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A Risk Perspective

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WHAT IMPEDES CONSUMERS' DELIVERY DRONE SERVICE ADOPTION? A RISK PERSPECTIVE

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Technical Report

Despite widespread plans of big companies like Amazon and Google to develop unmanned delivery drones, scholarly research in this field is scarce, especially in the information systems field. From technical and legal perspectives, drone delivery in last-mile scenarios is in a quite mature state. However, estimates of user acceptance are varying between high skepticism and exaggerated optimism. This research follows a mixed method approach consisting both qualitative and quantitative research, to identify and test determinants of consumer delivery drone service adoption. The qualitative part rests on ten interviews among average consumers, who use delivery services on a regular basis. Insights gained from the qualitative part were used to develop an online survey and to assess the influence of associated risks on adoption intentions. The quantitative results show that especially financial and physical risks impede drone delivery service adoption. Delivery companies who are currently thinking about providing a delivery drone service may find these results useful when evaluating usage behaviors in the future market for delivery drones.

Keywords: Mixed method, drone, delivery drone, technology acceptance model, risks

NOTE: This document represents research in progress and is an early version that has not yet undergone a rigorous review process. It also has not yet been professionally copy-edited. All errors are our own.

1 Introduction

The logistic market is facing new challenges and requirements through digitalization and the continuously growing e-commerce sector. For example, in 2019, retail e-commerce sales worldwide amounted to 3.53 trillion US dollars (Statista 2019a). Statistics further propose that, for example, in Germany alone, about 4.3 billion parcels will be shipped yearly (Statista 2019b). Postmen and postwomen are more and more struggling to deliver parcels in a proper, service-orientated and customer-friendly way. Consequences are delayed or damaged parcels, stressed employees and angry customers. On the other hand, also the customer expectations are continuously increasing. Customers expect better availability of the offered products, which can only be guaranteed with a quick delivery to every front door. In addition to that, also the general constant research for cost and time reducing innovations at logistic and e-commerce companies drives the search for new alternatives to deliver parcels from the factory to the customer's door. According to Nozick and Turnquist (2000), it is very important to keep the costs to a minimum level to be competitive enough to survive in the tough logistic and e-commerce market.

Probably the most innovative of all current alternative delivery methods are delivery drones, which are supposed to deliver parcels by air (Finn & Wright 2012). Drones offer many advantages over the current truck delivery such as lower emissions, lower maintenance cost and faster delivery. The required technique is already in a late developing stage (Lee et al. 2016). Problems for a more widespread and general use of delivery drones are still related to some final technical details as well as regulations, which restrict the possibilities of area-wide drone usage (Feil 2013).

Once remaining technical and regulative issues have been solved, the success of drone delivery services will be based upon user acceptance in the context of specific business models. While some notable research on drone delivery in general (e.g., Bambury 2015) and drone delivery adoption in particular (e.g., Khan et al. 2019; Yoo et al. 2018) exists, the current discourse lacks at least two aspects: First, the adoption-related studies focus almost exclusively on the technology acceptance model (TAM) and remain silent on a drone-specific risks, and second, no study provides a European focus. To this end, this study uses a mixed method approach, which means the research addresses key question by both quantitative and qualitative methods, to identify and quantify possible barriers to drone delivery service acceptance on end user side. In particular, the aim of the qualitative part is to examine risk-related factors that affect consumer acceptance of delivery drones (Wiedmann et al. 2011). The quantitative part then assesses relative differences in how risk perceptions influence adoption intentions. For the qualitative study, ten German online consumers were interviewed. With the gained data it was possible to develop eight hypotheses, which rest – as other studies in the field – on TAM, but which were enriched by an overarching risk perspective. For the quantitative part, an online survey was used.

The contribution of this research therefore is 1) a TAM-based theoretical model that explains drone delivery service adoption through a risk-assessment lens and 2) a quantitative assessment of influences of different risk types and other drone-specific and delivery-specific factors on adoption intention. The results are useful for theory development at the intersection of TAM and risk research, as well as designing drone delivery business models.

2 Theoretical background

2.1 Definition and literature on delivery drones

Drones are officially called *Unmanned Aircraft* (UA) by the European Union (Schrader 2017, p. 378). In the pertinent literature, we also find descriptions like *Unmanned Aircraft Vehicle* (UAV) (Finn & Wright 2012) or *Unmanned Aerial System / Unmanned Aircraft System* (UAS) (Clarke 2014). Many definitions can be found in the literature, too. One suitable working definition would be the following: drones are “unmanned aircrafts, that can fly autonomously” (Villasenor 2012). The term drone was first used by the US Navy in 1935 (Clarke 2014) and for a very long time, drone usage was only restricted to military purposes (Bischof 2017). Due to multiple investments, drones became cheaper and better, which made it possible for many people and companies to buy drones for non-military purposes. Nowadays, drones are used in the agricultural sector, for example, to fertilize big areas or to control hard to access wine hills. Drones are also used by police and fire departments, to get an overview about emergency situations as well as by modern film production companies, which are able to shoot movies in new angles (Bischof 2017). Bamburry (2015) further talks about a study from the *Association for Unmanned Vehicle Systems International (AUVSI)* out of the *Forbes Magazine*, which came to the conclusion that by the time of 2025, the drone industry will make about 82 billion dollars sales.

The competition for the fastest, safest and most reliable delivery drone model started a long time ago already. In 2013, Amazon CEO Jeff Bezos announced the development of *Prime Air*, a drone, which is supposed to carry up to 2.5-kilogram parcels within 30 minutes from the depot to the customer (Tagesschau Online 2018). In 2016, Prime Air was first tested in Cambridge. The participating customer received his Fire-TV Box and a box of popcorn 13 minutes after his online order. Since then, Prime Air is back in Amazons developing center and did not get launched so far (Tagesschau Online 2018).

