An Interdisciplinary Approach to Examining the Adoption of Drone Delivery Services

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Abstract

Since drone delivery service started in Iceland in 2017, various business organizations have considered the adoption of the technology. This study examines critical factors that are pertinent to the adoption of drone delivery services by end users, based on the theoretical foundations such as social networking, marketing, and technology. Adopting survey data collected from 157 college students, this study investigated the relationships among opinion passing, personal innovativeness, perceived ease of use, and perceived usefulness and their effect on the decision to adopt drone delivery services, and among these factors. One major finding is that perceived usefulness had the strongest impact on the intention to adopt, followed by personal innovativeness. Opinion passing and perceived ease of use, however, were found to have no effect on the intention. In addition, personal innovativeness played a significant role in increasing opinion passing, followed by behavioral intention and perceived usefulness. Lastly, perceived ease of use had a direct influence on perceived usefulness, but not the intention. Academic and practical implications are drawn from these findings to conclude the study.

Keywords: Drone, personal innovativeness, opinion passing, perceived ease of use, perceived usefulness, behavioral intention

1. INTRODUCTION

A growing number of industries, including retail, food, and healthcare, are embracing drone delivery services because they can potentially streamline their supply chain operations. For instance, the healthcare industry is experimenting with using drones to deliver medical supplies to medically-underserved populations in rural areas, as well as to deliver prescriptions to the front door of patients' houses in urban areas in order to reduce long wait times (Lin, Shah, Mauntel, & Shah, 2018). With supply chain disruption due to natural disasters, non-

government organizations (NGOs) have mobilized drones to deliver emergency commodities to disaster-affected regions and to minimize the distribution costs of disaster-relief operations (Chowdhury, Emelogu, Marufuzzaman, Nurre, & Bian, 2017). In the private sector, the first delivery service started by Flytrex in Reykjavik, Iceland in 2017 (Gilchrist, 2017). In Shanghai, China, ele.me, one of the major online food delivery platforms in China, began a drone delivery service in 2018, delivering take-out meals across the city (Whittaker, 2018). In the U.S., major advocates of drone delivery services, such as Amazon, UPS, and Domino's, are continuously experimenting and fine-tuning the technology. According to the Wall Street Journal, U.S. federal regulators and industry officials expect to start drone delivery service for limited packages in 2018 (Pasztor, 2018). Given these changes in the market, the adoption and diffusion of the technology must be just around the corner although the current drone delivery services are mostly justified for public use. Therefore, it is important to understand the relevant factors to adoption of technology in the perspective of its potential users. This study adopts a customer-driven approach in order to understand the key factors that can motivate users to adopt drone delivery services.

The customer-driven approach considers the adoption of drone delivery services from the perspective of the end user. Customers are more likely to be attracted and loyal to a product or service when it responds to their needs (Luigi, Oana, Mihai, & Simona, 2011). A simple way to understand the adoption cycle of new technology is to break it into three stages: awareness, consideration, and adoption. Since many customers are still not aware of the usefulness of drone delivery services, it is important to generate and disseminate lead sources (e.g. customer success stories, product comparisons, etc.) to potential users in order to trigger them into stepping into the process (Koshner, 1997). Marketing theory has shown that the word-of-month (WOM) marketing strategy is particularly useful at the early product introduction stage because it can help a company identify target customers and offer incentives to increase their interest in adopting the new technology (Kulviwat, Bruner Ii, Kumar, Nasco, & Clark, 2007). The interpersonal behavioral approach sometimes can be more effective than the technology acceptance approach in terms of predicting the behavioral use of new technology (Huang, 2017). With the growing number of customers consuming product information via social media, WOM is becoming even more important than ever due to its network effect, and because of its salient influence, this study considers opinion passing, one key WOM element, as a critical factor in the acceptance of drone delivery services at the early stage.

Personal innovativeness is an important individual trait that has marketing implications in terms of information technology adoption. The inclusion of personal innovativeness can help one understand how to accelerate the technology diffusion process during the inception of a new technology (Ritu & Jayesh, 1998). With limited resources, it is more effective to accelerate the technology diffusion process by identifying individuals with high personal innovativeness as key change agents and opinion leaders (Rogers, 1983). For companies interested in offering drone delivery services with limited resources, they will need to first and foremost learn to identify individuals with high personal innovativeness traits and rely on them to convince the majority of users to adopt this innovative service.

Perceived ease of use (PEOU) and perceived usefulness (PU) are two central constructs of the technology acceptance model (TAM), as they mediate the relationship between external variables (e.g. subjective norm, perceived risks, job relevance) and the behavioral intention to use new technology (Fred D. Davis, Richard P. Bagozzi, & Paul R. Warshaw, 1989). PEOU is a user's subjective belief about the degree of ease of using a particular technology, and PU is a user's subjective belief about the ability of using particular technology to enhance his/her job performance. While these two central factors are distinct from each other and have a direct effect on behavioral intention (Kulviwat et al., 2007), PEOU as a primary belief factor has a direct effect on the secondary belief factor of PU (Abdullah, Ward, & Ahmed, 2016).

Using survey data collected from college students, this study integrates social network, marketing, and technology acceptance theories, and explores the potential influence of the key factors of each theory as regards the behavioral intention to adopt drone delivery services. In addition, the study assesses the relative influence of each factor on the intention of users to adopt this innovative service. With improved understanding, the study can provide insights into how to maximize the use of limited resources in order to promote the diffusion of drone delivery services into the pubic.

