Exploring perceived risk in building successful drone food delivery services

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Abstract

Purpose – This paper aims to explore the types of perceived risks involved with using drone food delivery services. Furthermore, this study investigates the relationship between perceived risk and image of drone food delivery services. Lastly, this study examines the effect of image of drone food delivery services on desire, intentions to use and willingness to pay more.

Design/methodology/approach – This study collected data from 331 respondents in Korea. Before the start of the survey, the respondents were given a video, which made it easier for them to understand drone food delivery services.

Findings – The three types of perceived risks (i.e. time risk, performance risk and psychological risk) have a negative influence on image of drone food delivery services and, thus, aids in increasing desire, intentions to use and willingness to pay more.

Originality/value – The concept of perceived risk was applied to the context of drone food delivery services in this study in combination with other understudied concepts, image, desire, intentions to use and willingness to pay more. This study is one of the first studies that applied those significant concepts to the context of drone food delivery services, even though there are a large number of papers in the technology field. Thus, the findings of this study will be important to foodservice companies when building successful drone food delivery services.

Keywords Image, Perceived risk, Willingness to pay more, Desire, Drone food delivery services, Intentions to use

Paper type Research paper

Introduction

The recent development of new technology has completely transformed the way business has been implemented. The hospitality and tourism industry is also widely adopting new technology. For example, self-service technology, such as hotel self-check-in/check-out kiosk and airport self-check-in kiosk, has become commercialized (Kim and Qu, 2014). In addition, customers can dine in a restaurant where everything is operated automatically (Marks, 2016). Radio-frequency identification chips are inserted inside of the plate to improve inventory management and satisfy customers in the restaurant industry (Anja, 2016).

Recently, drone food delivery services have attracted attention in the food service industry and refer to services that deliver food ordered by customers using a drone. A few years ago, consumers were skeptical about the commercialization of drone food delivery services, but now there is a growing expectation for the services because drone food delivery services have been successfully tested in many countries, such as Iceland, Korea, New

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Zealand and the UK (Bamburry, 2015; Morgan, 2017; Reid, 2016). This has resulted in consumers having higher expectations for new technology, but they also have fear, hesitation or negative attitudes about a new technology because they perceive unexpected adverse consequences before and during use, which is also known as "perceived risk" (Wu *et al.*, 2012). More importantly, the perceived risk is negatively correlated with the adoption of a new technology, so it is very important to study what risks consumers perceive when a new technology is introduced. Although there have been some studies that are related to perceived risk in the hospitality and tourism industry (Lee, 2016; Mohseni *et al.*, 2018), research related to perceived risk in the context of drone food delivery services is extremely scarce.

A number of unanswered questions remain with the development of a drone as a new delivery tool and the lack of empirical research addressing perceived risk associated with drone food delivery services. Therefore, the present research attempted to fill this void. More specifically, the purposes of this study were to:

- explore the types of perceived risks in using drone food delivery services;
- examine the relationship between perceived risk and image of drone food delivery services; and
- investigate the effect of image of drone food delivery services on desire, intentions to use and willingness to pay more.

From the point of view of foodservice companies, understanding customers' perceived risk in using drone food delivery services is very important to increase the potential for the successful introduction of new technology-based services.

Literature review

Drone food delivery services

A drone is defined as a small and unmanned aircraft with the capacity to fly autonomously because of the support of on board computers and sensors (Snead and Seibler, 2017). The early prototypes of drones were expensive and were often used for military purposes, but now they are provided with low-cost options and used in various industries for diverse purposes. For example, many studies have shown the cases of innovative uses of drone technology, such as forest inventory, air quality applications, fisheries management, farm management, highway management and entertainment shows at Olympic events (Bamburry, 2015; Coren, 2011; Gibson, 2018; Smith, 2015).

Drone technology has combined with product delivery services and has drawn a lot of attention from a variety of industries. Companies, such as Amazon, Google and UPS, are very interested in this new product delivery method using drones (Bamburry, 2015). Applying drone technology in the hospitality industry is no exception. Since 2013, Domino's Pizza is one of the leading franchises that has developed a drone capable of delivering pizzas (Pepitone, 2013). The San Francisco startup "TacoCopter" and Yelp-sponsored "Burrito Bomber" have quickly entered the fast-food delivery market using drones (Bamburry, 2015). After Domino's Pizza in New Zealand successfully tested delivering a pizza using a drone, the New Zealand government authorized Domino's Pizza to deliver food using drones (CNBC, 2016). Interests in the commercial use of drones have increased dramatically in many countries with successful operations of delivering food (Goodchild and Toy, 2018). Using drone food delivery services is also useful for some events. For example, the drones delivered cold beer to attendees at a music festival in South Africa, and the drones offered cocktails to guests at Marriott International (Ivanov *et al.*, 2017; Lee, 2017). Recently, China

newly approved 17 routes over an industrial zone in Shanghai that enabled consumers to receive their food delivered by drones within 20 min after confirming the order on their smartphones which is not always possible with conventional cars slogging through traffic. This shows that food safety or physical risks are not the major risks anymore, because food delivery services that use drone technology have been proved to provide food to customers in a safe way (Fingas, 2018). In this regard, having food delivered by drones is not just an imaginary concept in science fiction but already has become a reality.

The benefits of using drone food delivery services are numerous. For instance, consumers can get food quickly if they use drone food delivery services. Even consumers who live in remote areas can also enjoy food delivery services easily by using drone technology (Ivanov *et al.*, 2017). From the supply perspective, using drone food delivery services can reduce production costs because the services deliver food more quickly with less fuel and less labor. In other words, foodservice companies can expect diverse benefits because of not only a reduction of delivery costs but also the perspective of securing product delivery (Bamburry, 2015).

