drone technology, particularly for sustainable development, by considering the role of instructional videos as efficient and effective tools in our context. Moreover, our findings provide practical insights for organizations and policymakers interested in promoting the use of drone technology for sustainable development. For example, practitioners and policymakers can facilitate individuals' use of drone technology for sustainable development by creating and disseminating instructional videos about the effectiveness of drone technology on environmental challenges. Furthermore, as we emphasized in this study, these efforts can lead to greater drone technology adoption and utilization for sustainable development, which can significantly benefit society and the environment by advancing SDGs such as peacekeeping, combatting poverty, delivering aid, and climate action. For instance, drone technology helps society and communities deliver developmental materials such as vaccines, contraception, and humanitarian aid, as well as map and monitor crises by capturing images and video from the skies, and create global frameworks for sustainable assistance (Rosenthal, 2018).

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