The remainder of this paper is organized as follows. The literature related to behavioral

intention to use drone delivery services and its marketing, technology adoption, and personal innovativeness antecedents will be examined, followed by a research model and hypotheses based on the theoretical foundations. The research methodology is discussed with respect to the research design, data collection, and analysis method. Data analysis results is reported, suggesting the theoretical and practical implications drawn from the results. Finally, research directions and limitations are presented to conclude the study.

2. CONCEPTUAL FORMATION

Social network theory asserts that social relationships are a network structure that emerges from the interactions of social actors. As such, the social actors within the same network often affect each other in the decision-making process, including new technology adoption (Vannoy & Palvia, 2010). Social or peer influence can effectively encourage members of an online community for example to engage in a series of co-innovation activities (Wang, Hsiao, Yang, & Hajli, 2016).

In terms of drone delivery services, during the early adoption phase, most users are not aware of the existence of these services. The proliferation of social network services (SNS), such as Snapchat, Twitter, Instagram, and Facebook, provides a platform for users to connect with those innovative users that are knowledgeable about a wide variety of drone delivery services. A durable social network can be constructed with the emphasis of increasing the awareness of more innovative users about drone delivery services. These users will then expand their personal networks and help more innovative network participants with otherwise unattainable resources, such as access to information about drone delivery services and their potential benefits. A growing number of studies have tried to construct an "interaction network" or "conversation map" with Twitter and other social media in order to identify and profile the main constituencies (e.g. influencers) discussing a specific topic or a specific product or service (Kwak & Kim, 2017). One of such main constituencies could be users with personal innovativeness traits.

The Effect of Personal Innovativeness Traits on Increasing Passing Opinions about Drone Delivery Services

One prevalent social networking phenomenon is the growing use of Electronic word-of-mouth (eWOM) to disseminate product and service information. eWOM in SNS is often conceptualized into three elements: opinion seeking, opinion giving, and opinion passing (Chu & Kim, 2011a). The first two elements are common to online and offline WOM activities. However, the third element is unique in eWOM as social actors need to be willing to share content with others after identifying and generating useful content. Social influence is particularly effective at boosting network externalities for communities consisting of numerous small sub-networks (Kwak & Kim, 2017). Innovative users are more likely to pass personal opinions to other social actors as a social influence method and to increase network externality.

Drone delivery services are currently favored by scattered, small groups of communities. It is important for their providers to focus on using opinion passing as a social influence method in order to increase network size and externalities. A larger installed base can become an incentive for more innovative users to join the network and to learn more about drone delivery services (Henkel & Block, 2013). For instance, many companies have attempted to explicitly incentivize opinion-passing activities by rewarding customers that can help cross-sell and up-sell products (Godinho de Matos, Ferreira, & Krackhardt, 2014). AT&T for example offers the Buy One, Get One for customers interested in buying an iPhone X if they add a new line in addition to upgrading their current phone line. This example shows that it is important to identify innovative users and to encourage them to pass opinions and to motivate others in SNS to consider adopting drone delivery services. Thus, the following hypothesis is proposed:

H1: Personal innovativeness has a positive effect on opinion passing concerning the adoption of drone delivery services.

The Positive Effect of Personal Innovativeness on the Perceived Usefulness of the Adoption of Drone Delivery Services

Users with high personal innovativeness traits are more willing to try out new products or services (Lu, 2014). When these novelty seekers have positive experiences with new technology, they tend to have more positive perceptions of its usefulness (Ritu & Jayesh, 1998). Personal innovativeness is an effective predictor of the adoption of information technology, such as virtual reality simulation (Mary, Carol, & Vivek, 2012) and mobile commerce (Daştan & Gürler,

2016), and such a correlation is also likely to be present for the adoption of drone delivery services. As novelty seekers try out drone delivery services, they would become enthusiastic at communicating their usefulness to others. As such, users with a high degree of innovativeness are more likely to participate in co-creation activities, often perceived as useful. Thus, the following is proposed:

H2: Personal innovativeness has a positive effect on the perceived usefulness of drone delivery services.

The Effect of Opinion Passing on Increasing the Intention of Users to Adopt Drone Delivery Services

Social influence is a strong predictor of the intention to use, rather than performance expectations regarding new technology (Jennings, Arlikatti, & Andrew). Opinion passing by innovative users is an important social influence activity because it can influence less innovative users to adopt new products/services. For instance, farmers often trust the opinion of other farmers whom they consider successful and innovative in their farming operations even though they have different professional and personal characteristics (Genius, Koundouri, Nauges, & Tzouvelekas, 2014).

Opinion passing can have impact on the intention of users to adopt different products or services. In hospital environments, for example, the attitude of senior medical doctors can affect the intention of young medical doctors to use clinical informatics systems (Abyaomi, Evans, & Ocholla, 2017). In higher education institutions, the opinions among students can increase their intention to adopt information, communication, and technology (ICT) tools (Rosaline & Wesley, 2017). In face of the option of using advanced driver assistance systems (ADAS) to reduce the number of crashes, and enhance driver comfort, positive opinions among one's peers can also exert a significant influence on the adoption decision of drivers (Rahman, Lesch, Horrey, & Strawderman, 2017). Drone delivery services offer enticing reasons (e.g. cheaper and faster shipping at anytime and anywhere) for users to adopt them, and an increasing number of users are recognizing the positive reasons for doing so. The positive opinions of these users can potentially increase the intention of others to adopt these services; thus the following is proposed:

H3: Opinion passing has a positive effect on increasing the intention of users to adopt drone delivery services.

