Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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A change of perceived innovativeness for contactless food delivery services using drones after the outbreak of COVID-19

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ABSTRACT

This study aims to identify how behavioral intentions are formed in the context of drone food delivery services using the moderating role before and after the outbreak of COVID-19. A conceptual model including eight hypotheses was developed and tested based on the data of two consumer samples, one collected before and the other after the outbreak of COVID-19. The data analysis results showed that perceived innovativeness positively affects attitude. In addition, the attitude, the subjective norm, and perceived behavioral control have a positive influence on behavioral intentions. Lastly, the outbreak of COVID-19 played a moderating role in the relationship between the attitude and behavioral intentions.

1. Introduction

The world has witnessed the advent of various innovative technologies. In particular, drones open up infinite possibilities in the industry of food delivery services (Bamburry, 2015; Hwang et al., 2019). Moreover, drones are regarded as an innovative solution to the drawbacks of the existing food delivery methods, such as cars or motorcycles, which involve heavy road traffic and environmental pollution (Doole et al., 2018; Kim and Hwang, 2020). Even though drone-based food delivery services are not currently allowed for civil and commercial uses in many countries, research is focusing on developing and implementing procedures (Business Insider, 2020; Frachtenberg, 2019; Jaramillo et al., 2019). For example, the Irish startup Manna has conducted a couple of hundred test flights daily to pave the way for a permanent drone food delivery service in the outskirts of Dublin (Bloomberg, 2020). In the current environment, drones are anticipated to translate into pervasive use in food delivery services in the not too distant future.

According to the World Health Organization (WHO) (2020a), the coronavirus disease (COVID-19), which was first detected in Wuhan, China in December 2019, is an infectious disease that is caused by the novel coronavirus. The agency also released that the COVID-19 virus spreads primarily through the respiratory system of people infected. As a result, the practice of social distancing was mainly recommended as a method to reduce human-to-human transmission. Likewise, authorities worldwide have announced and implemented various public health measures, which include self-quarantining and restricting peoples' movement. For instance, the citizens in Italy experienced a nearly two-month stay-at-home enforcement, which is the longest lockdown in Europe (The Guardian, 2020). The government in Korea ran a campaign for people to refrain from outdoor activities and to adhere to physical distancing guidance to stem the coronavirus (The Korea Herald, 2020). Some countries have gradually eased the rules and regulations. However, there are still many places where social distancing is enforced to some extent, and it will be the norm even in the post COVID-19 (Fox News, 2020; Jain, 2020).

The theory of planned behavior (TPB) is a framework that was proposed by Ajzen (1991) for comprehension of consumer behavior. The TPB postulates that the individuals' behavioral intentions are determined by attitude, the subjective norm, and perceived behavioral control (Ajzen, 1991). This multi-attribute theory has long dominated attempts to explain individuals' behaviors/intentions in the hospitality industry (Chen and Li, 2010; Giger and Piçarra, 2017; Hwang et al., 2020a,2020b; Huh et al., 2009; Kim and Hwang, 2020). Moreover, many efforts incorporating additional variables into the TPB have been made to enhance the predictive power of consumers' behavioral intentions. For instance, Yang, Lee, and Zo (2017) proposed a theoretical framework that is grounded in the TPB with extra facilitators and barriers to better investigate the individuals' acceptance of smart home services.

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More recently, Hwang et al. (2020a,2020b) focused on the pro-environmental role of drones in food delivery services, and they deepened the TPB with the awareness of the consequences as a key moderator to explicate the formation of consumers' behavioral intentions. Meanwhile, in the domain of technology adoption, many studies have paid attention to the concept of perceived innovativeness, which refers to consumers' perceptions that various products/services involve innovation attributes, such as novelty and uniqueness. Innovation challenges, which are the development of a novel product/service that fits the needs of a consumer and a market, are inevitable in today's competitive market (Gruber et al., 2008). Likewise, many studies articulated the role of perceived innovativeness to create a competitive advantage and generate better chances with the consumer adoption of novel technology (Ahlstrom, 2010; Hwang et al., 2019; Ottenbacher and Harrington, 2009; Seebode et al., 2012). Therefore, the literature suggests that a clear understanding of the consumers' perception of innovativeness is essential to explain their attitude to new products or services.

The coronavirus outbreak has caused intense pressure to offer/receive services with no human contacts (Karim et al., 2020; Wen et al., 2020). Even though it is not always feasible to stay apart, people are more likely to avoid human contacts unless they are imperative. As such, the lockdowns and the restrictions during the coronavirus pandemic have changed people's food consumption habits and behaviors (Business Wire, 2020; Jain, 2020; Manivannan et al., 2020). In other words, more people remained at home during the days of social distancing, which has increased demand for food delivery services with a caution to avoid human-to-human contact. Foodservice practitioners have responding on such considerable shift and adopted their business model to be more flexible which involve extra precautions in minimizing human contact such as expanded sanitation protocols, more options of take-away, drive-through, and delivery (EHL, 2020). Authorities have also continuously shared and advised best practices in managing food pick-up and delivery to protect both employees and patrons (FDA, 2020). However, the fears of human contact are exaggerated due to the increase of COVID-19 cases (WHO, 2020b). Furthermore, there were several incidents related to delivery services that more than 72 families in New Delhi were forced to self-quarantine after a pizza delivery man tested positive for COVID-19 (India Today, 2020). This new environment has focused attention on drones, which do not require face-to-face contact during food delivery services (Research and Markets, 2020; The Times, 2020; Zeng et al., 2020). Since drones are designed to simply drop off foods at the customer's front door without human encounters, they are therefore considered a smart tool for *contactless* delivery which has become more important due to COVID-19.

The present study is focused on the roles of drone-based food delivery services during the pandemic. We aim to understand how individuals' behavioral intentions are formed in the context of drone food delivery services and the changes induced by the COVID-19 pandemic through an extended TPB. Hence, the purpose of the current study is to address the following research questions. (1) How does the perceived innovativeness toward drone food delivery services influence attitude? (2) What associations exist among the study variables rooted in the TPB? (3) Are there significant differences in the formation of the consumers' behavioral intentions before and after the outbreak of COVID-19?

2. Literature review

2.1. Roles of drones in food delivery services during COVID-19

Drones are defined as unmanned aerial vehicles that autonomously fly in natural and man-created environments (Floreano and Wood, 2015). The application of drones has been frequently addressed with enormous potential across diverse sectors, which include agricultural practices, control surveillance, disaster management, environment preservation, and transport operations (Bamburry, 2015; Frachtenberg, 2019; Restas, 2015; Shavarani et al., 2018). Floreano and Wood (2015) described how drones would contribute to agriculture, because they assist farmers to easily spray crops with pesticides and monitor the crop growth over large areas with high-resolution cameras. Restas (2015) articulated the great utility of drones for detecting dangers and managing disasters, such as earthquakes, floods, and forest fires. Several experiments have also determined its cost effectiveness in various environments and settings (Doole et al., 2018; Welch, 2015). In addition, delivery service drones enhance the quality of services in congested or remote areas with the premium values of superb accessibilities and superior speed compared to any other conventional delivery modes (Haidari et al., 2016; Hwang et al., 2019; Kim and Hwang, 2020; Shavarani et al., 2018).