After Amazons announcement, also other big players and StartUps started working on their own delivery drone. Also in 2013, the German logistic company Deutsche Post DHL tested their *Parcelcopter* for the first time over the river Rhine in Bonn (Dorling et al. 2017). In 2014, the *Parcelcopter* managed to transport medicine in urgent situation from the German mainland to the island of Juist (Deutsche Post Online 2019). Two years later, in 2016, the Parcelcopter was tested in the Bavarian Alps and managed to carry medicine and sporting good under difficult circumstances from the valley to the mountain (Deutsche Post DHL 2019). Since 2018, Deutsche Post DHL runs a pilot test with the drone company *Wingcopter*, where drones provide medicine for a remote island in the middle of the African Lake Victoria. The distance of 60 kilometers could be bridged in about 40 minutes.

Since 2014, it is known that also *Google* is developing a delivery drone, called *Project Wing,* with a testing center in Queensland. The aim of this drone is to deliver medicine and defibrillators in urgent situations (Bamburry 2015). In 2016, Project Wing started to provide students in Virginia with Burritos via drone delivery (Project Wing 2019a). Project Wings greatest success so far is the permission to transact regular commercial drone flights in the area of Canberra, after a successful 18-month test period (Project Wing 2019a). At the same time, Google announced that another testing area will be installed in 2019 in Helsinki, where citizens are able to order food, medicine and small emergency goods as for example diapers and ice scrapers (Project Wing 2019b).

Also UPS, an American logistic company, started to work on a delivery drone in 2013 (Bamburry 2015). UPS is working on a model which integrates drone delivery in the ordinary delivery by trucks. Therefore, UPS ordered 18 new electronic trucks with an integrated landing field on the roof. According to Business Insider Deutschland (2017), mailmen are supposed to provide the drones on the roof with a parcel and are able to continue doing their job afterwards. While the mailmen are supposed to follow their original job, the drone is supposed to fly to the given address meanwhile, drop the parcel and find the way back to the truck, which changed the position during that time. Moreover, the drone is also supposed to get charged while waiting on the roof for the next order. Successful tests were held in Florida in 2017 (Business Insider 2017).

In addition to the previous mentioned big companies, also a bunch of other smaller companies and institutions are interested in delivery drones. Both the Swiss- and Australian Post announced first tests in the past, as well as the Arabic Emirates, who plan to deliver official government documents as permits and ISs via drones (Cuthbertson 2016; Dorling et al. 2017). Even the fast food industry is interested in a revolution of the food delivery: Start Up´s in the Silicon Valley for example are working on the *Burrito Bomber* and the *TacoCopter*, which are supposed to deliver burritos and tacos to the customer. Also the pizza-chain dominos already developed the drone prototype *DRU*, which is supposed the deliver pizza in the future (Bamburry 2015).

In addition to all the testing and developing companies, some developing teams managed to be even one step further. The DPDgroup is transacting a regular, 15-kilometer distanced drone flights to a remote entrepreneur center since 2016. The drone is able to carry parcels up to 3 kilogram. Furthermore, both in Zürich and in Lugano, drones deliver blood samples between hospitals, the university and laboratories (ZDF Heute Online 2018; Müller 2019). Table 1 summarizes major steps in drone delivery research and development.

Date	Event
2011	
July	*TacoCopter*-idea is published on a website
2012	
December	*Burritobomber*-idea is published with a promotion video
2013	
October	Delivery drone Start-up *Flirtey* is founded
December	Announcement of *Amazon Prime Air* with the promise to launch within 5 years
December	First tests of the Parcelcopter in Bonn, Germany with *Deutsche Post DHL*
December	*UPS* admits after an inquiry, to be interested in delivery drones
2014	
February	*United Arab Emirates* announce plan to use delivery drones to transport government documents
August	Plans of *Project Wing* by *Google X* and already taken tests are being published
September	*Deutsche Post DHL* starts pilot project with drone flights from the German mainland to the island of Juist
2015	
February	*UPS* orders 18 electronic delivery trucks with included drone landing field on the roof
2016	
May	*Deutsche Post DHL* starts testing the *Parcelcopter* in the Bavarian Alps
July	First ever commercial drone flight in the US by *Flirtey* in cooperation with *7Eleven*
August	Announcement of the cooperation between *Domino´s Pizza* and *Flirtey*
September	*UPS* tests drones in Massachusets, United States
September	*Project Wing* starts delivering Burritos to students in Virginia, United States

November	First ever Pizza delivery by Dominos in New Zealand
December	*DPDgroup* starts worldwide first commercial delivery drone flight in France
December	Maiden flight of *Amazons Prime Air* in Cambridge, United Kingdom
2017	
February	*UPS* tests for the first time the new trucks with drones
March	Tests with drone *Frida*, which is supposed to transport blood samples in Lugano, Switzerland
April	*Project Wing* starts testing the transport of medicine and food in Canberra, Australia
2018	
October	*Deutsche Post DHL* starts project to transport medicine from Mainland to *Lake Victoria* in Africa
December	Originally announced deadline of launching *Amazon Prime Air*
December	Project-start to transport blood samples in Zurich, Switzerland
December	*Project Wing* announces tests in and around Helsinki, Finland
2019	
April	Authorities in Canberra permit Project Wing a regular business
May	Kick off for a regular drone delivery by DHL Express in Guangzhou, China 2nd drone crash in Switzerland, close to playing kids

Table 1 History of the delivery drone[1]

2.2 Related work

Academic research conducted to understand potential user reaction to delivery drones is scarce. We searched in multiple academic databases such as Google Scholar, EconLit and Nexis Uni for peer-reviewed articles in academic journals and international conferences. Search terms included *delivery drone adoption, parcel drone*, *logistic drone* and various alternative terms and spellings.