The Positive Effect of Personal Innovativeness on the Intention of Users to Adopt Drone Delivery Services

Personal innovativeness has a positive influence on utilitarian and hedonic values (Hong, Hsieh, & Lin), and utilitarian values include perceived usefulness and expected performance, while hedonic values concern the fun and playfulness perceptions of users (Lu, 2014). Along with the increase in the utilitarian and hedonic values of technology comes the increased intention of users to adopt this technology. The causal effect of personal innovativeness on the increase of adoption intention can be found in many information technologies, such as mobile hotel booking systems (Ozturk, Nusair, Okumus, & Hua, 2016) and smart watches (Hong, Hsieh, & Lin, 2017). It is plausible that drone delivery services could also be susceptible to the positive influence of personal innovativeness. Thus, the following is proposed:

H4: Personal innovativeness can increase the intention of users to adopt drone delivery services.

The Positive Effect of Perceived Usefulness on the Intention of Users to Adopt Drone Delivery Services

Perceived usefulness is an important determinant of beginning and continuation of emerging technology, such as mobile commerce applications (Daştan & Gürler, 2016; Eun-Yong, Soo-Bum, & Yu Jung Jennifer, 2017), food delivery applications (Eun-Yong et al., 2017), and mobile tourism applications (Chen & Tsai, 2017). Drones are useful at reducing delivery times and human labor, as well as possible to deliver customers a wide variety of products, such as small parcels, medications, pizza, etc. When users perceive the benefits of using drones to deliver items to them, they are more likely to adopt these services. Thus, the following is proposed:

H5: Perceived usefulness can increase the intention of users to adopt drone delivery services.

The Positive Effect of Perceived Ease of Use on the Intention of Users to Adopt Drone Delivery Services

Perceived ease of use (PEOU) is a person's belief about using a particular system without spending too much effort (Fred D. Davis et al., 1989). PEOU is a strong predictor of the intention to use rather than performance expectations regarding new technology (Jennings et al.). PEOU has a positive effect on the intention of users to adopt different technologies, such as virtual reality learning (Hsiu-Mei & Shu-Sheng, 2018), cloud computing (Shana & Abulibdeh, 2017), educational video games (Sánchez-Mena, Martí-Parreño, & Aldás-Manzano, 2017), and electronic health records (Tubaishat, 2017). Flying a drone to deliver goods to customers requires a team of drone experts and GPS technology; however, receiving drone delivery services is free of effort, as users only need to know where to pick up their delivered items after a drone drops off them. Because of the perceived ease of use, users are more likely to adopt drone delivery services; thus the following is proposed:

H6: Perceived ease of use can increase the intention of users to adopt drone delivery services.

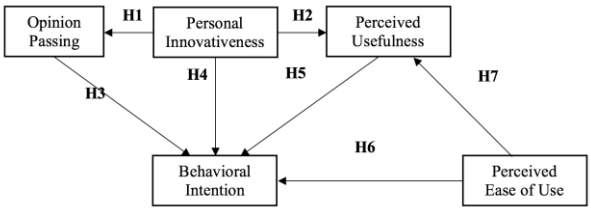
The Positive Effect of Perceived Ease of Use on the Perceived Usefulness of Drone Delivery Services

Although both perceived ease of use and perceived usefulness are usability factors (Ifinedo, Pyke, & Anwar, 2018), they are distinct from each other and the former factor has a positive influence on the latter factor (Fred D. Davis et al., 1989). By increasing the PEOU of the adopted system, users are more likely to perform better and contribute their improved performance to the increased PEOU. In order to enjoy the benefits of using drone delivery services, users will need to know how to place an order online. For instance, they turn on the location service for the drone delivery application, receive an alert for product delivery information, and use GPS to identify the delivery location. Simplifying these tasks can directly increase the users' PEOU, thereby improving their PU for the drone delivery service. Thus, the following is proposed:

H7: Perceived ease of use has a positive influence on the perceived usefulness of drone delivery services.

The above discussion leads to the development of the present research model (Figure 1).

Figure 1. Theoretical Model for the Adoption of Drone Delivery Services



3. RESEARCH METHODOLOGY

Survey

In order to test the hypotheses proposed, an online survey was conducted to collect data. Participants of the survey watched a drone delivery video to have a clear understanding on the service before answering questions. They answered the questions based on the assumption that a drone delivery service will be introduced soon. Total 182 undergraduate students participated in the survey. They were taking a required business course, *Information Technology in the Organization*, in a public university in the USA. Those students voluntarily participated in the study in order to receive 0.5% of their final grade as extra credit. We used a total 157 responses for analysis, excluding 25 invalid, incomplete responses. Table 1 below illustrates the profile of the respondents.

Table 1. Profile of Respondents

Category	Group	Frequency	Portion
Gender	Males	91	57.9
	Females	66	42.1
Age	18-22	97	61.8
	23-30	29	18.4
	31-50	16	10.2
	over 50	15	9.6

Reliability and Validity of Survey Instrument

Existing items were employed to measure the major constructs of this study (Appendix 1). The questions for the constructs were placed on a 5-point Likert scale, ranging from 1 "strongly disagree" to 5 "strongly agree." Table 2 presents the constructs and their sources, including their

loadings. We discarded items with loadings lower than 0.7 in order to ensure their indicator reliability (Chin, 2010).

Additional tests were performed to ensure the validity and reliability of the constructs. Cronbach's α coefficients for the measurement were higher than the acceptable cut-off value of 0.7 (Chin, 2010; Hair, Sarstedt, Pieper, & Ringle, 2012), suggesting internal consistency reliability. Convergent validity was examined with composite reliability and average variance extracted (AVE) and all of the values for composite reliability exceeded the recommended threshold of 0.7 (Fornell & Larcker, 1981), with the smallest AVE being 0.547, which is larger than the cut-off of 0.5 (Fornell & Larcker, 1981; Hulland, 1999). In addition, the square root of the construct's AVE was greater than the correlations with other constructs, ensuring discriminant validity of the measurement (Chin, 2010). Lastly, we checked the variance inflation factors (VIFs) of the constructs in order to determine the degree of multicollinearity. The VIFs ranged from 1.55 to 4.61, which was far below the recommended threshold of 10 (Chin, 2010), suggesting no significant multicollinearity in the model. Table 2 and Table 3 respectively summarize the model quality indicators and the correlations with square root of AVE on the diagonal discussed.