Canada, China, and Australia are some of the first countries to allow commercial drones (Welch, 2015). Furthermore, aerial food deliveries by drone are also tested in other developing countries. For example, Zomato, which is one of India's biggest food tech companies, announced the successful test of food delivery using drones in June 2019, and a total of 13 delivery companies have recently been given the permission to use drones for food delivery services in India (The Week, 2020). Nonetheless, commercializing drone food delivery services has been at opposite poles of the debate. A group of people welcome the application of drones in food delivery services based on the numerous aforementioned benefits, whereas some others expressed various concerns and would like to limit the applicability of this idea (Bamburry, 2015; Clothier et al., 2015). Likewise, Hwang and Choe (2019) examined how consumers perceive the unexpected adverse outcomes with using drone food delivery services and its impact on consumer behavior. Their results determined that time risk, performance risk, and psychological risks exerted a negative influence on the image of drone-based food delivery services. In a nutshell, it can be said that people have a mixture of different perceptions regarding drone food delivery services which highlight the pros and the cons. Thus, there are still many countries that restrict the commercial use of drones for food delivery services.

Since the onset of COVID-19 in December 2019, people have started to experience a new style of living, which includes social distancing, on the basis of the current evidence that the coronavirus invades the body through the respiratory system (WHO, 2020a). This also led to regulations in many countries that enforce people to practice physical distancing, which includes staying at least 6 feet away from other people in order to avoid being exposed to the coronavirus (The Guardian, 2020; The Korea Herald, 2020). For example, Karim et al. (2020) described how the government in Malaysia has imposed a movement control order to prevent the spread of COVID-19. As of 8 September 2020, 27.24 million cases and 891,031 deaths have been confirmed as a result of the coronavirus. However, no vaccines or treatments have been found to control the coronavirus (CNN, 2020; WHO, 2020b). Thus, the need for people to rely on social distancing measures is increasing in order to cope with the extended fight against COVID-19, and these trends affect the food service industry as people adjust to a new manner of food consumption as well (Jain, 2020; Wen et al., 2020). In other words, because the public is urged to stay apart and remain in their homes in order to halt the spread of the coronavirus, the demand for food delivery services has dramatically increased. Furthermore, a contactless delivery option is generally accepted by people due to the highly contagious nature of the coronavirus. Hence, contactless food delivery services are required in order to avoid human contacts between the delivery personnel and the customers. Likewise, drones have emerged as an ideal solution for food delivery services without human-to-human contact and have drawn incremental attention during the COVID-19 pandemic (The Times, 2020). According to Research and Markets (2020), drones during the recent crisis caused by the coronavirus were recognized to have five distinctive roles: virus detection, sprayer, food delivery, surveillance, and emergency medical delivery. This means that drones are even more highlighted as an innovative tool to deliver essential food to isolated individuals or patients who are locked down. In fact, there are experts

who address the high possibilities of a reintroduction of the pandemic later this year, and it is hard to predict when a vaccine will become available to prevent the coronavirus (CNN, 2020). Likewise, Jain (2020) asserted that social distancing will be a common practice, and the industry practitioners should reinvent themselves and find newer techniques to serve foods with minimal or no human interaction. Therefore, changing lifestyles, which are another *new normal*, and the incremental demands of food delivery in a contactless manner are anticipated not only in the post-pandemic but in the long term. Drones in food delivery services are currently untapped with respect to mass commercialization, but the services have become more feasible now that they help to cope with the changing demand after the outbreak of COVID-19.

2.2. Perceived innovativeness

Entrepreneurs have strived to improve their technological competencies under the name of innovation. According to the European Commission (1995, p. 1), innovation refers to "the renewal and enlargement of the range of products and services and the associated markets; the establishment of new methods of production, supply and distribution; the introduction of changes in management, work organization, and the working conditions and skills of the workforce." Meanwhile, Rogers (2003) asserted that an innovation exists only if it is perceived by consumers. Following this notion, Lowe and Alpert (2015) argued that an innovation depends on the different degrees of the innovation that consumers perceive and distinguish perceived innovativeness from product innovativeness. To be specific, perceived innovativeness describes how novel a product or service is, while product innovativeness is related to the fundamental innovation characteristics, such as relative advantages and compatibility (Lowe and Alpert, 2015). Likewise, perceived innovativeness was defined as "the perceived degree of newness and improvement over existing alternatives." (Lowe and Alpert, 2015, p. 15) By integrating the conceptualizations in the literature, perceived innovativeness in the current study is the degree of novelty that consumers perceive toward drone-based food delivery services on the basis of their characteristics.

Numerous scholars demonstrated that perceived innovativeness helps companies to gain a competitive edge in the market, and it plays a salient role with the consumers' acceptance of novel technology (Ahlstrom, 2010; Hwang et al., 2019; Ottenbacher and Harrington, 2009; Seebode et al., 2012). For example, Lafferty and Goldsmith (2004) confirmed the significant influence of the consumers' perceptions of the newness or the freshness of a product on their responses, which include the attitude toward the brand and the intention to purchase the new product. Shams, Alpert, and Brown (2015) explicated the associations among the consumers' perceived product innovativeness, a firms' innovativeness, and brand innovativeness, and they articulated how the consumers' perceived innovativeness affects their daily life and changes their behavior. Fantinato et al. (2018) studied the perceived innovativeness towards smart toys, which emerged as educational and entertaining toys, and they validated the positive impact of perceived innovativeness on the consumers' overall evaluations. The stream of these existing studies indicates that when an individual perceives a high degree of innovativeness from a product or a service, he/she demonstrates a positive response, such as a favorable attitude and a greater intention to purchase, use, or spread a positive word-of-mouth. Therefore, it is of the utmost importance for the successful diffusion of novel technologies (Hwang et al., 2019; Leckie et al., 2018).

2.3. The theory of planned behavior (TPB)

The TPB is an extension of the theory of reasoned action (TRA), which was proposed by Ajzen and Fishbein (1980). The TPB considers not only behavioral beliefs and normative beliefs, which were suggested in the TRA, but it also the control beliefs that contain resources and opportunities possessed by an individual (Ajzen, 1991). Among the three determining factors inducing behavioral intentions in the TPB, attitude is the first construct that refers to "the degree to which a person has a favorable or unfavorable evaluation or appraisal of the behavior." (Ajzen, 1991, p. 188) To be more specific, the TPB predicts when individuals have a more favorable attitude and when they have a tendency to perform a particular behavior. Second, the subjective norm represents to what degree a person feels that significant others want him or her to act in certain way (Fishbein and Ajzen, 1975). In the TPB, the greater intentions to comply with a particular behavior are formed when people who are important to themselves believe that they should engage in that behavior. The last construct, which is perceived behavioral control, reflects the perceptions of both the internal and the external constrains on a specific behavior (Ajzen, 1991). In other words, the TPB postulates that with a higher degree of perceived behavioral control, it is more likely that a person intends to behave. In the field of the technology, perceived behavioral control generally describes the individuals' level of knowledge, degree of skills, adequate resources, and experiences necessary regarding using a technology (Huh et al., 2009).