Next, the current food delivery services (e.g. cars or motorcycles) have resulted in serious problems, such as fatalities, personal injuries and costs (Reuters, 2017). In the USA, there have been numerous lawsuits regarding accidents while delivering pizzas (Cherney, 2016). These vehicle crashes make all parties unhappy (e.g. pizza companies, deliverers and the victim's families). In Nanjing, China, it was reported that 90 per cent of all traffic accidents occur because of food delivery services. A 15-min delay will be counted as a 50 per cent commission deduction, making deliverers always in a hurry (China Labour Bulletin, 2017). Using drones to deliver food to customers may solve the previously mentioned problems, because drones are not manipulated by the individual piloting ability but by a computer program, which has been inputted with the proper coordinates (Kesteloo, 2018). If drones are widely commercialized, traffic management can be performed efficiently according to several altitudes in the sky (Jang, 2017). Through the mobile communications network (e.g. LTE, 5 G), users are provided with flight information (e.g. location, altitude and route) and safety information (e.g. weather, airspace congestion and obstacles). Therefore, the risk of drones colliding in the sky is extremely rare (Jang, 2017).

Lastly, it is argued that at least 70,000 jobs would be created if the drone regulations were relaxed and more drones were commercialized in the USA (Dillow, 2013). Camhi (2017) also anticipated that drone delivery will accelerate the growth of online sales as free and fast shipping becomes available, so consumers will be more satisfied and become more loyal to use drone delivery services.

Although these high-technology tools provide many benefits, it should be noted that some people are reluctant to the use drones. When Americans were asked about their views about science and the future in a recent survey, 63 per cent of Americans think that it would be a change for the worse if drones are commercialized in their lives (Smith, 2014). This means that, while some consumers welcome drone technology that challenges traditional methods of transportation, others are nervous about the advent of these drones in their lives (Bamburry, 2015). From the customer perspective, using drone food delivery services may be considered as accepting a new technology rather than simply using a service. Ramadan *et al.* (2017) examined the emergence of drones as a service-based technology in retailing, provided that the customer accepts the technology. Kwon *et al.* (2017) explored consumers' concerns regarding drone technology and found that some customers hesitated to adopt this new technology because they are concerned about some problems related to illegal delivery.

Despite the importance of studying consumers' perception toward the use of drones for delivery, there has currently been surprisingly little research. To overcome consumers'

concerns of using drone food delivery services, identifying its perceived risk is a necessary course of action.

Perceived risk theory

Perceived risk is defined as "the nature and amount of risk perceived by a consumer in contemplating a particular purchase decision" (Cox and Rich, 1964, p. 33). It is argued that perceived risk occurs when consumers have uncertainty about the potential outcomes of a behavior and the possible unhappiness resulting from it (Forsythe and Shi, 2003). This can be more simply stated as risk "being the possible loss" in a choice situation (Taylor, 1974, p. 54). Based on the previous studies, perceived risk in using drone food delivery services is defined as the subjectively determined expectation of loss by a drone food delivery services in this study.

The perceived risk theory explains how consumers perceive risk and how they attempt to avoid negative results of their purchase decisions (Bauer, 1960). As consumers are more likely to avoid or decrease negative outcomes rather than maximize benefits with taking some risks, it is very critical to study perceived risk to understand their behavior (Im *et al.*, 2008). Meanwhile, consumers' perceived risk tends to be reinforced when their concerns are associated with novel technologies. The concept of perceived risk related to novel technologies has been well documented in the hospitality and tourism field (Kim and Qu, 2014; Morosan, 2012). For example, some restaurants adopted biometric systems to improve the overall management of their staff, but they have not yet with consumers because it is expected that consumers will perceive a high degree of psychological risks toward the new technology, such as fear, hesitation and some negative feelings (Morosan, 2012). Kim and Qu (2014) stated that some travelers may have difficulties using new technology, such as hotel self-service kiosks, and they are more likely to be less satisfied with the hotel.

Facets of perceived risk

In the history of new technology research, the following five types of perceived risk have been identified from previous studies:

(1) financial risk;
(2) time risk;
(3) privacy risk;
(4) performance risk; and
(5) psychological risk (Chen, 2013; Martins *et al.*, 2014; Pascual-Miguel, Agudo-Peregrina and Chaparro-Peláez, 2015).

First, financial risk refers to the possibility of the loss of money because of an inappropriate purchasing decision (Forsythe and Shi, 2003; Kushwaha and Shankar, 2013). If consumers think that there will be a certain probability of not getting enough value for the money spent, they are more likely to perceive high levels of financial risk (Kim, Kim, and Leong, 2005). Such financial risk is a phenomenon that is always present when consumers use a new technology for the first time (Anja, 2016), so consumers could also worry about loss of money in using drone food delivery services.

Second, time risk is defined as the possibility that consumers will waste time, be inconvenienced or waste effort using a new service (Garner, 1986). Consumers may have difficulties navigating the new system and find appropriate information, which results in waste of their time and a delay of receiving products/services (Forsythe and Shi, 2003). Drone food delivery services have not yet popularly commercialized to the public. As a

result, it is expected that consumers may have to spend more time to accept and be familiar with using the drone food delivery technology.