Table 2. Quality Indicators

Construct	CA	CR	AVE	VIF
OP	0.773	0.969	0.562	1.832
PEOU	0.898	0.989	0.698	3.147
PU	0.822	0.979	0.642	2.156
PI	0.748	0.935	0.600	1.554
BI	0.924	0.992	0.645	4.161

※ **CA:** Cronbach's α, **CR:** Composite Reliability, **AVE:** Average Variance Extracted, **VIF:** Variance Inflation Factor

Table 3. Correlations with Square Root of AVE on the Diagonal

Construct	OP	PEOU	PU	PI	BI
OP	**0.750**				
PEOU	0.110	**0.834**			
PU	0.310	0.701	**0.740**		
PI	0.445	0.110	0.190	**0.777**	
BI	0.274	0.506	0.611	0.311	**0.837**

Structural Model and Hypothesis Test

Structural Equation Modeling (SEM) with Partial Least Squares (PLS) was employed to test the proposed hypotheses. SEM is a reliable technique to test multiple causal relationships (Henseler, Ringle, & Sinkovics, 2009), and is not sensitive to the issues about population, scale of measurement, and residual distribution (Chin, 1998; Fornell & Bookstein, 1982). Table 4 and Figure 2 summarize the results of the hypothesis tests.

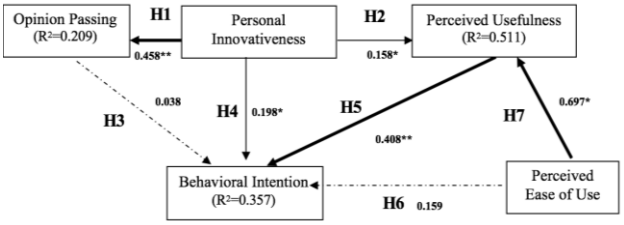
Personal Innovativeness (PI) explained 20.9% of the variance in Opinion Passing (OP) (R^2 = 0.209). PI had a positive influence on OP at the 99% confidence level (β = 0.458; t = 5.33), supporting Hypothesis 1. Hypothesis 2 was supported at the 95% level (β = 0.158; t = 1.99), suggesting a positive impact of PI on Perceived Usefulness (PU). PI and Perceived Ease of Use (PEOU) explained 51.1% of the variance in PU (R^2 = 0.511). Hypothesis 4 was supported at the 95% level, indicating a positive effect of PI on Behavioral Intention (BI) to use drone delivery. The effect of PU on BI was positive and statistically significant at the 99% level, supporting Hypothesis 5. OP, PI, PU, and PEOU together explained 35.7% of the variance in BI (R^2 = 0.357). Finally, Hypothesis 7 was supported at the 99% level, suggesting a positive impact of PEOU on PU. Different from the prediction, however, was Hypothesis 3 and Hypothesis 6, which were found to be not statistically significant. This suggests that OP and PEOU does not have a relationship with BI. One potential reason that ease of use may not be a good measure of behavioral intention can depend on how drone delivery is implemented. For instance, if it is just a third option on the screen (e.g. 1-day shipping, ground or 2-hour drone), ease of use may never really have an impact on behavioral intention.

Table 4. Results of Hypothesis Testing

Hypothesis	Coeff.	t-stat.	Result
H1: PI → OP	0.458	5.33**	*Supported*
H2: PI → PU	0.158	1.99*	*Supported*
H3: OP → BI	0.038	0.42	*Not Supported*
H4: PI → BI	0.198	2.11*	*Supported*
H5: PU → BI	0.408	3.52**	*Supported*
H6: PEOU→BI	0.159	1.40	*Not Supported*
H7: PEOU→PU	0.697	13.06**	*Supported*

※ **Significance:** *p < 0.05, **p <0.01

Figure 2. Research Model with Results of Hypothesis Testing



※ **Significance:** *p < 0.05, **p <0.01

4. DISCUSSION AND IMPLICATIONS

This study examined how marketing, technology adoption, and personal innovativeness factors affect the users' intention to adopt drone delivery services. Five out of seven proposed hypotheses were supported. Support of Hypotheses 1, 2, and 4 indicate that personal innovativeness plays a central role in the adoption of drone delivery services by increasing opinion passing, perceived usefulness, and behavioral intention. This finding confirms previous study concerning the strong predictive power of personal innovativeness regarding adoption intention, particularly in the domain of information technology (Mary et al., 2012).

In the survey, the subjects were asked to report the personal reasons why they would or would not like to use drone delivery services as soon as they become available from companies, such as Amazon, Domino's Pizza, and Netflix. Based on the responses, it was clear that some users had a high degree of personal innovativeness and these users were more likely to consider drone delivery services useful and to adopt them as soon as they become available. Innovative users expressed such opinions as the following:

"I want to try it out and see if it is for me or not;" "It will be interesting to see the package delivered and much faster and more reliable that with other modes of transportation."
"It seems very futuristic," and "I think it would be cool."

Thus, it is important to identify users with high personal innovativeness because this factor can promote technological opinion leadership and gadget lovers (Thakur, Angriawan, & Summey, 2016).