[1] Bamburry, D. (2015). Drones: Designed for product delivery. *Design Management Review*, *26*(1), 40-48.

Dorling, K., Heinrichs, J., Messier, G. G., & Magierowski, S. (2017). Vehicle routing problems for drone delivery. *IEEE Transactions on Systems, Man, and Cybernetics: Systems*, *47*(1), 70-85.

DPDHL (2018). DHL Paketkopter. URL: https://www.dpdhl.com/de/presse/specials/dhl-paketkopter.html [Last access: 2019/10/21].

Wing (2019 a). Wing in Australia. URL: https://wing.com/australia/canberra/ [Last access: 2019/10/21].

Wing (2019 b). Wing in Helsinki. URL: https://wing.com/finland/helsinki/ [Last access: 2019/10/21].

Tagesschau Online (2018). Amazon und sein Prime Air. URL: https://www.tagesschau.de/wirtschaft/boerse/amazon-drohne-101.html [Last access: 2019/10/21].

General studies on drone delivery			
Study	*Research Question*	*Research Design*	*Core Findings*
Dorling et al. (2016)	Developing vehicle routing problems (VRPs) specifically for drone delivery scenarios	Mathematically derive and experimentally validate an energy consumption model, derive mixed integer linear programs	Optimizing battery weight and reusing drones are important to keep costs low and deliver fast
Ferrandez, et al. (2016)	Investigate the notion of the reduced overall delivery time and energy of a truck-drone network	Comparing in –tandem system with a stand-alone delivery effort. K-means clustering Hybrid Newton method	Improvements with in-tandem delivery efforts Multiple drones per truck save both energy and time
Hong et al. (2017)	Developing a new coverage model that can optimize location of recharging stations for delivery drones	Euclidean shortest path (ESP)	Effective model for construction of drone delivery network that covers large urban areas
Lee (2017)	What is the potential value of introducing modular design to a drone delivery system	Simulation of two scenarios – with and without modular drones	Modular drones can save delivery time and energy consumption
Sanjab et al (2017)	Introducing a mathematical framework for analyzing and enhancing the security of drone delivery	Formulation of a zero-sum network inderdiction game	The subjective decision making of the vendor and attacker leads to adopting risky path selection strategies
Shavarani et al. (2018)	Finding the optimal number and locations of launch and recharge stations with the objective of minimizing the total costs of the system	Euclidean shortest path (ESP) alogrithm	For the City San Francisco, 22 recharge stations are necessary
Key studies on delivery drone adoption			
Khan et al. (2018)	Gauge the acceptance of drone delivery in the Pakistani urban consumer market	Online survey (n=307), Pakistan	Consumers perceive privacy issues
Ramadan et al. (2016)	Understanding consumer acceptance of drone technology	conceptual	Service quality is core risk/driver
Yoo et al. (2018)	Exploring the factors affecting attitudes to drone delivery service and intention to adopt	Online survey (n=296), USA	Personal innovativeness positively affects adoption Speed and environmental friendliness positively affect adoption Complexity, performance risk, privacy risk negatively affect adoption

Table 2 Previous research on delivery drones

While general content about delivery drones could be found easily, papers about delivery drone adoption were both rare and from countries such as the USA and Pakistan. Articles with a European focus could not be found. Table 2 provides an (non-exhaustive) overview of general studies on drone delivery as well as an overview of adoption- and acceptance-related studies.

Overall, extant studies about consumer adoption of delivery drones found that the privacy risk, which means to divulge sensitive data, is a major concern for accepting the drone delivery technology. Except the work of Khan et al. (2018), the studies reported that potential delivery drone users also see concerns in safety and performance risks. The fear of crashing drones and the following danger of getting injured or loose personal belongings thus also has an influence on the adoption intention. In addition to that, Yoo et al. (2018) found connections between the level of adoption intention and personal innovativeness as well as the area of residence. Furthermore, Yoo et al. (2018) reports that speed and the environmental friendliness are major reasons for consumers to adopt delivery drone technology.

3 Research

In this research, we followed a mixed method approach, which includes a qualitative as well as a quantitative research component. A huge advantage of that approach is the ability to examine a research question from different perspectives and to overcome disadvantages from both research methods. Following common practice in qualitative research (Morgan 1998), we first conducted interviews in person, with chosen people in order to examine different perceptions of risks and benefits of drone delivery. An interview guide was used, but mostly the interviews were led freely. We ended up interviewing ten online consumers in different living situations. Every interview lasted approximately ten minutes. All the interviews were transcribed and content analysis (with both in vivo and axial coding; Saldaña 2015) was applied to identify recurring themes in the interview transcripts. With the results of the interviews in mind, an online survey was sent out, which was answered by 211 respondents.

3.1 Qualitative research

All participants were Germans between 19 and 65 years old with 7 male and 3 female. Seven of them claimed ecological consumption to be important while three didn’t have an opinion about that. Almost everyone (nine people) prefers to receive the parcel at his or her front door and four people claimed to be an innovative person. The approximate money spending on online shopping went from less than hundred to more than thousand Euros per year. The ten interviews were recorded and written down immediately afterwards. Both the interviewer and another author, who was not involved in the data collection, read the transcripts and used labels to identify emerging topics and concepts and discussed the outcome afterwards. As a result, various factors which are closely related to prior research in delivery drone technology as well as new factors were found.

3.2 Qualitative research findings

With the qualitative study, we were able to get a first overview about the risks and benefits, potential adopters of delivery drones do perceive. Throughout all interviews with our participants, skepticism was perceptible. Especially when we asked what kind of risk they fear about using a drone as a shipping method for the parcel, we noticed upcoming barriers.