Third, privacy risk involves the possibility of consumers' personal information, such as credit card numbers and phone numbers, being exposed and misused (Forsythe and Shi, 2003). Consumers have a sense of insecurity whenever they need to provide their personal information when using a new technology (e.g. online shopping, biometrics in a hotel and mobile hotel reservations) (Forsythe and Shi, 2003; Kim *et al.*, 2008; Wang and Wang, 2010). As consumers have to use drone food delivery services via a mobile application, they are more likely to be concerned about their private information.

Fourth, performance risk refers to the loss incurred when the service does not perform as expected (Horton, 1976; Kushwaha and Shankar, 2013). According to Forsythe and Shi (2003), purchasing a product online without directly touching, feeling and seeing the product may increase the level of performance risk. Similarly, consumers who want to use drone food delivery services would also perceive performance risk because they cannot make accurate decisions about the performance before using the service.

Lastly, psychological risk is defined as the risk that the service purchased will have a negative effect on the consumer's peace of mind or self-perception (Garner, 1986). Previous studies indicated that psychological risk is also a potential loss of self-image (Kim *et al.*, 2008). Consumers may create negative emotions under the risk of accepting drone food delivery technology, resulting in anxiety or frustration.

Effect of perceived risk on image of drone food delivery services

First, this study proposed the relationship between perceived risk and image based on the following theoretical and empirical backgrounds. Consumers are anxious about the unexpected results when they use new technology-based services (Martins *et al.*, 2014), so if they perceive high levels of risk from the new technology-based services, they would have an unfavorable image of the services (Aghekyan-Simonian *et al.*, 2012). Curran and Meuter (2005) investigated the relationship between perceived risk and attitude toward the self-service technology. They found that people who did not perceive any difficulties using self-service technology and considered the transaction safe and secure will find the new technology very useful and convenient to meet their travel needs. In contrast to this, it is expected that people who perceived a high level of risk of adopting a new technology to use a specific product are more likely to form a negative image about the new technology. Kaushik *et al.* (2015) argued that the overall attitude toward the self-service technology decreases as the perceived risk increases in the context of the hotel self-service technology. Previous studies have commonly suggested that the more people perceived risk in using a new technology, the more likely they would form a negative image of the product that adopted the new technology. Based on the theoretical and empirical backgrounds, the following hypothesis is proposed:

H1. Perceived risk has a negative influence on image.

Effect of image of drone food delivery services on desire

Desire can be defined as "a state of mind whereby an agent has a personal motivation to perform an action or to achieve a goal" (Perugini and Bagozzi, 2004. p. 71). The concept of desire has been neglected in the social science field, and it has been often considered to be similar with the concept of intention. For example, the theory of planned behavior introduced by Ajzen (1991) has served as a leading attitude model, which explains that

intentions result directly from the impact of attitude without going through desires, assuming that desires do not differ from intentions (Stasson and Fishbein, 1990). However, desires are believed to be very important in the genesis of human actions and should be considered theoretically and empirically different from intention (Perugini and Bagozzi, 2004). The thing that distinguishes desire from intention or attitude is that desire reflects motivation, which is typically a first step toward a decision to act (Perugini and Bagozzi, 2004). Although the concept of desire has not been frequently applied in empirical research in the hospitality and tourism industry, it is a potentially meaningful concept for those seeking a more precise understanding of each customer's adoption of a new technology in the hospitality setting.

Empirical studies have found a relationship between image and desire (Han and Hwang, 2016; Hudson *et al.*, 2011). For example, Hudson *et al.* (2011) investigated viewers' desire to visit a destination. They suggested that viewers who created a positive image of the destination after watching the film showed a higher level of desire to visit the destination. In addition, Han and Hwang (2016) examined the process of cruise travelers' environmentally responsible decision-making and found that travelers who consider an environmentally responsible cruise positive and attractive expressed a stronger desire to travel with the responsible cruise in the future. As a result, it can be inferred that, when consumers perceived that overall image for using drone food delivery services is good, they are more likely to desire using drone food delivery services when ordering food. Thus, the following hypothesis is proposed:

H2. Image has a positive influence on desire.

Effect of image of drone food delivery services on behavioral intentions

Ajzen and Fishbein (1980) defined behavioral intentions as the likelihood that a person will engage in a given behavior. As the ultimate goal of suppliers is to retain loyal customers for a profit, studying customers' behavioral intentions is a critical factor (Zeithaml *et al.*, 1996). Previous studies have shown that the image that customers create toward a particular product can motivate and increase their intentions to use the product and increase their willingness to pay more to use that product (Han *et al.*, 2009; Kaushik *et al.*, 2015; Lee *et al.*, 2010; Ryu *et al.*, 2008). For instance, Ryu *et al.* (2008) showed that there is a positive relationship between restaurant image and customers' behavioral intentions. In addition, Han *et al.* (2009) investigated hotel customers' eco-friendly decision-making processes and found that the more positive image customers had regarding an eco-friendly hotel, the more they are willing to stay at the green hotel and the more willing they are to spend extra to stay at the green hotel. Similarly, Lee *et al.* (2010) proved that the image of hotels is positively related to customers' intentions to stay at the hotel and their intentions to spend more money to stay at that hotel.

In terms of adopting a new technology in the hospitality and tourism context, Kim and Qu (2014) developed a theoretical model to identify the relationship between overall attitudes toward using a self-service kiosk in a hotel and behavioral intentions to use the new technology. The data analysis results showed that overall attitudes play a critical role in the formation of behavioral intentions. Kaushik *et al.* (2015) also explored how behavioral intentions are formed in the hotel industry. They suggested that a favorable overall perception about a self-service hotel will generate high levels of intentions to adopt the new technology.