The TPB is one of the most cited theories in explicating the consumers' behavioral intentions in the literature. For example, Giger and Piçarra (2017) used the framework of the TPB to explain the individuals' intentions to interact with social robots. On the other hand, many scholars encompassed the external factors in the groundwork of the TPB to improve its predictive utility with the consumers' behavioral intentions. In particular, even though the TPB was validated as a superior framework to explain the consumer behavior in many studies, there were also endeavors to extend the TPB in order to enhance its predictive value in the domain of technology acceptance (Crespo and del Bosque, 2008; Kamble et al., 2019; Kim et al., 2014; Kim and Hwang, 2020; Ramadan et al., 2017). For instance, Chen and Li (2010) integrated the technology readiness with the TPB for the comprehension of the consumer adoption of e-service. Yang (2012) augmented the TPB with the construct of perceived usefulness and perceived enjoyment to examine the determinants of consumer adoption in the mobile shopping context. Ramadan et al. (2017) adopted the potential functional benefits, the relational attributes, and the perceived risks into the TPB to discuss the consumers' intention to accept their use of delivery drones. More recently, Jing et al. (2019) explored the factors that affect the consumer intentions of autonomous vehicles, and they successfully explained the individuals' choice intentions through an extended TPB, which involved knowledge and perceived risk. This literature provides the evidence of effectively incorporating the external factors into the TPB in order to better explain consumer adoption in the technology context.

2.4. Conceptual model and hypotheses development

The individuals' attitude toward a particular product or service is built on their knowledge and information about the quality of the product/service (Oliver et al., 1997). In the domain of a technical product/service, innovativeness is one of the important measurements of its quality of uniqueness (Lowe and Alpert, 2015), so it therefore can be inferred that there is a significant influence of perceived innovativeness on the individuals' attitude. The existing studies support this type of association in the consumer behavior of technology acceptance (Mamun and Kim, 2018; Shams et al., 2015; Watchravesringkan et al., 2010). Boisvert (2012) examined the relationship between perceived innovativeness of a newly introduced vertical service line extension and attitude, and the analysis results from 664 survey responses validated the hypothesis that the greater the perceived innovativeness, the more positive the consumers' reciprocal attitudes are. Im et al. (2015) conceptualized that novelty is an element of product creativity and illustrated how it generates the perception of a hedonic value, which eventually affects the consumers' attitude toward a new product. Also, the effect of the consumers' perception of innovativeness towards various consumer goods was investigated by Lowe and Alpert (2015). They tested its impact on the utilitarian attitude and the hedonic

attitude, and their results revealed that the greater perception of technology newness tended to increase a favorable attitude, particularly with greater hedonic attitude. Mamun and Kim (2018) examined the effect of the perceived innovativeness of student response systems (SRSs), and their results indicated that students who find the innovativeness in SRSs have a favorable attitude towards the use of the system. Recently, Hwang et al. (2019) explored how perceived innovativeness enhances the consumers' favorable responses based on 324 pieces of data in the context of drone food delivery services, and they discovered that perceived innovativeness exerted a critical influence on attitude. In accordance with the current literature, this study postulated the following hypothesis.

H1. The perceived innovativeness toward drone-based food delivery services significantly enhances attitude.

Abundant evidence in the literature that relates to the technology adoption supports the significant relationships among the study variables rooted in the TPB. The studies that aimed to understand the consumer behavior validated the important role of attitude, the strong effect of subjective norm, and the considerable impact of perceived behavioral control on the intentions to accept novel technology (Chen and Li, 2010; Giger and Piçarra, 2017; Hwang et al., 2020a,2020b; Jing et al., 2019; Lowe and Alpert, 2015). For example, Crespo and del Bosque (2008) adopted the TPB to identify the determining factors that lead individuals to becoming online shoppers, and their results denoted the close links among the proposed variables in the electronic commerce context. Yang (2012) examined the associations among the constructs in the extended TPB on the basis of 400 collected responses, and the author confirmed the meaningful influences of attitude, the subjective norm, and perceived behavioral control on the behavioral intentions toward mobile shopping. The individuals' intentions to deal with social robots were tested on the framework of the TPB in the study conducted by Giger and Piçarra (2017), and the results particularly underlined the important role of attitudes with inducing the greater intentions. Yang et al. (2017) validated the critical influence of attitude, the subjective norm, and perceived behavioral control on the intentions to use smart home services. More recently, Kamble et al. (2019) built their theoretical model based on the TPB for the comprehension of the users' perceptions on the adoption of block chain technology, and their results using 181 supply chain professionals in India emphasized the essential roles of attitude and perceived behavioral control with generating behavioral intentions. In the context of drone food delivery services, Hwang et al. (2019) presented a significant relationship between attitude triggered by the perception of the innovativeness and behavioral intentions. The literature supports the TPB with explicating the consumer behavior successfully, and therefore the current study posited that the individuals' behavioral beliefs, normative beliefs, and control beliefs are the key determinants of their behavioral intentions towards drone food delivery services.

H2. The attitude toward drone-based food delivery services significantly enhances the behavioral intentions.

H3. The subjective norm toward drone-based food delivery services significantly enhances the behavioral intentions.

H4. The perceived behavioral control toward drone-based food delivery services significantly enhances the behavioral intentions.

Consumer behavior involves the potential risk or uncertainty that any behavior of a consumer will produce consequences (Bauer, 1960). In this respect, the concept of perceived risk was proposed, and Stone and Grønhaug (1993) suggested six types of perceived risk, namely financial, functional, physical, psychological, social, and time, in the consumer and marketing contexts. Perceived risk has been also extensively examined in the hospitality and tourism contexts, since it affects the formation of an individual's decision-making. Particularly, the impact of foodborne diseases, infectious diseases, and safety and security that relate to accidents and terrorism were widely examined. For instance, Lu et al. (2016) applied the TPB to explore international students' intentions to conduct leisure travel activities, which was based on 217 responses from a university in Northern Taiwan. Their analysis results demonstrated the meaningful moderating impact of perceived risk in the link between the subjective norm and behavioral intentions. Meanwhile, perceived risk has been often studied in the adoption of a novel technology as well. For example, security and privacy are frequently proposed as forms of perceived risk in the domain of technology adoption. As such, Wells et al. (2010) demonstrated how the individuals' risk perspective influences the association between the perceived novelty of information technology innovation and attitude. Ahmed et al. (2013) indicated that privacy is a critical risk that consumers perceive in the field of electronic commerce, and they investigated the moderating role of this type of risk in the formation of behavioral intentions. The results of their analysis using 250 data found a salient moderating effect in the relationship between attitude and the future intentions in the online shopping context. Kim et al. (2014) examined the moderating effect of food technology neophobia within the extended TPB to predict consumer behavior in the genetically modified food context, and their results revealed the significant moderating role of food technology neophobia in the link between attitude and behavioral intentions and the social norm and behavioral intentions.