Almost every interviewee reported seeing a big physical risk with delivery drones. With physical risk, the interviewees were talking about the risk of a drone crashing down which can cause dangerous injuries for both human beings and animals as well as big damage to cars or other valuable belongings. Also the scenarios for a drone crash were discussed and multiple reasons came out. Besides technical issues, also criminal activities like hackers manipulating the software and people shooting at drones or a collision of drones from different companies were often mentioned as potential reasons for a crash. Another important issue we could find was loss risk, which means the fear to lose the ordered parcel due to an incorrect GPS signal. Another major concern was a financial risk. People fear to spend more money for using a drone instead of using the known delivery truck. Also data risk was developed as a big issue. Data risk stands for divulging sensitive data, which would keep private, if another shipping method was used. Apart from these four major issues, many more risks came up like noise risk, harassment risk, spy risk, damage risk, job risk, optical risk, liability risk and consume risk. The quantity of mentions made us concentrate only on the four first mentioned risks. Table 3 depicts every mentioned risk, including the most important quotes and the number of codes.

Perceived delivery drone risk	**Number of Codes**	**Key Quotes**
Physical risk	10 of 32 (31.25%)	I fear that drones will crash due to technical errors or due to manipulation by criminals (23 y.o. / female) Delivery drones will be targets for criminals or bored teenager. A crash can cause a lot of damage and injure human beings and animals badly (23 y.o. / male) Especially when a lot of drones from a lot of different companies are flying around, a collision becomes possible (65 y.o. / male)
Loss risk	5 of 32 (15.625%)	It is possible that the drone delivers the parcel to the wrong place. What happens then? (63 y.o. / male)
Financial risk	4 of 32 (12.5%)	I believe that companies will let us pay more for this service (27 y.o. / male)
Data risk	4 of 32 (12.5%)	A drone that flies in my garden has the opportunity to film everything, including the inside of my home through the windows. I don't want to give out these kind of information (33 y.o. / female)
Noise risk	2 of 32 (6.25%)	The new and strange noises in the air will be very annoying (24 y.o. /male)
Further risk categories mentioned: Harassment risk, Spy risk, Damage risk, Job risk, Optical risk, Liability risk, Consume risk		

Table 3 Qualitative research findings

3.3 Hypotheses

The success of new technology is mainly determined by users' adoption intention and subsequent acceptance (Heidenreich et al. 2017). Both in the past and the present, the big and permanent challenge for companies was and is finding factors, which encourage potential customers to purchase the product. After many decades of research, a bunch of theories and models to predict how and why customer adopt information technology, were published (King & He 2006; Venkatesh et al. 2003).

One of the most discussed and used model (see Gillenson & Sherrell 2002), due to its simplicity and comprehensibility (King & He 2006), is the Technology Acceptance Model (TAM) by Fred D. Davis (1986). Scientific investigations found, that the TAM indeed is able to predict the intention of adopting information technology better than other models. As TAM can be applied to various contexts and can be extended with various exogenous factors (King & He 2006), we build our conceptual model around the basic tenet of TAM. At the core, TAM specifies perceived ease of use and perceived usefulness as dominant drivers of technology acceptance. As other TAM research (see Hein et al. 2018), we enriched our model by a set of risk-related factors. Here, we used the four main risk categories found in the qualitative prestudy. Furthermore, based on pretest feedback, we further integrated additional adoption related factors such as social influence, prior drone-related knowledge, and attitude towards social interaction. The resulting conceptual model is depicted in Figure 1.

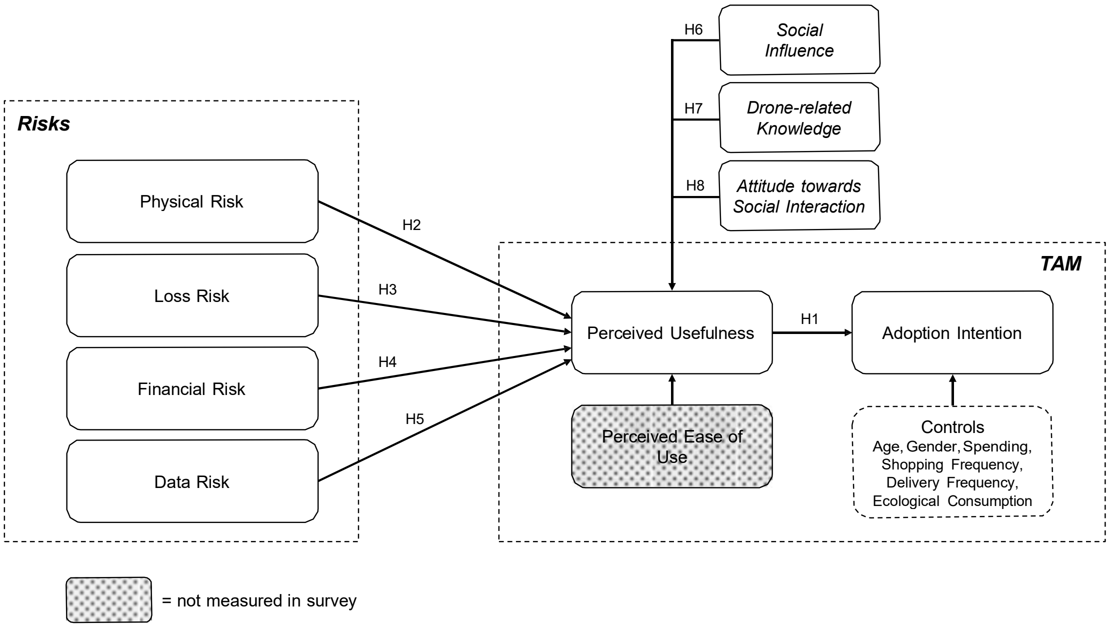

Figure 1 *Conceptual model*

The first hypothesis repeats the basic TAM tenet that once a technology is perceived as useful, individuals also possess a high adoption intention (e.g. Dwivedi et al. 2019; Legris et al. 2003; Tarhini et al. 2015). According to TAM, adoption intention is also a function of perceived ease of use. However, we felt that – in contrast to other studies (e.g. Hein et al. 2018) – perceived ease of use cannot be accurately assessed by respondents without ever having used a drone. We therefore decided to only capture perceived usefulness in our questionnaire (see Figure 1). The first hypothesis therefore states:

H1: Perceived usefulness is positively related to adoption intention.