In summary, the literature shows that, once customers have a positive image about the product, they are more likely to have high levels of intentions to use and willingness to pay

more. Therefore, it can be inferred that image of drone food delivery services is likely to enhance the consumers' intentions to use the services and increase the level of willingness to pay more to use the services. This leads to the following hypotheses.

H3. Image has a positive influence on intentions to use.

H4. Image has a positive influence on willingness to pay more.

Effect of desire on behavioral intentions

According to the model of goal-directed behavior (MGB), when consumers have a desire to engage in a certain behavior, they are more likely to show behavioral intentions (Perugini and Bagozzi, 2001), which suggests that desire is an important predictor of behavioral intentions. In addition, many previous studies have empirically found a positive relationship between desire and behavioral intentions. Han *et al.* (2015) investigated how to enhance behavioral intentions in the context of medical hotels. They found that desire is a critical factor that affects behavioral intentions. In addition, Han *et al.* (2017) stated that desire positively affected behavioral intentions in the bicycle tourism industry. More recently, Han *et al.* (2018) examined the effect of desire to take pro-environmental actions on green loyalty in the cruise industry. The results of the data analysis revealed that the desire to take pro-environmental actions was a critical factor affecting green loyalty. Based on previous studies, following hypotheses are proposed:

H5. Desire has a positive influence on intentions to use.

H6. Desire has a positive influence on willingness to pay more.

Proposed model

Based on theoretical backgrounds, six theoretical hypotheses were derived. Figure 1 shows the conceptual model.

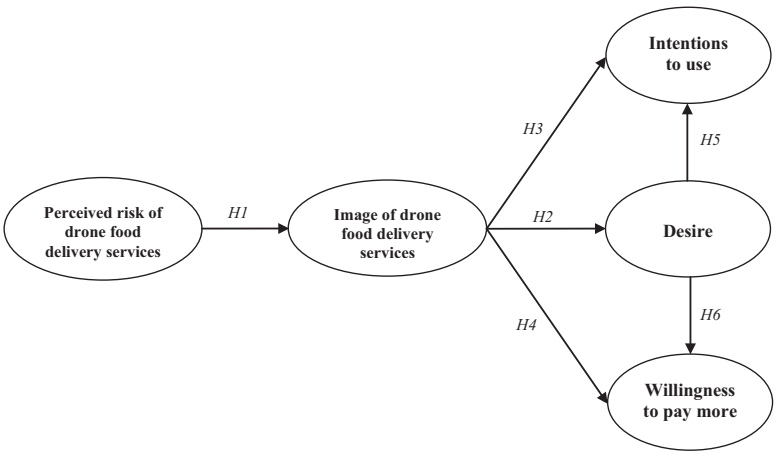

Figure 1.
Proposed conceptual model

Methodology

Measurement

To measure each concept, this study used the following measurement items that have been proven to be reliable and valid in previous studies. First, perceived risk was measured with 15 items that were adopted from Chen (2013), Martins *et al.* (2014), Pascual–Miguel *et al.* (2015). Image was measured with three items used by Han *et al.* (2009) and Jani and Han (2014). Desire was measured with three items borrowed from Han and Yoon (2015). Measurements for intentions to use were adapted from Zeithaml *et al.* (1996), and those for willingness to pay were from Han *et al.* (2009).

In addition, the first version of the questionnaire was designed based on the measurement items. For the content validity, the following expert groups reviewed the questionnaire thoroughly:

- three professors who majored in restaurant management; and
- three drone experts who hold a remote pilots certificate.

While some scholars insist including four to six items to measure one construct to increase its theoretical validity (Hinkin *et al.*, 1997), some researchers recommend to include parsimonious items, because reducing the number of items per construct can improve the model fit by the total number of indicators (Hair *et al.*, 2006). Therefore, the current study included three items to measure each construct.

Data collection

A pretest was performed to evaluate the reliability of the measurement items. The test was conducted based on a total of 50 actual food service patrons using an online questionnaire survey in Korea. The initial version of the questionnaire was developed in English, so it was translated into Korean using the blind translation–back-translation method. The respondents watched approximately 2 min and 30 s of video related to drone food delivery services before starting the survey. The video easily described the system and operation of drone food delivery services so that the respondents could easily understand the services. The results of data analysis indicated that all of the values of Cronbach's α for each construct were greater than 0.70, which supports a high level of reliability (Nunnally, 1978).

In addition, the main survey was also conducted based on the online questionnaire survey using an online market research company in Korea. The respondents participated in the questionnaire after watching the video related to drone food delivery services, which was similar to the pretest. The questionnaire was randomly distributed through email to 2,794 respondents who have used food delivery services within the last six months. Among them, 346 responded to the questionnaire. Furthermore, 15 outliers were deleted through visual inspection and a Mahalanobis distance check. As a result, 331 respondents were used for statistical analysis.

Data analysis

Demographic profile of the samples

Of the total 331 respondents, 58 per cent ($n = 192$) were males and 42 per cent ($n = 139$) were females. The average age of the respondents was 35.04 years. The respondents in their 20s represented the majority, which accounted for 37.5 per cent ($n = 124$) of the total. The respondents with a monthly household income between US$2,001 and US$3,000 accounted for 22.4 per cent ($n = 74$). The majority of the respondents were single (56.8 per cent, $n = 188$).

In regard to educational levels, people who had a bachelor's degree represented 58.6 per cent ($n = 194$), followed by an associate's degree (16.0 per cent, $n = 53$), graduate degree (14.8 per cent, $n = 49$), and less than a high school diploma (10.6 per cent, $n = 35$).