In the field of consumer behavior during and after a pandemic, studies illustrated that the outbreak of infectious diseases, such as severe acute respiratory syndrome (SARS) and influenza A (H1N1), strongly influence individuals' behavior changes (Bults et al., 2011; Sadique et al., 2007). Indeed, the incidence of the coronavirus has created various risk perceptions that include the fear of human contact, and they have led people to prefer contactless services wherever possible. Likewise, Djalante et al. (2020) articulated the current consumer responses to the coronavirus in Indonesia and staying at home and maintaining social distancing to avoid human contacts are the main changes in public behavior. Long and Khoi (2020) centered on the risk perception during COVID-19, and they endeavored to explain individuals' food hoarding behavior by applying the TPB. In addition, Jain (2020) asserted the needs of a novel approach in food services, because the industry will continue to suffer from the backlash of COVID-19 even post coronavirus. Also, social distancing will be the norm that affects the hospitality industry. In this regard, Manivannan et al. (2020) described the option of contactless delivery, which was introduced recently due to the impact of COVID-19 on the online food delivery industry. Drones in food delivery are now much more highly recognized as an innovative tool, which enables contactless services (Research and Markets, 2020; The Times, 2020; Zeng et al., 2020). Therefore, we infer that there will be a notable difference in the formation of the consumers' behavioral intentions towards drone food delivery services before and after the outbreak of COVID-19. This means that using drones in food delivery services is regarded as a precautionary behavior after the outbreak of COVID-19, and the theoretical background and the evidence led to the following hypotheses.

H5a. The outbreak of COVID-19 moderates the association between the perceived innovativeness and the attitude.

H5b-d. The outbreak of COVID-19 moderates the associations among constructs rooted from the TPB, which include the attitude, the subjective norm, the perceived behavioral control, and the behavioral intentions.

Our theoretical framework involves the five latent constructs with a total of fifteen measurement items and eight hypotheses. Fig. 1 displays the proposed conceptual model.

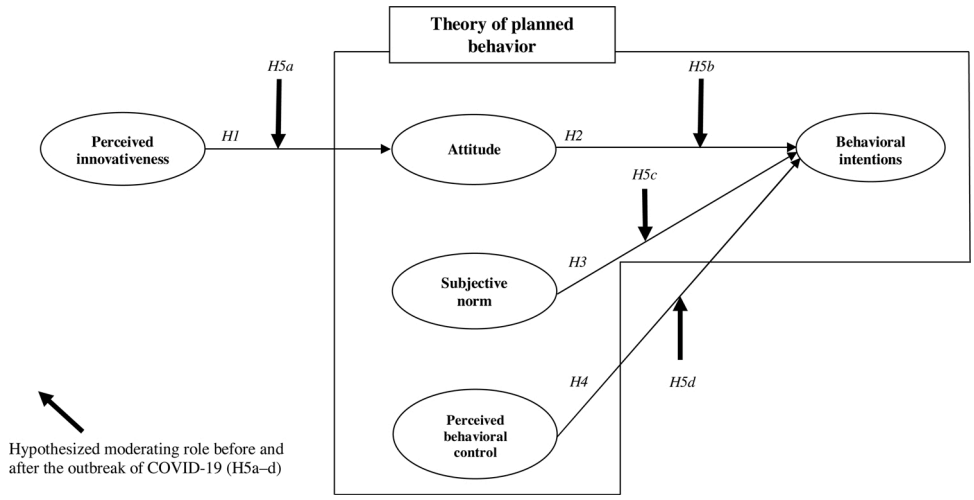


Fig. 1. Proposed conceptual model.

3. Methodology

3.1. Measures

Each concept was measured using the items that were verified to be reliable and valid in prior research. First, perceived innovativeness was measured with three items used by Fu and Elliott (2013) and Hwang et al. (2019). Second, the measurement items for the four constructs of TPB, namely attitude, the subjective norm, perceived behavioral control, and behavioral intentions, were adapted from Ajzen (1991) and Perugini and Bagozzi (2001). All of the measurement items were modified to fit the context of drone food delivery services and were measured using a seven-point Likert-type scale (1 = strongly disagree; 7 = strongly agree).

3.2. Data collection

In order to test the moderating role before and after the outbreak of COVID-19, two surveys were conducted to collect data before and after the outbreak of COVID-19. In the case of before the outbreak of COVID-19, data had previously been collected for research on drone food delivery services other than the purpose of this study via a survey conducted in February 2018 in South Korea for three days using the online company's system. In South Korea, drone food delivery services are not currently activated, so the respondents were required to watch a video for about 2 min and 30 s showing how drone food delivery services operate in order to improve their understanding of the services before answering the questionnaire (see Appendix). In addition, if the respondents did not watch the video, the survey system was set so that it wouldn't move on to the next page. The online survey company mentioned above sent an e-mail invitation to a total of 2794 members, and 346 members completed the survey. From that, 26 outliers were deleted because of multivariate outliers and visual inspections. As a result, statistical analysis was conducted based on 320 samples.

In terms of after the outbreak of COVID-19, the same video was shown to respondents before the survey to improve their understanding of drone food delivery services in May 2020 in South Korea for three days. The survey was sent to 1,479, of whom 343 participated. However, seven samples were deleted due to multivariate outliers and visual inspections.

4. Data analysis

4.1. Profile of respondents

The demographic profile of the respondents for both surveys is shown in Table 1. First, in terms of before the outbreak of COVID-19, there were more male (n = 186 and 41.9%) than female (n = 134 and 41.9%) participants. In addition, the 20 s age group (n = 122 and 38.1%) were the most, which was followed by the 30 s age group (n = 96 and 30.0%). Regarding the education level, 58.1% of the respondents (n = 186) reported holding a bachelor's degree, and 56.6% of respondents (n

Table 1
Profile of survey respondents.