On the other hand, some participants showed reservations about embracing drone delivery services and would like to see more users adopt the service before considering adopting it. These users were considered less innovative and they made such comments as the following:

"I would only use it if absolute dire need situations where a delivery must be done in a matter of a few hours as in emergency situation."
"I would likely not use them right at first, but after seeing how well they work out I may consider using them depending on price and things."
"I just don't like the idea. Too many liability issues if the package doesn't get there or is damaged on delivery. I feel companies would be less likely to return my money to me even though it would be their fault."

These remarks affirm our finding about the importance of identifying users with personal innovativeness traits and encouraging them to become opinion leaders to help pass on opinions about the usefulness of drone delivery services to others.

Perceived usefulness had the largest impact on the user's intention to adopt drone delivery services based on our findings. This corroborates previous study where perceived usefulness had a direct positive effect on behavioral intention to adopt different technological services, such as mobile commerce (Kalinic & Marinkovic, 2016) and mobile instant messaging (Yoon, Jeong, & Rolland, 2015). The participants in this study considered drone delivery services to be useful mostly because of their fast delivery and convenience. The following comments confirm with our findings:

"From a business perspective, if I needed something ASAP (machine down, etc.), drone service would be beneficial."
"I would love 30min delivery!"
"Faster delivery."
"Get items quickly instead of having to wait or drive out to get them. Save Time!"
"It could be useful for time sensitive delivery."
"I would like to receive shipments sooner."
"You can get what you need with a short wait time."
"Convenient and fast delivery."
"Seems fast and convenient."

Perceived ease of use appeared not to be important to users without prior experience with using drone delivery services. When asked for their personal reasons why they would or would not adopt drone delivery services, most users emphasized usefulness, or expressed concerns about the services. The top positive reasons for the perceived usefulness included convenience, delivery speed, and the top negative reasons included security, noise, privacy, safety, price, and location. No users in our survey had comments directly related to the perceived ease of use for drone delivery services. Experience is

one of the best predictors for the perceived ease of use of technology (Abdullah et al., 2016). After experiencing various drone delivery services, users may be able to make a better judgment about the importance of perceived ease of use. However, the subjects in this study lacked prior experience and could not validate the assumption.

Although perceived ease of use might not have a direct effect on the user's intention to adopt drone delivery services, it had a significant influence on perceived usefulness. This indicates a strong mediation effect of perceived usefulness in the relationship between perceived ease of use and the adoption intention of drone delivery services. This finding corroborates previous study, where perceived ease of use was able to improve the perceived usefulness of food delivery apps (Eun-Yong et al., 2017). However, their joint effect shown in the adoption of other technologies was not present in the behavioral adoption of drone delivery services.

Theoretical Contributions

One major theoretical contribution of this study is to construct an integrative research model and to empirically test the impacts of the marketing (opinion passing), personality traits (personal innovativeness), and technology adoption (perceived ease of use and perceived usefulness) factors on the intention to use drone delivery services. All of these factors together were found to explain approximately 35% of the variance in the decision to use these delivery services. This finding is theoretically valuable in the context of drone delivery services while it indicates that other factors that could better explain the remaining larger variance need to be further explored.

Another theoretical contribution is that prior work has mainly emphasized both perceived ease of use and perceived usefulness as two important antecedents of technology adoption. This study departs such prior work and suggests that perceived usefulness rather than perceived ease of use is a more important technology adoption factor with respect to its influence on the intention to adopt drone delivery services.

Moreover, this study found that personal innovativeness is a salient factor having a direct effect on perceived usefulness, opinion passing, and behavioral intention. This confirms the importance of identifying innovative users as opinion leaders for increasing the intention to use drone delivery services. Effective opinion leaders are the best marketing choice as they can not only increase the velocity of the technological diffusion process, but also the maximum cumulative number of adopters (Cho, Hwang, & Lee, 2012). Users with the personal innovativeness trait not only have a strong intention to adopt these services, but also have the tendency to tell others about their usefulness. Recruiting effective innovative users as opinion leaders is one effective way to promote the adoption and diffusion of drone delivery service (Jingyuan & Salmon, 2018) and to reduce the time to reach a critical mass in the domain (Cho et al., 2012).

Contrary to general expectations about the importance of opinion passing as a marketing factor, and perceived ease of use as a technology adoption factor, the finding of this study suggests that they do not have a direct impact on the adoption of drone delivery services. At the early adoption stage of these services, it is imperative to improve the perceived usefulness of innovative users so that they can influence others, thereby increasing their intention to adopt the services.

Practical Contributions

This study offers practical insights into promoting the adoption of drone delivery services by identifying innovative users and improving their perception concerning their usefulness. First, as our findings show, it is a valuable strategy for firms to identify and to encourage innovative users (individuals with the high personal innovativeness trait) in both online and offline social communities to pass their positive opinions to others concerning their drone delivery services. Digital opinion leaders' persuasive messages, for instance, are effective in changing the attitudes of followers and influencing them in their adoption and purchasing decisions (Huhn Nunes, Sabino de Freitas, & Leão Ramos, 2018). These innovative users are not only early adopters but they also can help articulate the usefulness of drone delivery services to other users.

Most users in the study perceived the usefulness of drone delivery services as fast and convenient. Firms providing the services should explore methods to improve the user's perception of their usefulness as well as improving the perceived ease of use of the services.

Opinion passing is an important eWOM activity; however, its impact on the adoption of drone delivery services is not as salient as was expected. Firms may want to consider using

traditional word-of-mouth methods (e.g. hosting events, information sessions) (Chu & Kim, 2011a) to seek opinions and to provide feedback to prospective users of drone delivery services.