Literature shows that consumers are more interested in reducing potential risks then to increase the usefulness of an innovation (Mitchell 1999). Thus, the consumer behaviour is highly influenced by the individual perceived risk, because consumers are often uncertain and unexplained about potential risks (Bauer et al. 2005). The physical risk aspect is about concerns about the consumer health or the health of other human beings or animals (Nelson 2002). In this specific case, also the damage of valuable personal belongings, for example cars, is included in the physical risk aspect. In our qualitative research we found, that this risk develops from the general possibility of a drone crash. A drone that crashes on a human being or an animal can cause serious injuries while a drone crashing into a valuable personal belonging can cause an expensive damage. This risk aspect becomes even more popular due to the various possibilities of reasons for a drone crash. For example, besides technical issues, a drone crash can also be caused by criminals, who can either shoot the drone down or hack themselves into the system, to let the drone fly into whatever they want. Thus we imagine that:

H2: Physical risk is negatively related to perceived usefulness.

The loss risk aspect reflects the concern of losing the delivered parcel. As we found out in our quantitative research, potential consumer fear that drones might not find the supposed deliver place and deliver the parcel to an unknown place.

H3: Loss risk is negatively related to perceived usefulness.

In our previous accomplished qualitative research we found out, that potential consumers fear to pay more for the shipping service by drone than they are used to by truck. As long as it remains unknown how much the shipping cost will be for a drone delivery in the future, this perceived risk will continue to exist. Boone and Ganeshan (2013) found out that high shipping costs often lead to a decreasing order frequency and a lower order value.

H4: Financial risk is negatively related to perceived usefulness.

In the literature it is known for a long time already, that the use of a new technology is often linked with perceived risks to individual users. Another risk, which comes up quite often in the literature, is about data related issues or privacy concerns (Collier 1995). Collier (1995) pointed out, that a privacy concern "is about the perceived threat to our individual privacy owing to the staggering and increasing power of information-processing technology to collect vast amounts of information about us…outside our knowledge, let alone our control". As 12.5% of the mentioned risks in our previous qualitative research were about privacy concerns, we propose that:

H5: Data risk is negatively related to perceived usefulness.

Past research found out that certain technologies are believed to project a specific image of their consumers (Golob et al. 1997). In a process of consumption stereotyping, other people interpret the meaning of a delivery drone for example and draw a conclusion about its consumer (Ligas 2000). Thus, we believe that potential delivery drone user will use this service to swagger and to get a better social status. We expect that:

H6: Social Influence is positively related to perceived usefulness.

A general psychological attribute of consumer acceptance is the existing knowledge about the technology itself. The existing knowledge affects the cognitive processes which are linked to a consumer´s decision and is therefore also a major determinant of the user acceptance. The ability to understand the features und usage of a specific innovation is determined by a consumers existing knowledge (Moreau et al. 2001). With a higher level of existing knowledge about the product itself or a product similar to it, the innovation is perceived less complex (Sheth 1968). Especially when the innovation is completely unknown by the consumer, a lot of risks will be perceived (Wu & Wang 2004).In this case, knowledge about drones in general could help to overcome perceiving risks and to appreciate the service in a better way. Thus we expect that:

H7: Drone-related knowledge is positively related to perceived usefulness.

Our last hypothesis wasn't part of our previous qualitative research. After a discussion among the authors, and based on pretest feedback, another determinant which might also has an influence on the perceived usefulness was integrated. We believe, that the social interaction with the postmen or the postwomen, who deliver the parcel, or the person who is sitting behind the counter in a delivery shop is well appreciated (Schaarschmidt & Höber 2017). In conclusion, the loss of these social interactions, while using the delivery drone service, might stop people from adoption. We expect that:

H8: Attitude towards social interaction is negatively related to perceived usefulness.

3.4 Quantitative research findings

The quantitative part aimed at testing hypotheses. To this end, we developed questions in eight different categories. Except loss risk and attitude towards social interaction, all items were based on established scales, measured with a seven-point-Likert scale (see Appendix Table 6). After a pre-test with three volunteers, the actual examination was transacted. A link to an online questionnaire was distributed online through social networks. In total, 211 German volunteers provided an assessment of all our questionnaire items within 14 days. The gender participation was almost equal (49% male, 50% female, 1% no information) and the age ranged from 15 years to 87 years. We included several filter questions to control for the quality of data and to avoid biased results regarding our tested hypotheses, ensuring that our respondents were old enough and knowledgeable to do online shopping.