Exploratory factor analysis

The factor analysis on the underlying structure of perceived risk of drone food delivery services showed five factors with eigenvalues higher than 1 (see Table I). The Kaiser–

Variables	Standardized factor loadings	Eigenvalue	Explained variance	Cronbach's α
Financial risk		2.875	19.165	0.974
The cost of using drone food delivery services is likely to be burdensome	0.961			
Drone food delivery services are likely to cost more than I thought	0.949			
I might get overcharged if I use drone food delivery services	0.942			
Time risk		2.781	18.540	0.952
The possible time loss from learning about using drone food delivery services is high	0.944			
If I use drone food delivery services, I am more likely to lose time because of the switching to a different delivery service	0.943			
It will take time to learn how to use drone food delivery services	0.912			
Privacy risk		2.766	18.440	0.965
Using drone food delivery services may not protect my personal information (e.g. credit card number, phone number, address, etc.)	0.923			
Personal information (e.g. credit card number, phone number, address, etc.) when using drone food delivery services may be stolen by others	0.908			
Personal information (e.g. credit card number, phone number, address, etc.) could be exposed when using drone food delivery services	0.901			
Performance risk		2.686	17.904	0.937
The probability that something is wrong with the performance of drone food delivery services is high	0.919			
Drone food delivery services do not seem to perform well	0.912			
Considering the expected level of performance of drone food delivery services, it would be risky to use it	0.902			
Psychological risk		2.533	16.889	0.910
The usage of drone food delivery services would lead me to a psychological loss	0.877			
Using drone food delivery services would not fit in well with my self-image	0.863			
Using drone food delivery services makes me feel anxiety	0.850			

Notes: Total explained variance = 90.938%; KMO measure of sampling adequacy = 0.837; Bartlett's test of sphericity ($p < 0.001$)

Table I.
Exploratory factor analysis for perceived risk of drone food delivery services

Meyer–Olkin (KMO) measure of sampling adequacy was 0.837, which supports the useful validation of the factor model. In addition, the factor model explained 90.938 per cent of the variance. The factor loadings for all items exceeded 0.850. Lastly, the values of Cronbach's α for checking the reliability of items within each dimension exceeded the 0.70 threshold (Nunnally, 1978).

Proposed model revision

By extracting the five factors from perceived risk of drone food delivery services, the proposed model was revised (Figure 2).

Confirmatory factor analysis

Following an exploratory factor analysis, a confirmatory factor analysis was used to evaluate the uni-dimensionality of the scales and to validate the overall measurement model. As shown Table II, the goodness-of-fit measures to assess the overall model fit reported an acceptable level (χ^2 = 551.732, df = 288, χ^2/df = 1.916, $p < 0.001$, NFI = 0.954, IFI = 0.978, CFI = 0.977, TLI = 0.973, RMSEA = 0.053) (Byrne, 2001). The values of all the factor loadings were equal to or greater than 0.823 and were significant at the $p < 0.001$ level. Table II shows the specific variables with their standardized factor loadings.

Table III shows that average variance extracted (AVE) values for the nine constructs used were higher than the 0.50, confirming high level of convergent validity (Fornell and Larcker, 1981). All the values of composite reliabilities were greater than 0.70, ranging from 0.912 to 0.975, which indicates that all the constructs had a suitable internal consistency (Hair *et al.*, 2006). Lastly, the discriminant validity was satisfactory because all the AVE values for each construct were greater than all of the squared correlations (R^2) between any pair of the constructs (Fornell and Larcker, 1981).