Limitations and Future Work

The findings of this study warrant careful interpretations because of certain limitations. First, the participants in the study were mostly students, even though they were encouraged to ask their family members to complete the same survey. Since the majority of the participants were students, the findings can be best generalizable to student users. Future research could recruit a larger sample size that represents different age and income groups. In this way, the findings could be more generalizable to the general population.

Second, all three factors (marketing, technology adoption, and personal innovativeness factors) examined in this paper could only explain 35.7 % of the variance in adoption intention of drone delivery services. Future research may want to explore other factors in the same areas or other relevant factors in other research areas. For instance, researchers can investigate whether traditional marketing methods and other technology adoption factors (e.g. perceived playfulness) can contribute to the remaining larger variance in the adoption of the intention to use drone delivery services. Some consumers are more concerned about the risk of a package being damaged by a drone even though it can be delivered quickly. Future research may want to focus on acceptance of drone delivery services from the risk/benefit perspective.

Third, drone delivery services vary with industries, and the users in the domains have different degrees of technology self-efficacy. All of these uncontrollable factors can possibly affect users' intention to adopt drone delivery services. Future work may want to divide a larger, general sample into different groups based on their technology self-efficacy and types of drone delivery services (e.g. delivering medical supplies, groceries, souvenirs, and food). Fourth, although innovative users can adopt drone delivery services themselves, passing their opinions on to others alone has no effect on the intention to adopt these services. WOM consists of three major elements: opinion seeking, opinion giving, and opinion passing. When these three elements work in concert, they can have a positive impact on the satisfaction level of users in the online community (Nagy, KemÉNy, SzŰCs, Simon, & Kiss, 2017). However, this study only investigated a single eWOM element: opinion passing. Future research may want to assess the relative and joint influence of these three essential WOM elements on the adoption intention of drone delivery services.

5. CONCLUSIONS

The demand for drone delivery services is growing as they have become more mature and their value propositions are attractive to not only business organizations but also users. In order to understand the driving factors in the adoption of drone delivery services, this study employed an interdisciplinary approach by combing marketing, technology adoption, and social network factors into an integrative research model.

Empirical survey data from 157 subjects examined the proposed hypotheses. The findings indicated that perceived usefulness had the largest impact on the intention to adopt drone delivery services, followed by personal innovativeness. In addition, personal innovativeness was found to play a central role not only in directly affecting the intention to adopt these delivery services, but also the users' perceived usefulness and opinion passing. These findings not only contribute to research on the adoption of drone delivery services, but also inform practitioners regarding the utilization of different methods to promote the use of drone delivery services.

6. REFERENCES

Abdullah, F., Ward, R., & Ahmed, E. (2016). Investigating the influence of the most commonly used external variables of TAM on students' Perceived Ease of Use (PEOU) and Perceived Usefulness (PU) of e-portfolios. *Computers in Human Behavior, 63*, 75-90. doi: 10.1016/j.chb.2016.05.014

Abyaomi, O. K. y. y. c., Evans, N. D. e. u. a. z., & Ocholla, D. N. O. u. a. z. (2017). FACTORS THAT INFLUENCE MEDICAL DOCTORS' BEHAVIOURAL INTENTION TO USE CLINICAL INFORMATICS. *Mousaion, 35*(1), 130-154. doi: 10.25159/0027-2639/2321

Chen, C.-C., & Tsai, J.-L. (2017). Determinants of behavioral intention to use the Personalized Location-based Mobile Tourism Application: An empirical study by integrating TAM with ISSM. *Future Generation Computer Systems*. doi: 10.1016/j.future.2017.02.028

Chin, W. W. (1998). The partial least squares approach to structural equation modeling. *Modern methods for business research, 295*(2), 295-336.

Chin, W. W. (2010). How to write up and report PLS analyses *Handbook of partial least squares* (pp. 655-690): Springer.

Cho, Y., Hwang, J., & Lee, D. (2012). Identification of effective opinion leaders in the diffusion of technological innovation: A social network approach. *Technological Forecasting & Social Change, 79*, 97-106. doi: 10.1016/j.techfore.2011.06.003

Chowdhury, S., Emelogu, A., Marufuzzaman, M., Nurre, S. G., & Bian, L. (2017). Drones for disaster response and relief operations: A continuous approximation model. *International Journal of Production Economics, 188*, 167-184. doi: 10.1016/j.ijpe.2017.03.024

Chu, S.-C., & Kim, Y. (2011a). Determinants of consumer engagement in electronic word-of-mouth (eWOM) in social networking sites. *International Journal of Advertising: The Quarterly Review of Marketing Communications, 30*(1), 47-75. doi: 10.2501/IJA-30-1-047-075

Chu, S.-C., & Kim, Y. (2011b). Determinants of consumer engagement in electronic word-of-mouth (eWOM) in social networking sites. *International journal of Advertising, 30*(1), 47-75.

Daştan, İ., & Gürler, C. (2016). Factors Affecting the Adoption of Mobile Payment Systems: An Empirical Analysis. *EMAJ: Emerging Markets Journal, 6*(1), 16-24. doi: 10.5195/emaj.2016.95

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: a comparison of two theoretical models. *Management science, 35*(8), 982-1003.

Eun-Yong, L. E. E., Soo-Bum, L. E. E., & Yu Jung Jennifer, J. (2017). FACTORS INFLUENCING THE BEHAVIORAL INTENTION TO USE FOOD DELIVERY APPS. *Social Behavior & Personality: an international journal, 45*(9), 1461-1473.

Fornell, C., & Bookstein, F. L. (1982). Two Structural Equation Models: LISREL and PLS Applied to Consumer Exit-Voice Theory. *Journal of Marketing Research (JMR), 19*(4), 440-452.