The survey contained questions concerning all constructs listed in Figure 1 as well as control variables such as age, gender, spending, shopping frequency, delivery frequency, and ecological consumption. We started our analysis with a confirmatory factor analysis (CFA) for all items that represent model variables (i.e. risk types, perceived usefulness, social influence, drone-related knowledge, attitude towards social interaction). Model fit was assessed using a the ration of χ^2 to degrees of freedom (χ^2/df), incremental fit index (IFI), Tucker-Lewis-index (TLI), comparative fit index (CFI), and root mean square error of approximation (RMSEA). The CFA indicated that the model fit the data well (χ^2/df = 1.677; IFI = .955; TLI = .941; CFI = .954; RMSEA = .057). In addition, all constructs display good reliability (composite reliability > .7) and average variances extracted (AVE). In addition, discriminant validity is given, because the square root of AVE is greater than each pairwise correlation (Fornell & Larcker, 1981) (Table 4).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1 Physical Risk	**0.864**								
2 Loss Risk	0.258	**0.794**							
3 Financial Risk	0.433	0.374	**0.804**						
4 Data Risk	0.607	0.303	0.575	**0.770**					
5 Social Influence	-0.300	0.077	-0.389	-0.228	**0.897**				
6 Drone Knowl.	-0.163	-0.122	-0.203	-0.102	0.268	**0.791**			
7 Attitude Inter.	0.330	0.116	0.250	0.254	-0.100	-0.057	**0.766**		
8 Perc. Usefulness	-0.572	-0.159	-0.639	-0.495	0.381	0.187	-0.435	**0.925**	
9 Adop. Intention	-0.521	-0.192	-0.609	-0.488	0.312	0.183	-0.421	0.808	**0.871**
Average variance extracted (AVE)	0.747	0.630	0.646	0.593	0.805	0.626	0.586	0.857	0.759
Composite reliability (CR)	0.898	0.773	0.845	0.743	0.892	0.869	0.728	0.923	0.904

Table 4 Correlations and discriminant validity

Next, the hypothesized model was assessed with structural equation modelling (SEM) and a maximum likelihood estimator using IBM SPSS Amos 25. A model that reflected the one in Figure 1 (i.e. including the control variables age, gender, shopping frequency, ecological consumption and spending), has a reasonable fit with the underlying data (χ^2/df = 2.327; IFI = .860; TLI = .840; CFI = .858; RMSEA = .080). However, as some of these measures fall below certain thresholds, we also calculated a model without the control variables. Control variables often display no significant relationships with dependent variables, a fact that results in poorer model fit. The overall model without control variables had a good fit with the data (χ^2/df = 1.916; IFI = .932; TLI = .920; CFI = .931; RMSEA = .066). Although the model fit is better for the model without control variables, the following results pertain to the model *with* controls.

Table 5 below gives us information about which proposed hypotheses are supported according to our findings. To summarize, four of the eight examined hypotheses are supported. First, as with other TAM studies (e.g. Hein et al. 2018), perceived usefulness has a significant influence on the intention to adopt an innovation (ß = 0.795, $p < 0.001$). Thus, H1 can be claimed supported. From our four extracted types of perceived risk, only two (physical and financial) are negatively related to perceived usefulness. Therefore, H2 and H4 are supported. Interestingly, financial risk (ß = -0.501, $p < 0.001$) has the bigger influence on perceived usefulness than physical risk (ß = -0.321, $p < 0.001$). We could not find a significant connection between loss risk and data risk with perceived usefulness. Also, no significant influence on perceived usefulness was discovered at social influence and drone-related knowledge. However, a significant influence on perceived usefulness was observed for the attitude towards social interaction (ß = -0.261, $p < 0.01$), supporting H8. None of the control variables yielded significance.

		β	Sig.	Supported
H1	Perceived usefulness → Intention to adopt	0.795	$p < 0.001$	Yes
H2	Physical risk → Perceived usefulness	-0.321	$p < 0.001$	Yes
H3	Loss risk → Perceived usefulness	0.113	n.s.	No
H4	Financial risk → Perceived usefulness	-0.501	$p < 0.001$	Yes
H5	Data risk → Perceived usefulness	-0.014	n.s.	No
H6	Social influence → Perceived usefulness	0.116	$p < 0.1$	No
H7	Drone-related knowledge → Perceived usefulness	0.039	n.s.	No
H8	Att. tow. Social interaction → Perceived usefulness	-0.261	$p < 0.01$	Yes

Table 5 Results of structural equation modelling

4 Discussion and conclusion

This study attempts to contribute to addressing a research gap that is both theoretically and managerially important. It works towards explaining individuals´ adoption intention of delivery drones services. For this purpose, this study is based on an established acceptance model (i.e. TAM) and relies on extant exploratory research on user acceptance and delivery drones as well as on findings from two own studies. In interviews with ten volunteers with different backgrounds we identified important risk-related factors for our following large scale quantitative survey study. The results provide important insights about potential barriers of the user acceptance for delivery drones.

In our quantitative research we found that both the physical risk and, even more, the financial risk have significant negative influence on the perceived usefulness of the delivery drone. Companies which are thinking about integrating a drone delivery in their service range should keep an eye on these two risks and develop actions to approach the customer in these areas to minimize these risks. In our qualitative research we found about the financial risk that potential customers wish to be faced with the same amount of shipping cost as they are used to with the truck delivery today. Any raise will probably cause customer shrinkage. To prevent customer shrinkage due to a perceived physical risk, companies need to provide actions that will gain customers’ trust towards the technical performance of drones. Again, we found out in our quantitative research some of the activities that potential customers wish to be installed from delivery drone using companies. Many interviewees demanded safety procedures that stop drones from falling down unhindered for example by the help of a parachute. In addition to that, to prevent drones from different companies to collapse, potential customers from our study wish special air lanes to be introduced. Securing the operating software in the best way possible is another way of gaining trust with potential customers, as hackers will not have a chance to manipulate the route. Apart from these two risks, also the attitude to a social interaction with an employee of the logistic company turned out to have a significant influence on the perceived usefulness. This issue could be further analyzed to find countermeasures, since drones do not provide any social interaction between the customer and any other human being. With the perceived usefulness having a significant influence on the intention to adopt, the framework of our research model found in the literature is supported.

We acknowledge limitations of this study that may serve as a starting point for future research. First, both qualitative interviews and the quantitative survey took part in Germany. While this was intended to contribute a European focus, it is in no way guaranteed that the German market is similar to other markets, which is why cross-cultural generalizations should be taken with care. Furthermore, this study only captured a theoretical customer behavior as drone delivery is not yet in all-day use. Once the first company provides this service and customers are able to make their first experience with delivery drones, the understanding in delivery drones might change and new studies may need to replicate our findings.