Variable	Before the outbreak of COVID-19 (n = 320)	After the outbreak of COVID-19 (n = 336)	Merging the data (n = 656)
Gender			
Male	186 (58.1%)	173 (51.5%)	359 (54.7%)
Female	134 (41.9%)	163 (48.5%)	297 (45.3%)
Age			
20s	122 (38.1%)	102 (30.4%)	224 (34.1%)
30s	96 (30.0%)	104 (31.0%)	200 (30.5%)
40s	69 (21.6%)	100 (29.8%)	169(25.8%)
50s	33 (10.3%)	30 (8.9%)	63 (9.6%)
Education level			
Less than High school diploma	34 (10.6%)	28 (8.3%)	62 (9.5%)
Associate's degree	51 (15.9%)	42 (12.5%)	93 (14.2%)
Bachelor's degree	186 (58.1%)	222 (66.1%)	408 (62.2%)
Graduate degree	49 (15.3%)	44 (13.1%)	93 (14.2%)
Marital status			
Single	181 (56.6%)	195 (58.0%)	376 (57.3%)
Married	137 (42.8%)	137 (40.8%)	274 (41.8%)
Others	2 (.6%)	4 (1.2%)	6 (.9%)
Income level			
6001$ US and over	58 (18.1%)	21 (6.3%)	79 (12.0%)
5001$ US -6000$ US	36 (11.3%)	10 (3.0%)	46 (7.0%)
4001$ US -5000$ US	47 (14.7%)	29 (8.6%)	76 (11.6%)
3001$ US -4000$ US	51 (15.9%)	48 (14.3%)	99 (15.1%)
2001$ US -3000$ US	74 (23.1%)	94 (28.0%)	168 (25.6%)
1001$ US -2000$ US	42 (13.1%)	66 (19.6%)	108 (16.5%)
Under 1000$ US	12 (3.8%)	68 (20.2%)	80 (12.2%)

= 317) were single. Lastly, the highest percentage of respondents earned between US $2001 ~ US $3000 ($n$ = 74 and 23.1%).

Second, in the case of after the outbreak of COVID-19, the number of male respondents (n = 173 and 51.5%) was slightly higher than that of female respondents (n = 163 and 48.5%). The majority of the respondents that they were in their 30 s (n = 104 and 31.0%), which was followed by the 20 s age group (n = 102 and 30.4%). Furthermore, 66.1% of the respondents (n = 222) had a bachelor's degree. Regarding the marital status, 58.0% of respondents (n = 195) were single. Lastly, the highest percentage of respondents earned between US $2001–US $3000 ($n$ = 94, 28.0%).

4.2. Confirmatory factor analysis

The results of the confirmatory factor analysis (CFA) for the three models, which include before the outbreak of COVID-19 and after the outbreak of COVID-19 and merging the two, indicated that the overall fit of the measurement model was statistically satisfactory (Before the outbreak of COVID-19: χ^2 = 191.611, df = 80, χ^2/df = 2.395, p < .001, NFI = .963, CFI = .978, TLI = .971, and RMSEA = .066; After the outbreak of COVID-19: χ^2 = 220.013, df = 80, χ^2/df = 2.750, p < .001, NFI = .959, CFI = .973, TLI = .965, and RMSEA = .072; and Merging before and after the outbreak of COVID-19: χ^2 = 286.395, df = 80, χ^2/df = 3.580, p < .001, NFI = .973, CFI = .980, TLI = .974, and RMSEA = .063) (Byrne, 2001). All of the factor loadings were equal to or greater than 0.856 for before the outbreak of COVID-19, 0.823 for after the outbreak of COVID-19, and 0.853 for the merged version. Table 2 shows the specific variables used in this study along with their standardized factor loadings.

As presented in Table 3, the values of all the average variance extracted (AVE) for the three models were higher than 0.50, which indicates a high level of convergent validity (Fornell and Larcker, 1981). The composite reliabilities of all the constructs for the three models exceed 0.70, which suggests an acceptable level of internal consistency (Hair et al., 2006). Lastly, the results indicate that the values of all the AVE for the three models were greater than all of the squared correlations (R^2) between any pair of constructs, which suggests a satisfactory level of discriminant validity (Bagozzi and Yi, 1988).

4.3. Structural equation modeling

The proposed model was tested using structural equation modeling analysis. The overall evaluation of the model fit revealed a satisfactory fit of the model to the data (χ^2 = 342.465, df = 86, χ^2/df = 3.982, p < .001, NFI = .942, CFI = .950, TLI = .939, and RMSEA = .086). Fig. 2 describes the results with the standardized coefficients and their t-values. All four proposed hypotheses were statistically supported at p < .05. More specifically, a positive relationship between perceived innovativeness and attitude was identified (β = .565 and t = 14.915*), which supported Hypothesis 1. Furthermore, attitude (β = .696 and t = 21.334*), the subjective norm (β = .267 and t = 9.458*), and perceived behavioral control (β = .188 and t = 6.555*) positively influenced behavioral intentions. Hence, Hypotheses 2, 3, and 4 were supported.

4.4. Measurement-invariance assessment

This study conducted a measurement invariance assessment that was suggested by Steenkamp and Baumgartner (1998). The two groups were before the outbreak of COVID-19 (n = 320) and after the outbreak of COVID-19 (n = 336). As shown in Table 4, the non-restricted model (χ^2 = 411.623, df = 160, χ^2/df = 2.572, p < .001, NFI = .961, CFI = .976, TLI = .968, and RMSEA = .049) and the full-metric invariance model (χ^2 = 436.295, df = 175, χ^2/df = 2.493, p < .001, NFI = .958, CFI = .975, TLI = .970, and RMSEA = .048) had satisfactory fit statistics. Furthermore, the difference between the two models was not significant ($\Delta\chi^2$ = 24.672 < χ^2 = .01(df = 15) = 30.580), which suggested that the full metric invariance was supported.

Table 2
Confirmatory factor analysis: Items and loadings.

Construct and Scale Item	Standardized Loading[a]		
	Before the outbreak of COVID-19	After the outbreak of COVID-19	Merging before and after the outbreak of COVID-19
Perceived innovativeness			
Drone food delivery services seem unique.	0.927	0.929	0.925
Drone food delivery services seem new.	0.933	0.875	0.908
Drone food delivery services seem creative.	0.856	0.846	0.853
Attitude			
Unfavorable – Favorable	0.869	0.901	0.883
Bad – Good	0.926	0.882	0.907
Negative – Positive	0.930	0.911	0.925
Subjective norm			
Most people who are important to me think I should use drone food delivery services when ordering food.	0.905	0.912	0.913
Most people who are important to me would want me to use drone food delivery services when ordering food.	0.954	0.968	0.964
People whose opinions I value would prefer that I use drone food delivery services when ordering food.	0.963	0.970	0.967
Perceived behavioral control			
Whether or not I use drone food delivery services when ordering food is completely up to me.	0.865	0.823	0.868
I am confident that if I want, I can use drone food delivery services when ordering food.	0.912	0.960	0.973
I have resources, time, and opportunities to use drone food delivery services when ordering food.	0.929	0.912	0.882
Behavioral intentions			
I will use drone food delivery services when ordering food.	0.952	0.952	0.951
I am willing to use drone food delivery services when ordering food.	0.909	0.955	0.926
I am likely to use drone food delivery services when ordering food.	0.962	0.965	0.963