Fornell, C., & Larcker, D. F. (1981). Structural equation models with unobservable variables and measurement error: Algebra and statistics. *Journal of marketing research*, 382-388.

Fred D. Davis, a., Richard P. Bagozzi, a., & Paul R. Warshaw, a. (1989). User Acceptance of Computer Technology: A Comparison of Two Theoretical Models. *Management science*(8), 982.

Genius, M., Koundouri, P., Nauges, C., & Tzouvelekas, V. (2014). Information Transmission in Irrigation Technology Adoption and Diffusion: Social Learning, Extension Services, and Spatial Effects. *American Journal of Agricultural Economics, 96*(1), 328-344. doi: https://academic.oup.com/ajae/issue

Gilchrist, K. (2017). World's first drone delivery service launches in Iceland. Retrieved August 6, 2018, from https://www.cnbc.com/2017/08/22/worlds-first-drone-delivery-service-launches-in-iceland.html

Godinho de Matos, M., Ferreira, P., & Krackhardt, D. (2014). PEER INFLUENCE IN THE DIFFUSION OF IPHONE 3G OVER A LARGE SOCIAL NETWORK. *MIS quarterly, 38*(4), 1103-A1115.

Hair, J. F., Sarstedt, M., Pieper, T. M., & Ringle, C. M. (2012). The use of partial least squares structural equation modeling in strategic management research: a review of past practices and recommendations for future applications. *Long range planning, 45*(5-6), 320-340.

Henkel, J., & Block, J. (2013). Peer influence in network markets: a theoretical and empirical analysis. *Journal of Evolutionary Economics, 23*(5), 925-953. doi: 10.1007/s00191-012-0302-4

Henseler, J., Ringle, C. M., & Sinkovics, R. R. (2009). The use of partial least squares path modeling in international marketing *New*

challenges to international marketing (pp. 277-319): Emerald Group Publishing Limited.

Hong, J.-C., Hsieh, P.-C., & Lin, P.-H. - The effect of consumer innovativeness on perceived value and continuance intention to use smartwatch.

Hong, J.-C., Hsieh, P.-C., & Lin, P.-H. (2017). - The effect of consumer innovativeness on perceived value and continuance intention to use smartwatch. *Computers in Human Behavior, 67*, 264-272.

Hsiu-Mei, H., & Shu-Sheng, L. (2018). An Analysis of Learners' Intentions Toward Virtual Reality Learning Based on Constructivist and Technology Acceptance Approaches. *International Review of Research in Open & Distance Learning, 19*(1), 91-115.

Huang, C.-C. (2017). Cognitive factors in predicting continued use of information systems with technology adoption models. *Information Research, 22*(2), 1-29.

Huhn Nunes, R., Sabino de Freitas, A., & Leão Ramos, F. (2018). The effects of social media opinion leaders' recommendations on followers' intention to buy. *Revista Brasileira de Gestão de Negócios, 20*(1), 57-73. doi: 10.7819/rbgn.v20i1.3678

Hulland, J. (1999). Use of partial least squares (PLS) in strategic management research: A review of four recent studies. *Strategic management journal*, 195-204.

Ifinedo, P., Pyke, J., & Anwar, A. (2018). Business undergraduates' perceived use outcomes of Moodle in a blended learning environment: The roles of usability factors and external support. *Telematics and Informatics, 35*, 93-102. doi: 10.1016/j.tele.2017.10.001

Jennings, E., Arlikatti, S., & Andrew, S. - Determinants of Emergency Management Decision Support Software Technology: An Empirical Analysis of Social Influence in Technology Adoption.

Jingyuan, S., & Salmon, C. T. (2018). Identifying Opinion Leaders to Promote Organ Donation on Social Media: Network Study. *Journal of Medical Internet Research, 20*(1), 16-16. doi: 10.2196/jmir.7643

Kalinic, Z., & Marinkovic, V. (2016). Determinants of Users' Intention to Adopt M-Commerce: An Empirical Analysis. *Information Systems and e-Business Management, 14*(2), 367-387. doi: https://link.springer.com/journal/volumesAndIssues/10257

Koshner, E. L. (1997). A Market-Focused and Customer-Driven Approach to Growth. *Human Resource Planning, 20*(2), 9-14.

Kulviwat, S., Bruner Ii, G. C., Kumar, A., Nasco, S. A., & Clark, T. (2007). Toward a unified theory of consumer acceptance technology. *Psychology & Marketing, 24*(12), 1059-1084.

Kwak, D., & Kim, W. (2017). Understanding the process of social network evolution: Online-offline integrated analysis of social tie formation. *PLoS ONE, 12*(5), 1-16. doi: 10.1371/journal.pone.0177729

Lin, C. A., Shah, K., Mauntel, C., & Shah, S. A. (2018). Drone delivery of medications: Review of the landscape and legal considerations. *American Journal of Health-System Pharmacy, 75*(3), 153-158. doi: 10.2146/ajhp170196

Lu, J. (2014). Are personal innovativeness and social influence critical to continue with mobile commerce? *Internet Research*(2), 134. doi: 10.1108/IntR-05-2012-0100

Luigi, D., Oana, S., Mihai, T., & Simona, V. (2011). PURSUING A CUSTOMER-DRIVEN APPROACH FOR INNOVATION AND MARKETING EXCELLENCE. *Studies in Business & Economics, 6*(2), 19-26.