Appendix

	Standardized Factor Loadings
Physical risk (adapted from Wiedmann et al. 2011)	
I am concerned that my drone usage would injure my neighbors, housemates, or pets physically.	0.758
I am concerned that a drone could hurt me.	0.942
I am concerned that a drone could injure me during the unloading process.	0.882
Loss risk (own development)	
I am concerned that packages could get lost during delivery.	0.780
I am concerned that the package could get damaged during delivery.	0.807
Data risk (adapted from Hein et al. 2018)	
I am concerned that delivery drones could threaten my privacy.	0.839
I am concerned that I have to share more data to use drone delivery.	0.694
Financial risk (adapted from Wiedmann et al. 2011)	
I am concerned that potential extra costs for drone delivery are not worth it.	0.844
I think I can spend my money more wisely than investing in drone delivery.	0.755
I am concerned that an investment in drone delivery does not pay off.	0.810
Perceived usefulness (adapted from Hein et al. 2018)	
I think delivery drones are a good idea.	0.955
I think delivery drones are useful.	0.895
Drone-related knowledge (adapted from Bauer et al. 2005)	
I am very well informed about drones.	0.884
I would consider myself an expert when it comes to drones.	0.804
I know more about drones that my friends and family.	0.780
I follow messages about drones in the media.	0.630
Attitude towards social interaction (own development)	
I would miss smalltalk with postal workers.	0.923
I have a positive attitude towards postal workers.	0.566
Social influence (adapted from Hein et al. 2018)	
I would use delivery drone usage to swagger.	0.890
I would feel privileged when using delivery drones.	0.904

Table 6. Items and factor loadings

References

Bamburry, D. (2015). Drones: Designed for product delivery. *Design Management Review*, *26*(1), 40-48.

Bauer, F. (2012). *Integratives M&A-Management: Entwicklung eines ganzheitlichen Erfolgsfaktorenmodells*. Springer-Verlag.

Bauer, H. H., Reichardt, T., Barnes, S. J., & Neumann, M. M. (2005). Driving consumer acceptance of mobile marketing: A theoretical framework and empirical study. *Journal of Electronic Commerce Research*, *6*(3), 181.

Bischof, C. (2017). Drohnen im rechtlichen Praxistest. *Datenschutz und Datensicherheit-DuD*, *41*(3), 142-146.

Boone, T., & Ganeshan, R. (2013). Exploratory analysis of free shipping policies of online retailers. *International Journal of Production Economics*, *143*(2), 627-632.

Business Insider Deutschland (2017). UPS tests drone delivery system. URL: https://www.businessinsider.de/ups-tests-drone-delivery-system-2017-2?r=US&IR=T [11.12.2018].

Clarke, R. (2014). Understanding the drone epidemic. *Computer Law & Security Review*, *30*(3), 230-246.

Collier, G. (1995). Information privacy. *Information Management & Computer Security, 3*(1), 41–45.

Cuthbertson A. (2016). Australia post to launch drone delivery. URL: https://www.newsweek.com/australia-post-drone-delivery-service-drones-449442 [Last access 2019/11/05].

Deutsche Post Online (2018). DHL Paketkopter. URL: https://www.dpdhl.com/de/presse/specials/dhl-paketkopter.html [Last access 2019/11/05].

Dorling, K., Heinrichs, J., Messier, G. G., & Magierowski, S. (2017). Vehicle routing problems for drone delivery. *IEEE Transactions on Systems, Man, and Cybernetics: Systems*, *47*(1), 70-85.

Dwivedi, Y. K., Rana, N. P., Jeyaraj, A., Clement, M., & Williams, M. D. (2019). Re-examining the unified theory of acceptance and use of technology (UTAUT): Towards a revised theoretical model. *Information Systems Frontiers*, *21*(3), 719-734.

Feil F. (2013). Amazon, DHL, UPS, Google und die Zukunft der Logistik. URL: https://web.archive.org/web/20150105043654/http:/blog.cebit.de/2013/12/06/amazon-dhl-ups-google-und-die-zukunft-der-logistik/ [Last access: 2019/11/06].

Finn, R. L., & Wright, D. (2012). Unmanned aircraft systems: Surveillance, ethics and privacy in civil applications. *Computer Law & Security Review*, *28*(2), 184-194.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable varia bles and measurement error. *Journal of Marketing Research*, *18*(1), 39-50.

Gillenson, M. L., & Sherrell, D. L. (2002). Enticing online consumers: an extended technology acceptance perspective. *Information & Management*, *39*(8), 705-719.

Golob, T. F., Bunch, D. S., & Brownstone, D. (1997). A vehicle use forecasting model based on revealed and stated vehicle type choice and utilisation data. *Journal of Transport Economics and Policy*, 69-92.

Heidenreich, S., Spieth, P., & Petschnig, M. (2017). Ready, steady, green: Examining the effect tiveness of external policies to enhance the adoption of eco-friendly innovations. *Journal of Product Innovation Management*, *34*(3), 343-359.

Hein, D., Rauschnabel A. P., He J., Richter L. & Ivens S. B. (2018). What Drives the Adoption of Au tonomous Cars? *Proceedings of the International Conference on Information Systems (ICIS)*, San Francisco, CA.

King, W. R., & He, J. (2006). A meta-analysis of the technology acceptance model. *Information & management*, *43*(6), 740-755.

Khan, R., Tausif, S., & Javed Malik, A. (2019). Consumer acceptance of delivery drones in urban are-as. *International Journal of Consumer Studies*, *43*(1), 87-101.