Goodness-of-fit statistics.
Before the outbreak of COVID-19: χ^2 = 191.611, df = 80, χ^2/df = 2.395, p < .001, NFI = 0.963, CFI = 0.978, TLI = 0.971, and RMSEA = .066.
After the outbreak of COVID-19: χ^2 = 220.013, df = 80, χ^2/df = 2.750, p < .001, NFI = 0.959, CFI = 0.973, TLI = 0.965, and RMSEA = 0.072.
Merging before and after the outbreak of COVID-19: χ^2 = 286.395, df = 80, χ^2/df = 3.580, p < .001, NFI = 0.973, CFI = 0.980, TLI = 0.974, and RMSEA = 0.063.
Notes 1: [a] All factors loadings are significant at p < .001.
Notes 2: NFI = normed fit index, IFI = incremental fit index, CFI = comparative fit index, TLI = Tucker-Lewis index, and RMSEA = root mean square error of approximation.

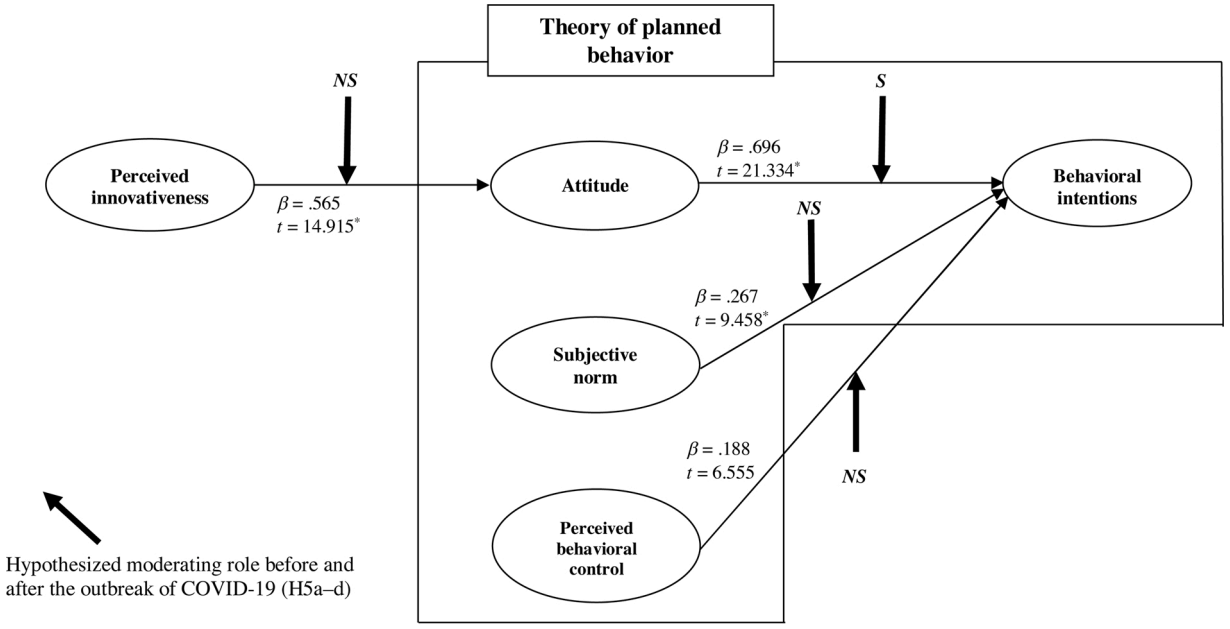
4.5. Moderating role of the outbreak of COVID-19

In order to check the moderating role of the outbreak of COVID-19,

Table 3
Descriptive statistics and associated measures.

	No. of items	Mean (Std dev.)	AVE	(1)	(2)	(3)	(4)	(5)
		5.58 (1.22)	0.821	0.932[a]	0.584[b]	0.373	0.513	0.609
(1) Perceived ease of use	3	5.50 (1.10)	0.781	0.915	0.545	0.106	0.279	0.474
		5.54 (1.16)	**0.803**	**0.924**	**0.557**	**0.251**	**0.407**	**0.537**
		4.86 (1.32)	0.826	0.341[c]	0.934	0.519	0.441	0.422
(3) Attitude	3	4.52 (1.33)	0.807	0.297	0.926	0.440	0.370	0.806
		4.69 (1.33)	**0.819**	**0.310**	**0.932**	**0.491**	**0.405**	**0.788**
		3.90 (1.45)	0.886	0.139	0.269	0.959	0.334	0.428
(4) Subjective norm	3	3.20 (1.37)	0.903	0.011	0.194	0.965	0.128	0.462
		3.54 (1.45)	**0.899**	**0.063**	**0.241**	**0.964**	**0.237**	**0.554**
		5.01 (1.16)	0.814	0.263	0.194	0.112	0.929	0.312
(5) Perceived behavioral control	3	4.98 (1.11)	0.810	0.078	0.137	0.016	0.927	0.400
		4.99 (1.14)	**0.826**	**0.166**	**0.164**	**0.056**	**0.934**	**0.454**
		4.58 (1.35)	0.886	0.371	0.588	0.354	0.266	0.959
(6) Behavioral intentions	3	3.95 (1.35)	0.917	0.225	0.650	0.213	0.160	0.971
		4.26 (1.38)	**0.896**	**0.288**	**0.621**	**0.307**	**0.206**	**0.963**

Notes 1: The unmarked values are for before the outbreak of COVID-19; Values in italics are for after the outbreak of COVID-19; and Values in boldface type are for merging before and after the outbreak of COVID-19.
Notes 2: AVE = Average Variance Extracted.
Notes 3: a. composite reliabilities are along the diagonal, b. correlations are above the diagonal, and c. squared correlations are below the diagonal.



$\chi^2 = 342.465$, df = 86, $\chi^2/df = 3.982$, $p < .001$, NFI = .942, CFI = .950, TLI = .939, and RMSEA = .0862

Fig. 2. Standardized theoretical path coefficients.
Notes 1: NFI = normed fit index, IFI = incremental fit index, CFI = comparative fit index, TLI = Tucker–Lewis index, and RMSEA = root mean square error of approximation.
Notes 2: *$p < .05$
Notes 3: S = Significant and NS = not significant.

Table 4
Measurement-invariance models.

	Models	χ^2	*df*	NFI	CFI	TLI	RMSEA	$\Delta\chi^2$	Full-metric invariance
Before and after the outbreak of COVID-19	Non-restricted model	411.623	160	0.961	0.976	0.968	0.049	$\Delta\chi^2$ (15) = 24.672 $p > .01$ (insignificant)	Supported
	Full-metric invariance	436.295	175	0.958	0.975	0.970	0.048		

Notes 1: NFI = Normed Fit Index, CFI = Comparative Fit Index, TLI = Tucker-Lewis Index, and RMSEA = Root Mean Square Error of Approximation.
Notes 2: $\Delta\chi^2$ (15) = 30.58 and $p > .01$.