Mary, F., Carol, K., & Vivek, P. (2012). Exploring the adoption of a virtual reality simulation : The role of perceived ease of use, perceived usefulness and personal innovativeness. *Campus-Wide Information Systems*(2), 117. doi: 10.1108/10650741211212368

Nagy, A., KemÉNy, I., SzŰCs, K., Simon, J., & Kiss, V. (2017). ARE OPINION LEADERS MORE SATISFIED? RESULTS OF A SEM MODEL ABOUT THE RELATIONSHIP BETWEEN OPINION LEADERSHIP AND ONLINE CUSTOMER SATISFACTION. *Society & Economy, 39*(1), 141.

Ozturk, A. B., Nusair, K., Okumus, F., & Hua, N. (2016). The role of utilitarian and hedonic

values on users' continued usage intention in a mobile hotel booking environment. *International Journal of Hospitality Management, 57*, 106-115. doi: 10.1016/j.ijhm.2016.06.007

Pasztor, A. (2018). Coming Soon to a Front Porch Near You: Package Delivery Via Drone. from https://www.wsj.com/articles/coming-soon-to-a-front-porch-near-you-package-delivery-via-drone-1520798822

Rahman, M. M., Lesch, M. F., Horrey, W. J., & Strawderman, L. (2017). Assessing the utility of TAM, TPB, and UTAUT for advanced driver assistance systems. *Accident Analysis and Prevention, 108*, 361-373. doi: 10.1016/j.aap.2017.09.011

Ritu, A., & Jayesh, P. (1998). A Conceptual and Operational Definition of Personal Innovativeness in the Domain of Information Technology. *Information systems research*(2), 204.

Rogers, E. M. (1983). *Diffusion of innovations*: New York : Free Press ; London : Collier Macmillan, c1983.
3rd ed.

Rosaline, S., & Wesley, J. R. (2017). Factors Affecting Students' Adoption of ICT Tools in Higher Education Institutions: An Indian Context. *International Journal of Information and Communication Technology Education, 13*(2), 82-94.

Sánchez-Mena, A. a. s. u. e., Martí-Parreño, J. j. m. u. e., & Aldás-Manzano, J. j. a. u. e. (2017). The Effect of Age on Teachers' Intention to Use Educational Video Games: A TAM Approach. *Electronic Journal of e-Learning, 15*(4), 355-365.

Shana, Z. z. y. c., & Abulibdeh, E. S. e. g. c. (2017). Cloud Computing Issues for Higher Education: Theory of Acceptance Model. *International Journal of Emerging Technologies in Learning, 12*(11), 168-184. doi: 10.3991/ijet.v12.i11.7473

Sim, L. L., & Koi, S. M. (2002). Singapore's Internet shoppers and their impact on traditional shopping patterns. *Journal of Retailing and Consumer Services, 9*(2), 115-124.

Thakur, R., Angriawan, A., & Summey, J. H. (2016). Technological opinion leadership: The role of personal innovativeness, gadget love, and technological innovativeness. *Journal of Business Research, 69*, 2764-2773. doi: 10.1016/j.jbusres.2015.11.012

Tubaishat, A. (2017). Perceived usefulness and perceived ease of use of electronic health records among nurses: Application of Technology Acceptance Model. *Informatics For Health & Social Care*, 1-11. doi: 10.1080/17538157.2017.1363761

Vannoy, S. A., & Palvia, P. (2010). The Social Influence Model of Technology Adoption. *Communications of the ACM, 53*(6), 149-153. doi: 10.1145/1743546.1743585

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS quarterly*, 425-478.

Wang, Y., Hsiao, S.-H., Yang, Z., & Hajli, N. (2016). The impact of sellers' social influence on the co-creation of innovation with customers and brand awareness in online communities. *Industrial Marketing Management, 54*, 56-70. doi: 10.1016/j.indmarman.2015.12.008

Whittaker, S. (2018). Alibaba's Ele.me Starts Food Delivery by Drone in Shanghai First. Retrieved August 6, 2018, from https://dronebelow.com/2018/05/30/world-first-alibaba-eleme-food-delivery-drone-shanghai/

Yoon, C., Jeong, C., & Rolland, E. (2015). Understanding individual adoption of mobile instant messaging: a multiple perspectives approach. *Information Technology & Management, 16*(2), 139-151. doi: 10.1007/s10799-014-0202-4

Appendix.1: Constructs and Items

Construct	Item	Source
Opinion Passing (OP)	When I receive product related information or opinion from a friend, I will pass it along to my other contacts on social networks (0.893) On social networks, I often influence my contacts' opinions about products (0.735) I like to pass along interesting information about products from one group of my contacts on my 'friends' list to another on social networks (0.855)	(Chu & Kim, 2011b)
Perceived Ease of Use (PEOU)	It is easy for me to become skillful in using drone delivery service (0.847) I find drone delivery service easy to use (0.915) I find it easy to use drone delivery service to do what I want it to do (0.877) Learning to use drone delivery service is easy for me (0.869)	(Davis, Bagozzi, & Warshaw, 1989)
Perceived Usefulness (PU)	Using drone delivery service enhances my daily productivity (0.838) I find drone delivery service useful in my daily activities (0.852) I believe drone technology would make my life easier (0.829) I believe drones can deliver packages to me faster than other forms of transportation (0.704)	(Davis et al., 1989)
Personal Innovativeness (PI)	I often try new brands before my friends and neighbors do (0.894) When I see a new brand on the shelf, I often buy it to see what it is like (0.893)	(Sim & Koi, 2002)
Behavioral Intention (BI)	I intend to use a drone delivery service in the next months (0.850) I predict I would use a drone delivery service in the next months (0.864) I will try to use a drone delivery service in my daily life (0.954)	(Venkatesh, Morris, Davis, & Davis, 2003)