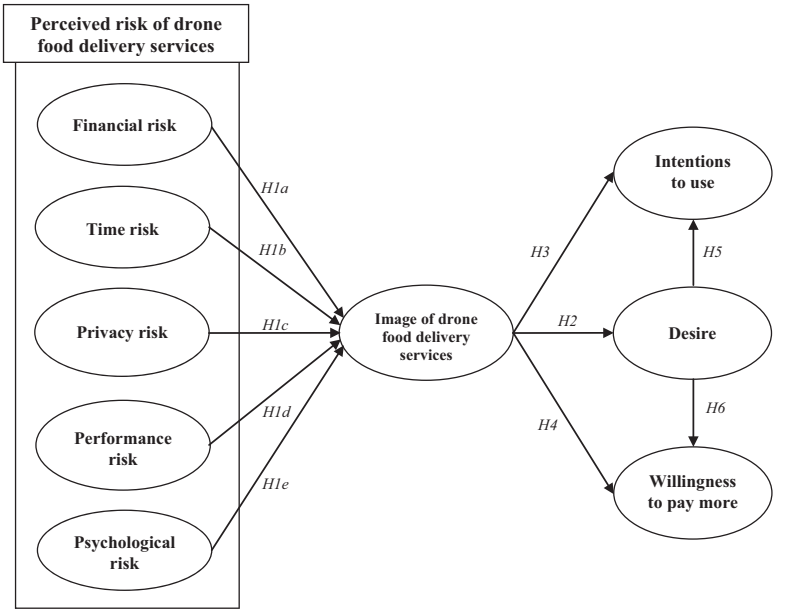

Figure 2.
Proposed model revision

Construct and scale item	Standardized loading[a]
Financial risk	
The cost of using drone food delivery services is likely to be burdensome	0.975
Drone food delivery services are likely to cost more than I thought	0.960
I might get overcharged if I use drone food delivery services	0.952
Time risk	
The possible time loss from learning about using drone food delivery services is high	0.949
If I use drone food delivery services, I am more likely to lose time because of the switching to a different delivery service	0.955
It will take time to learn how to use drone food delivery services	0.893
Privacy risk	
Using drone food delivery services may not protect my personal information (e.g. credit card number, phone number, address, etc.)	0.974
Personal information (e.g. credit card number, phone number, address, etc.) when using drone food delivery services may be stolen by others	0.930
Personal information (e.g. credit card number, phone number, address, etc.) could be exposed when using drone food delivery services	0.946
Performance risk	
The probability that something is wrong with the performance of drone food delivery services is high	0.919
Drone food delivery services do not seem to perform well	0.899
Considering the expected level of performance of drone food delivery services, it would be risky to use it	0.920
Psychological risk	
The usage of drone food delivery services would lead me to a psychological loss	0.894
Using drone food delivery services would not fit in well with my self-image	0.923
Using drone food delivery services makes me feel anxiety	0.823
Image	
Overall image for using drone food delivery services is good	0.950
Overall image I have about drone food delivery services is great	0.960
Overall, I have a good image about drone food delivery services	0.916
Desire	
I desire to use drone food delivery services when ordering food	0.956
My desire of using drone food delivery services when ordering food is strong	0.961
I want to use drone food delivery services when ordering food	0.964
Intentions to use	
I will use drone food delivery services when ordering food	0.957
I am willing to use drone food delivery services when ordering food	0.899
I am likely to use drone food delivery services when ordering food	0.960
Willingness to pay more	
I am likely to pay more for drone food delivery services	0.951
It is acceptable to pay more for drone food delivery services	0.966
I am likely to spend extra to use drone food delivery services	0.973
Goodness-of-fit statistics: $\chi^2 = 551.732$, df = 288, $\chi^2/\text{df} = 1.916$, $p < 0.001$; NFI = 0.954, IFI = 0.978, CFI = 0.977, TLI = 0.973, RMSEA = 0.053	

Notes: [a]All factors loadings are significant at $p < 0.001$ NFI = normed fit index; IFI = incremental fit index; CFI = comparative fit index; TLI = Tucker–Lewis index; RMSEA = root-mean square error of approximation; All items were measured on a seven-point Likert scale (1: strongly disagree, 4: neutral, 7: strongly agree)

Table II.
Confirmatory factor analysis: items and loadings

Table III.
Descriptive statistics and associated measures

	No. of items	Mean (SD)	AVE	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Financial risk	3	4.61 (1.69)	0.926	*0.974*[a]	0.083[b]	0.287	0.295	0.348	–0.052	–0.095	–0.146	0.018
(2) Time risk	3	4.29 (1.64)	0.870	0.007[c]	*0.953*	0.372	0.205	0.276	–0.226	–0.202	–0.232	–0.129
(3) Privacy risk	3	3.74 (1.63)	0.903	0.082	0.138	*0.965*	0.316	0.506	–0.169	–0.214	–0.227	–0.039
(4) Performance risk	3	4.54 (1.37)	0.833	0.087	0.042	0.100	*0.937*	0.426	–0.288	–0.221	–0.228	0.004
(5) Psychological risk	3	4.49 (1.46)	0.776	0.121	0.076	0.256	0.181	*0.912*	–0.339	–0.400	–0.433	–0.137
(6) Image	3	4.49 (1.28)	0.888	0.003	0.051	0.029	0.083	0.115	*0.960*	0.784	0.781	0.442
(7) Desire	3	4.30 (1.46)	0.922	0.009	0.041	0.046	0.049	0.160	0.615	*0.981*	0.732	0.514
(8) Intentions to use	3	4.51 (1.42)	0.882	0.021	0.054	0.052	0.052	0.187	0.610	0.536	*0.957.*	0.531
(9) Willingness to pay more	3	3.22 (1.62)	0.928	0.001	0.017	0.002	0.001	0.019	0.195	0.264	0.282	*0.975*

Notes: SD = standard deviation, AVE = average variance extracted; [a]composite reliabilities are along the diagonal; [b]correlations are above the diagonal, [c]squared correlations are below the diagonal

Structural model

Structural equation modeling was used to test the hypotheses. As shown in Table IV, the model had a good fit (χ^2 = 629.588, df = 307, χ^2/df = 2.051, $p < 0.001$, NFI = 0.948, IFI = 0.973, CFI = 0.972, TLI = 0.968, RMSEA = 0.056) (Byrne, 2001). The results showed that, among the ten estimated path coefficients, seven paths were statistically significant at the 0.05 level. The final results with standardized regression weights are exhibited in Figure 3.

More specifically, *H1a*, which proposed the effect of financial risk on image of drone food delivery services, was not supported (β = 0.043, $p > 0.05$). In addition, time risk had a negative influence on image of drone food delivery services (β = –0.129, $p < 0.05$). Thus, *H1* b was supported. Contrary to the expectation, there is no relationship between privacy risk and image of drone food delivery services (β = 0.054, $p > 0.05$). Hence, *H1c* was not supported. In the case of *H1d* and *H1e*, performance risk (β = –0.157, $p < 0.05$) and psychological risk (β = –0.243, $p < 0.05$) were found to be negatively associated with image of drone food delivery services, suggesting that *H1d* and *H1e* were supported. The data analysis results showed that image of drone food delivery services positively affects desire (β = 0.786, $p < 0.05$) and intentions to use (β = 0.131, $p < 0.05$), indicating that *H2* and *H3* were supported. However, image of drone food delivery services did not statistically affect willingness to pay more. Thus, *H4* was not supported. Lastly, the results revealed that desire was an important predictor of intentions to use (β = 0.830, $p < 0.05$) and willingness to pay more (β = 0.522, $p < 0.05$), thus supporting *H5* and *H6*.