Table 5
Moderating role of the outbreak of COVID-19.

Path	Unconstrained model				Constrained model	Tests of moderator	
	Before the outbreak of COVID-19		After the outbreak of COVID-19				
	β	t-value	β	t-value	$\Delta\chi^2$ (172) = 738.514	χ^2 difference	Hypotheses
H5a PI → A	.547	11.428*	0.592	9.964*	$\Delta\chi^2$ (173) = 738.602	$_{\Delta}\chi^2(1) = 0.088$	Not supported
H5b A → BI	.648	13.398*	0.742	16.492*	$\Delta\chi^2$ (173) = 745.628	$_{\Delta}\chi^2(1) = 7.114$*	Supported
H5c SN → BI	.300	7.034*	0.189	4.972*	$\Delta\chi^2$ (173) = 739.505	$_{\Delta}\chi^2(1) = 0.991$	Not supported
H5d PBC → BI	.230	5.375*	0.161	4.121*	$\Delta\chi^2$ (173) = 738.803	$_{\Delta}\chi^2(1) = 0.289$	Not supported

Notes 1: PI = Perceived innovativeness, A = Attitude, SN = Subjective norm, PBC = Perceived behavioral control, and BI = Behavioral intentions.
Notes 2: *$p < .05$.
Notes 3: $\Delta\chi^2(1) = 3.84$ and $p < .05$.

multiple-group analyses were conducted by comparing the chi-square difference between the unconstrained models and the constrained models according to the difference in the degrees of freedom (Byrne, 2001). In the results of the multiple-group analyses shown in Table 5, the outbreak of COVID-19 moderated the relationship between the attitude toward using drone food delivery services and behavioral intentions ($\Delta\chi^2 = 7.114 > \chi^2 = .5(1) = 3.84$, and df = 1), which supported Hypothesis 5b. More specifically, the path coefficient for the group after the outbreak of COVID-19 ($\beta = 0.592$ and $t = 9.964$*) was higher than for the group before the outbreak of COVID-19 ($\beta = 0.547$ and $t = 11.428$*). Contrary to expectations, Hypotheses 5a ($\Delta\chi^2 = .088 < \chi^2 = .5(1) = 3.84$ and df = 1), 5c ($\Delta\chi^2 = .991 < \chi^2 = .5(1) = 3.84$ and df = 1), and 5d ($\Delta\chi^2 = .289 < \chi^2 = .5(1) = 3.84$ and df = 1) were not statistically supported.

5. Discussion and implications

The recent outbreak of COVID-19 has brought appreciable changes to our lifestyles, which include the way of consuming food. These drastic changes in people's food consumption include the increased food delivery services and the needs of services with non-human contact (Business Wire, 2020; Jain, 2020; Manivannan et al., 2020). Thus, many entrepreneurs have endeavored to devise a contactless environment for food delivery services, and drones are currently receiving more attention than ever. In this regard, this study was designed to comprehend not only the formation of the behavioral intentions towards drone food delivery services but also the possible changes in the formation of the individuals' behavioral intentions of using drones for food delivery services over the coronavirus pandemic. For these study objectives, we incorporated perceived innovativeness into the TPB, which is a highly validated theory in explicating consumer behavior, and the empirical evidence was derived based on the data that were collected before and after the outbreak of COVID-19. The data analysis results have the following theoretical and managerial implications.

5.1. Theoretical implications

First, this is the first study that has incorporated perceived innovativeness into the TPB with drone food delivery services and uncovered the associations among the determining variables. As such, the analysis results denoted the critical role of perceived innovativeness with building the consumers' attitude toward drone food delivery services. This result is consistent with the previous studies (Boisvert, 2012; Hwang et al., 2019; Mamun and Kim, 2018; Shams et al., 2015), which provided empirical evidence for the strong impact of perceived innovativeness on attitude with the consumer adoption of novel technologies. Hence, the current research echoed the prior findings and validated the appropriateness of the extended TPB with evidence in the drone food delivery services context. In addition, the significant influence of attitude, the subjective norm, and perceived behavioral control on behavioral intentions were all statistically supported in this study. These results are coherent with the literature (Giger and Piçarra, 2017; Hwang et al., 2020a,2020b; Kamble et al., 2019; Lowe and Alpert, 2015), which adopted the TPB and confirmed its prevailing power to predict consumer behavior in various settings. Thus, the present study supports the application of the TPB to explicate consumers' behavioral intentions in the context of drone food delivery services.

Second, the current study is the first attempt to explore the potential changes in the formation of the consumer behavior with using drones for food delivery services over the outbreak of the coronavirus. The demand for contactless services has been dramatically increased, and the same phenomenon applies to the food delivery context (Jain, 2020; Wen et al., 2020). The convergence of smart technologies could aid the battle against infectious diseases, and drones have been highly respected during the recent pandemic as they enable food delivery services in a contactless environment (The Times, 2020; Zeng et al., 2020). Nonetheless, no studies have been conducted that empirically identify the impact of the onset of the coronavirus epidemic on consumers' responses towards the novel technology by helping their precautionary behavior. In respect of infectious diseases, the existing studies related to the cases of SARS and H1N1 determined the significant influence of these types of diseases on consumer behavior (Bults et al., 2011; Sadique et al., 2007). However, the current studies pertaining to COVID-19 do not provide sufficient evidence for the effect of this incident on the formation of the consumer behavior in the food delivery services. In this respect, this research is invaluable to prove the significant moderating effect of the COVID-19 outbreak with a piece of empirical evidence. The results of our study support the association over the COVID-19 pandemic with the empirical evidence in people's food consumption behavior. To be specific, we have separately collected the data before and after the outbreak of COVID-19 in order to examine the changes on the consumer responses. A measurement invariance assessment was conducted, and it validated the appropriateness of the full-metric invariance model. Overall, this research successfully identified how the formation of the individuals' behavioral intentions towards drone food delivery services changed before and after the outbreak of COVID-19. Therefore, this study has an important theoretical implication, which unearthed the notable difference in the consumers' technology acceptance over the recent incidence of the coronavirus.