Lee, H. L., Chen, Y., Gillai, B., & Rammohan, S. (2016). Technological disruption and innovation in last-mile delivery. *Value Chain Innovation Initiative*.

Legris, P., Ingham, J., & Collerette, P. (2003). Why do people use information technology? A critical review of the technology acceptance model. *Information & Management*, *40*(3), 191-204.

Ligas, M. (2000). People, products, and pursuits: Exploring the relationship between consumer goals and product meanings. *Psychology & Marketing*, *17*(11), 983-1003.

Mitchell, V. W. (1999). Consumer perceived risk: conceptualisations and models. *European Journal of Marketing*, *33*(1/2), 163-195.

Morgan, D. L. (1998). Practical strategies for combining qualitative and quantitative methods: Appli-cations to health research. *Qualitative Health Research*, *8*(3), 362-376.

Moreau, C. P., Lehmann, D. R., & Markman, A. B. (2001). Entrenched knowledge structures and con-sumer response to new products. *Journal of Marketing Research*, *38*(1), 14-29.

Müller A. (2018). Die Blutproben aus dem Züricher Universitätsspital gelangen jetzt per Drohne ins Labor. URL: https://www.nzz.ch/zuerich/die-blutproben-aus-dem-zuercher-universitaetsspital-gelangen-jetzt-per-drohne-ins-labor-ld.1441774 [Last access: 2019/10/26].

Nelson, S. C. (2002). Overview of the safety issues associated with the compressed natural gas fuel system and electric drive system in a heavy hybrid electric vehicle. *Engineering Science & Technology Division*, Oak Ridge National Laboratory.

Nozick, L. K., & Turnquist, M. A. (2001). Inventory, transportation, service quality and the location of distribution centers. *European Journal of Operational Research*, *129*(2), 362-371.

Project Wing (2019a). Wing in Australia. URL: https://wing.com/australia/canberra/ [Last access: 2019/11/10].

Project Wing (2019b). Wing in Helsinki. URL: https://wing.com/finland/helsinki/ [Last access: 2019/11/10].

Saldaña, J. (2015). *The coding manual for qualitative researchers*. Sage Publishing.

Schaarschmidt, M., & Höber, B. (2017). Digital booking services: comparing online with phone ser vices. *Journal of Services Marketing*, *31*(7), 704-719.

Schrader, C. (2017). Drohnen und Naturschutz (recht). *Natur und Recht*, *39*(6), 378-385.

Sheth, J.N. (1968). Perceived Risk and Diffusion of Innovations. *Insights into Consumer Behavior*, 173-188.

Statista (2019a). Retail e-commerce sales worldwide from 2014 to 2023 https://www.statista.com/statistics/379046/worldwide-retail-e-commerce-sales/ [Last access: 2019/11/10]

Statista (2019b). Anzahl der Sendungen von Kurier-, Express- und Paketdiensten (KEP) in Deutschland in den Jahren 2000 bis 2022 (in Millionen). URL: https://de.statista.com/statistik/daten/studie/154829/umfrage/sendungsmenge-von-paket- und-kurierdiensten-in-deutschland/ [Last access: 2019/11/10].

Tagesschau Online (2018). Amazon und sein Prime Air. URL: https://www.tagesschau.de/wirtschaft/boerse/amazon-drohne-101.html [Last access: 2019/11/12].

Tarhini, A., Arachchilage, N. A. G., & Abbasi, M. S. (2015). A critical review of theories and models of technology adoption and acceptance in information system research. *International Journal of Technology Diffusion (IJTD)*, *6*(4), 58-77.

Villasenor J. (2012). What is a drone, anyway? URL: https://blogs.scientificamerican.com/guest-blog/what-is-a-drone-anyway/ [Last access: 2019/11/12].

Wiedmann, K. P., Hennigs, N., Pankalla, L., Kassubek, M., & Seegebarth, B. (2011). Adoption barri ers and resistance to sustainable solutions in the automotive sector. *Journal of Business Re search*, *64*(11), 1201-1206.

Wu, J. H., & Wang, S. C. (2005). What drives mobile commerce?: An empirical evaluation of the revised technology acceptance model. *Information & Management*, *42*(5), 719-729.

Yoo, W., Yu, E., & Jung, J. (2018). Drone delivery: Factors affecting the public's attitude and intention to adopt. *Telematics and Informatics*, *35*(6), 1687-1700.

ZDF Heute Online (2018). Drohne im Einsatz der Medizin. URL: https://www.zdf.de/nachrichten/heute-in-europa/drohne-im-einsatz-der-medizin-100.html [Last access: 2019/11/01].

Related studies

Ferrandez, S. M., Harbison, T., Weber, T., Sturges, R., & Rich, R. (2016). Optimization of a truck-drone in tandem delivery network using k-means and genetic algorithm. *Journal of Industrial Engineering and Management (JIEM)*, *9*(2), 374-388.

Hong, I., Kuby, M., & Murray, A. (2017). A deviation flow refueling location model for continuous space: A commercial drone delivery system for urban areas. In *Advances in Geocomputation* (pp. 125-132). Springer, Cham.

Ramadan, Z. B., Farah, M. F., & Mrad, M. (2017). An adapted TPB approach to consumers' acceptance of service-delivery drones. *Technology Analysis & Strategic Management*, *29*(7), 817-828.

Sanjab, A., Saad, W., & Başar, T. (2017). Prospect theory for enhanced cyber-physical security of drone delivery systems: A network interdiction game. In *2017 IEEE International Conference on Communications (ICC)* (pp. 1-6). IEEE.

Shavarani, S. M., Nejad, M. G., Rismanchian, F., & Izbirak, G. (2018). Application of hierarchical facility location problem for optimization of a drone delivery system: a case study of Amazon prime air in the city of San Francisco. *The International Journal of Advanced Manufacturing Technology*, *95*(9-12), 3141-3153.

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