Discussion and implications

This study explored what types of perceived risks are in the context of drone food delivery services. In addition, this study examined the effects of perceived risk on image of drone food delivery services. Lastly, this study investigated how the image helped increase outcome variables, which include desire, intentions to use and willingness to pay more. To evaluate the proposed hypotheses, this study analyzed data collected from 331 respondents in Korea. The data analysis results provided the following important theoretical and managerial implications.

		Standardized estimate	*t*-value	Hypothesis
H1a	Financial risk→Image	0.043	0.620	Not supported
H1b	Time risk→Image	–0.129	–2.322	Supported
H1c	Privacy risk→Image	0.054	0.829	Not supported
H1d	Performance risk→Image	–0.157	–2.594	Supported
H1e	Psychological risk→Image	–0.243	–3.896	Supported
H2	Image→Desire	0.786	19.378	Supported
H3	Image→Intentions to use	0.131	3.217	Supported
H4	Image→Willingness to pay more	0.086	1.041	Not supported
H5	Desire→Intentions to use	0.830	18.957	Supported
H6	Desire→Willingness to pay more	0.522	10.457	Supported

Goodness-of-fit statistics: χ^2 = 629.588, df = 307, χ^2/df = 2.051, $p < 0.001$, NFI = 0.948, IFI = 0.973, CFI = 0.972, TLI = 0.968, RMSEA = 0.056

Notes: *$p < 0.05$; NFI = normed fit index; IFI = incremental fit index, CFI = comparative fit index; TLI = Tucker–Lewis index, RMSEA = root-mean square error of approximation

Table IV. Standardized parameter estimates for structural model

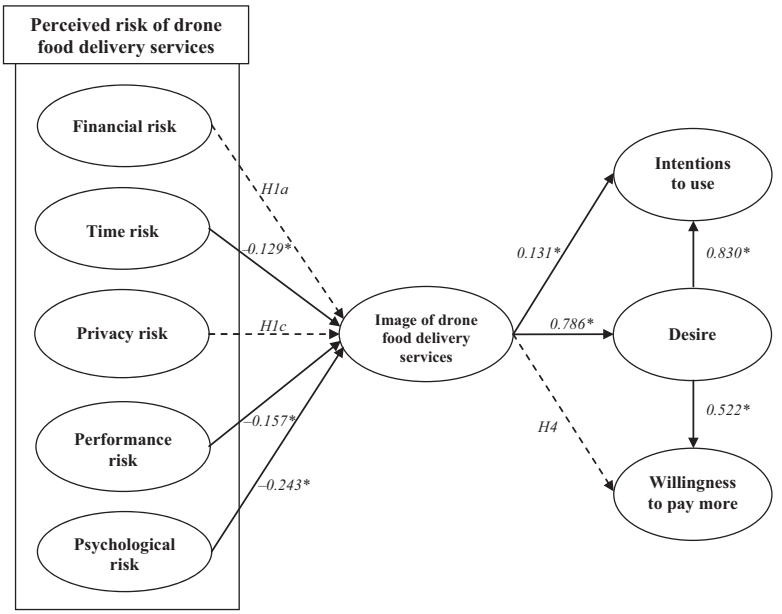

Figure 3.
Standardized theoretical path coefficients

Theoretical implications

First, contrary to expectations, financial risk has no effect on image of drone food delivery services (*H1a*). Masoud (2013) suggested that financial risk is a critical factor that affects consumer behavior in the context of a new technology product. Therefore, it can be inferred that consumers are willing to pay a certain amount of money for the use of drone food delivery services because they seem to expect financial risk when using an innovative technology. Therefore, foodservice companies need to measure the cost of drone food delivery services in view of the fact that consumers will be taking a certain level of financial risk.

Second, time risk was shown to have a negative effect on image of drone food delivery services. In technology research, most of the existing research has suggested that time risk is one of the important perceived risks, which negatively affects the adoption of new technology. For instance, Lee (2009) found that, when consumers perceived a high level of time risk when using online banking services, they are less likely to have a favorable attitude toward using the services. Unlike previous studies, this study found a negative effect of time risk on image in the context of drone food delivery services for the first time, which theoretically contributes to the existing literature. That is, when consumers feel that it will take time to learn how to use drone food delivery services, the overall image for using the services is not good.

Third, against expectations, the data analysis result showed no significant relationship between privacy risk and image of drone food delivery services (*H1c*). The result of this study differs from previous studies (Masoud, 2013; Yang *et al.*, 2015), which suggested that privacy risk, such as personal information leaks, hamper the adoption of a new technology. However, unlike existing research, privacy risk had no effect on image of drone food delivery services in this study. An interpretation of this result involves when consumers order food using their smartphones, they are required to provide personal information (e.g.

credit card numbers, phone numbers and addresses). This means that consumers are not reluctant to provide personal information because they know that providing personal information when ordering food is not a serious concern. For this reason, the relationship between privacy risk and image of drone food delivery services appears to be insignificant.

Fourth, the result of data analysis showed that performance risk had a negative impact on image of drone food delivery services. An interpretation of this analysis means that, when consumers feel that drone food delivery services do not seem to perform well, they have a bad image about the services. Previous studies have consistently suggested that performance risk is an important factor that affects outcome variables, including attitude, perceived value and acceptance intention (Lee, 2009; Yang *et al.*, 2015). In this regard, this study confirmed and extended the existing theoretical relationship by empirically finding the negative relationship between performance risk and image in the context of drone food delivery services.