Third, contrary to our expectations, a negligible moderating impact was found in the link between perceived innovativeness and attitude. Drones have received a considerable amount of attention in the past few years based on their advanced functionality and their usability in various aspects, such as saving time and navigating inaccessible areas. In other words, the general public perception might have been built in a way that drones are new, unique, and creative. Thus, we infer that the innovativeness of drones was already well perceived before the outbreak of the coronavirus, which may explain the insignificant moderating effect in that association. Furthermore, the relationships between the subjective norm and behavioral intentions and perceived behavioral control and behavioral intentions were not moderated by the outbreak of COVID-19. These findings are also contrary to our expectations, and we inferred several potential causes for these results. In the domain of drone food delivery services, the positive effect of the subjective norm

and perceived behavioral control were identified in other studies (Hwang et al., 2020a,2020b; Kim and Hwang, 2020). Compared to the current food delivery modes, using drones for food delivery services deserves a lot of credit, because they are an ideal way to avoid any unnecessary human contacts. This would possibly increase the subjective norm regarding the use of drone-based food delivery services after the outbreak of the coronavirus, and this may have led to the insignificant moderating impact of COVID-19 in the relationship between the subjective norm and behavioral intentions. In the meantime, drones have been partially commercialized around the world prior to the incidence of the coronavirus disease, and people may consider that they have sufficient resources and opportunities to use drones for food delivery services if they would like to. This means that people generally have a high perceived behavioral control regardless of the outbreak of the coronavirus, which led to the negligible moderating effect of COVID-19 in the link between perceived behavioral control and behavioral intentions.

5.2. Managerial implications

First, professionals in food delivery services are advised to promote drones as creative and unique food delivery means, because the analysis result indicated the vital impact of perceived innovativeness on attitude. In other words, drones in food delivery services should be imaged as a newly invented food delivery mode. Thus, companies in food delivery services should run extensive advertisements to introduce how drones in food delivery services are adding value to the current food delivery service methods, which are generally managed by car or motorbikes. The existing delivery means for food delivery services were addressed with several issues and problems related to efficiency, safety, and the environment (Doole et al., 2018; Kim and Hwang, 2020). Likewise, marketing communications that exhibit the benefits of using drones for food delivery services compared to the conventional food delivery modes could help to raise the perception of drone-based food delivery services as an innovative tool. This means that the advanced capabilities of the drones, which include superior efficiency and less damage to the environment, should be embedded in various kinds of communications to generate the perceptions of the novelty of drone food delivery services. Furthermore, the cost of food delivery using electric bikes is twice the amount of the cost of food delivery using drones (Doole et al., 2018). These types of benefits would be also powerful clues for the consideration of drone food delivery services in the developing countries. Moreover, our results confirmed that the positive attitude increased the intention to accept drone food delivery services, which is essentially important to imprint the innovativeness of drones into peoples' mind.

Second, food delivery operators are recommended to pay close attention to the encouragement of word-of-mouth on the basis of the analysis results, which validated the significant association between the subjective norm and behavioral intentions in the context of drone food delivery services. Involving potential consumers in the generation of word-of-mouth is regarded as being more powerful than any other marketing activities and channels (Fu et al., 2015; Jalilvand and Samiei, 2012). Therefore, drones for food delivery services should have an ample store of topics, which means that entrepreneurs should offer the general public innovative topics, stories, and events that are related to drone-based food delivery services in order to motivate and inspire individuals to spread the word out of their own volition and create promotional contents on social media. For example, the practitioners may consider hosting drone food delivery competitions and inviting people to the experiments of new drone capabilities in the food delivery context. Then a better degree of the subjective norm will be formed, which will strengthen behavioral intentions. Another way to promote word-of-mouth is to have the customers rate the service experience and leave comments about drone-based food delivery services. For instance, chatbots could be utilized to encourage feedback right after the usage of drones for food delivery services, and each comment from the customers could be used to raise the level of the subjective norm, which will eventually enhance behavioral intentions. In addition, opportunities exist to induce more favorable subjective norm when drone food delivery services are envisioned as a service mode that protects the environment since people generally support consumptions that reduce the burden on the environment (Hwang et al., 2019; Kim and Hwang, 2020). Thus, service providers in the food delivery industry should recognize and emphasize the substantial contribution of drones with the sustainability. Also, these initiates could be effectively managed through a partnership with a group of people who possess a high degree of internal environmental locus of control since they contribute to create an environmentally friendly environment through a various activities (Hwang et al., 2020a,2020b).

Last, infectious diseases change individuals' behavior (Bults et al., 2011; Sadique et al., 2007), and our data analysis supports how consumers radically changed their behavior with food consumption over the coronavirus epidemic. More specifically, the moderating role of the COVID-19 pandemic was identified in the relationship between attitude and behavioral intentions, and it is expected that using drones for food delivery services will accelerate during the post COVID-19 period. In fact, several policymakers have recently allowed drone food delivery services due to the drastic needs of contactless delivery during the COVID-19 pandemic (The Week, 2020). Hence, practitioners in the food delivery industry are recommended to document the current cases regarding how drones for food delivery contributed to avoid human-to-human contacts during the coronavirus crisis. These accumulated real cases then could be utilized to fully commercialize drone-based food delivery services in the future. This means that the experts in the field of the food delivery industry should use this information as supporting data to reconcile the rules and the regulations with the authorities that are involved in order to activate the drone-based food delivery services in many more places. On the basis of the current application of drones in food delivery services during COVID-19 (The Times, 2020; Zeng et al., 2020), we infer that people will consider drones as an ideal solution for food delivery without a high risk of human-to-human contacts. It is accordingly suggested to emphasize the operations of drone-based food delivery services, which are contactless. As such, the roles of drones during the coronavirus pandemic should be widely addressed in various channels, including the media. For example, the new option of drones in food delivery services can be installed with a hero image over COVID-19, and the concept of a contactless delivery tool for food delivery services. Meanwhile, the professionals should be able to manage different types of delivery modes in order to cope with any similar cases in the long term. In other words, having diverse delivery modes available at all times will enable them to shift to more suitable delivery methods in a state of emergency and propose it to consumers without chaos or a delay in order to come up with an alternative solution after the occurrence of a situation.

6. Limitations and future research

Numerous scholars have asserted the importance of consumer characteristics to determine behavioral intentions, since individuals' traits differ with accepting the technology (Chen and Li, 2010; Yang, 2012). This necessitates 0considering the consumer characteristics regarding technology, which include readiness and self-efficacy, so that future studies can provide more relevant implications for designing drone-based food delivery services that are compatible with the potential consumer traits. Meanwhile, people commonly tend to be more cautious without knowing the exact causes and ways to prevent the infection or the ultimate cure for diseases (Manivannan et al., 2020; Wen et al., 2020). The data we have collected to assess the consumers' responses after the outbreak of COVID-19 were still during the pandemic period, and future studies are required to revisit these responses as cases unfold over the coming months. In addition, the drone food delivery services are not yet operating in South Korea, so it is recommended to

conduct research on customers who actually have used the services in the future research. Lastly, even though the respondents were different before and after the outbreak of COVID-19 in this study, it would be more meaningful in future studies when comparing before and after the outbreak of COVID-19 using the same respondents.

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Appendix A. Screenshot from a video

Source from Yogiyo (2016).

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