Fifth, psychological risk was found to exert a negative impact on image of drone food delivery services. It is widely accepted that psychological risk is a critical factor to be managed when implementing a new technology (Chen, 2013; Martins *et al.*, 2014). The finding of this study also supports the above argument. This means that, when consumers feel nervous about using drone food delivery services, they are less likely to have a good image about the services. Unlike previous studies, this study is the first attempt to identify the effect of psychological risk on image of drone food delivery services, which is an important theoretical implication of this study.

Lastly, another important finding of this study was the impact of image on the outcome variables in the context of drone food delivery services for the first time. The data analysis results showed that image of drone food delivery services had a positive influence on desire, which in turn positively affects intentions to use and willingness to pay more. Similarly, prior research has suggested the significant role of image in influencing outcome variables (Han *et al.*, 2009; Kaushik *et al.*, 2015; Kim and Qu, 2014). The results mean that, when consumers perceive that the overall image of using drone food delivery services is good, they are more likely to have higher levels of desire when using drone food delivery services. Furthermore, consumers are more likely to use drone food delivery services and pay more for drone food delivery services when ordering food.

Managerial implications

First, this study found the effect of time risk on image of drone food delivery services (*H1b*). The finding has the following managerial implications as well. Above all, foodservice companies should explain the use of drone food delivery services to consumers in a simple manner. Therefore, it is necessary to create a user manual to accomplish this. In recent years, many consumers have tended to use smartphones instead of telephones when ordering food delivery. Therefore, it is necessary for the foodservice companies to utilize this point completely. For instance, if foodservice companies provide a video that anyone could easily watch and learn about the use of drone food delivery services, time risk that consumers perceive would be reduced. In particular, it is widely known that older people have more difficulty learning about the use of new devices than younger people (Kucukusta *et al.*, 2015). As a result, foodservice companies need to pay more attention to the elderly who might want to use drone food delivery services.

Second, *H1d*, which proposed a negative relationship between performance risk and image of drone food delivery services, was supported. The finding has key practical implications for foodservice companies, because it emphasizes the significance of managing performance risk in the context of drone food delivery services. As previously mentioned,

although some foodservice companies have successfully tested the implementation of drone food delivery services, consumers still have doubts about the performance of such services. This implies that foodservice companies must thoroughly check the performance of drones before launching the services. Furthermore, it is recommended to stress to consumers that drone food delivery services are superior to regular food delivery services. For example, drone food delivery services can bypass traffic congestion, so customers can get food quickly. In addition, it is widely known that the food delivery jobs are one of the most dangerous jobs in the USA (The Enterprise, 2007). Therefore, it would be helpful to decrease performance risk if foodservice companies emphasized that drones could make deliveries without the loss of human life.

Third, this study showed the important role of psychological risk in the formation of image of drone food delivery services (*H1e*). In terms of practical implications, consumers are nervous about the impact of using new technology on their self-images, which can lead to a psychological loss. To alleviate psychological risk, foodservice companies should strive to provide a good impression of drone food delivery services to consumers. For example, most foodservice companies currently use cars or motorcycles to deliver food. These vehicles are known to be a major cause of environmental pollution, so if foodservice companies emphasize that drone food delivery services play an important role in protecting the environment in their advertisements, consumers are likely to form a favorable impression of the service, which can reduce psychological risk.

Fourth, the data analysis results indicated that the important role of image of drone food delivery services in the formation of its outcome variables, such as desire, intentions to use and willingness to pay more (*H2* to *H6*). From the standpoint of foodservice companies, it needs to improve the image of drone food delivery services. For example, as previously suggested, reducing the three perceived risks (i.e. time, performance and psychological risks) would improve the image of drone food delivery services. In addition, if foodservice companies emphasized the innovative aspects of drone food delivery services that outperform traditional delivery services, such as cars or motorcycles, consumers would receive a good image from the services.

Limitations and future research

This study has several limitations. The first is related to the external validity. To evaluate the proposed model, the data were collected from Korean consumers only, so it is somewhat difficult to apply the findings of this study to other regions. Second, although this study focused on drone food delivery services, it is worthy to apply this proposed research model to other hospitality businesses, because technology-based services (TBS) have become an important issue in the hospitality industry (Pourfakhimi *et al.*, 2018; Sunny, Patrick, and Rob, 2018). For instance, Casa Madrona Hotel and Spa, which is located in California, USA, offers a service to deliver champagne using a drone for customers in the outdoor pool (Casamadrona, 2018). Third, the data were collected through an online company and the convenience sampling technique was applied. However, this method can cause selection biases (Wright, 2005), so it is recommended that different types of data collection methods be used to reduce biases. Lastly, it is hard to collect data from customers who have actually used drone food delivery services, because these services are not officially available in Korea yet. Thus, it will be meaningful to investigate the problems that arise during the service process for actual customers using drone food delivery service based on the service theory in future research.

Conclusion

This study investigated the importance of managing perceived risk in the context of drone food delivery services. For this, data were collected from 331 respondents in Korea. The data analysis indicated that time, performance and psychological risks negatively affect the image of drone food delivery services. In addition, this study found that the image has a positive influence on desire, which in turn positively affects intentions to use and willingness to pay more. This study provides important theoretical and practical implications for successful building of drone food delivery services. In particular, the most important finding of this study is to suggest how to reduce perceived risk of drone food delivery services for foodservice companies preparing the services.

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