EDICIONES Universidad de Valladolid

Drones for parcel and passenger transport: A qualitative exploration of public acceptance

Drones para el transporte de paquetes y pasajeros: un análisis cualitativo de la aceptación pública

ROBIN KELLERMANN
Technical University Berlin, Department Work, Technology, and Participation (Mobility Research Cluster),
MAR 1-1, Marchstraße 23, 10587, Berlin. Germany.
robin.kellermann@tu-berlin.de
https://orcid.org/0000-0003-2433-0832

LILIANN FISCHER
Wissenschaft im Dialog GmbH
Charlottenstraße 80, 10117, Berlin. Germany.
liliann.fischer@w-i-d.de

DOI: https://doi.org/10.24197/st.2.2020.106-138

RECIBIDO: 23/06/2020
ACEPTADO: 22/09/2020

Resumen: Los drones civiles y comerciales están a punto de convertirse en una tecnología clave de la vida cotidiana futura. Estimulado por recientes progresos tecnológicos y una mayor claridad regulatoria, especialmente las grandes ciudades están previendo el uso de drones para el transporte de paquetes y pasajeros con la esperanza de decongestionar el tráfico urbano. A pesar de que principalmente la población urbana se vería afectada por el uso del espacio aéreo cercano a la ciudad, solo pocos estudios abordaron la percepción y opinión pública sobre el uso de drones para el transporte. Con el objetivo de avanzar en la investigación sobre las actitudes y aceptaciones acerca de los drones, el artículo presenta resultados cualitativos de una serie de cinco grupos focales realizados en tres ciudades alemanas. El análisis de los grupos focales muestra que

Abstract: Civil and commercial drones are on the verge of becoming a key technology of future everyday life. Stimulated by recent technological progress and increasing regulatory clarity especially larger cities are anticipated to use drones for parcel and passenger transport hoping to relieve congested inner city traffic. Despite it is first and foremost the urban population that would be affected by accessing lower airspace, only few studies addressed the public perception of using transport drones. Aiming to fill the gap of attitudinal and acceptance research in the context of drones, the article embraces the subject by presenting qualitative results of a series of five focus groups conducted in three German cities. The analysis of discussions shows that participants were largely ambivalent towards the use of drones, putting special emphasis on a variety

los participantes son ambivalentes respecto del uso de drones, poniendo énfasis en una variedad de factores objetivos (seguridad, sustentabilidad, utilidad), subjetivos (la percepción general sobre la tecnología) y contextuales (las potenciales implicaciones sociales de la tecnología de drones). Enmarcado en la discusión de los factores identificados en el contexto de los debates científicos actuales y evaluando las potenciales implicancias sociales de los drones, el artículo provee un profundo análisis cualitativo de una de las más disruptivas y controversiales tecnologías futuras, que podría transformar tanto el mundo del transporte como el de las sociedades urbanas.

Palabras clave: drones; logística; transporte; urban air mobility; investigación cualitativa

of object-related factors (safety and security, sustainability, usefulness), subject-related factors (general perception of technology) and also context-related factors (potential societal implications of drone technology). Framed by a discussion of identified acceptance factors in the context of the present scientific debate and assessing drones' potential social implications the article provides a profound qualitative exploration into one of the most disruptive and controversial future technologies that may transform both the transport world and urban societies.

Keywords: drones; logistics; transport; urban air mobility; qualitative research

1. INTRODUCTION

Unmanned aerial vehicles (UAV), also commonly referred to as drones, have become a central technology in a variety of different use cases. Apart from sensory missions for the purpose of data collection, e.g. in agriculture or construction, the use of drones as transport devices for parcel or passenger transport is currently discussed as a central field for future applications.

The European Union is a pioneer in this area and is actively pushing for becoming a world leading region for the production and deployment of drone hardware and services. In 2013 the Commission appointed its institutions and initiatives to develop a long-term agenda for future research and regulation. While EASA (European Union Aviation Safety Agency) is responsible for creating a harmonized European regulatory framework for the use of drones, the SESAR Joint Undertaking is actively coordinating and concentrating research and development for safeguarding the future integration of drones into current airspace. After the Commission's adoption of common EU-wide drone rules in summer 2019, Europe is about to become "the first region in the world to have a comprehensive set of rules ensuring safe, secure and sustainable operations of drones both, for commercial and leisure activities" (EASA, 2019). Within the next 15 years, SESAR envisions the drone sector to employ 100.000 jobs and creating an economic impact exceeding €10 billion per year, which would culminate in a benefit of €140 billion up to 2035 (SESAR, 2016).

While the biggest economic value applies for sensory missions and data collection, the transport of parcels and passengers, summarized with the term 'urban air mobility', forms a yet important pillar. Passenger transport alone is anticipated to result in a market value of at least EUR 2 billion annually by 2031 with a market take-off in 2027 (SESAR 2018, p. 20). More precisely, passenger transport in low-level airspace is estimated for the three use cases of city-to-airport travel, taxi use (long distances) and commuting along heavily crowded routes. Investigating the possibility of using drones as a new transport medium, many countries have started to implementing national research programs and have opened dedicated test centres (Christen et al., 2018, p. 92f.; Nentwich and Horváth, 2018, p.26).

However, the use of drone fleets for the transport sector hinges not only on technical and regulatory aspects but will also heavily depend on the public acceptance (Chamata 2017, p. 126; Lidynia, Philipsen, and Ziefle 2017, p. 318; Rao, Gopi, and Maione 2016, p. 13). This is especially true for cities in which a large part of the population would be continually and directly exposed to drones once introduced as part of regular traffic. Still, there are only few studies that have investigated public acceptance of drones (West, Klofstad, Uscinski, and Connolly 2019; Boucher 2016; Lidynia, Philipsen, and Ziefle, 2018). As a consequence, we still know very little about how people think about using or being exposed to drone technologies.

Moreover, there is much uncertainty concerning questions of what might be most critical factors that inform or create acceptance of active and passive drone use.

Against this problematic background, the article addresses this research gap and looks at the attitude of the public towards drones as a potential transport technology with the help of a qualitative in-depth study. Based on results of five focus groups that were conducted in Berlin, Stuttgart and Erfurt in September and October 2019 the article - informed by theoretical framework of technical acceptance research - aims to explore the public acceptance of delivery and passenger drones and identifies key factors influencing public acceptance. The qualitative results will pave the way for further transnational and comparative studies.

2. THEORY

History of technology has argued that classical narratives about new (and disruptive) technology offers throughout the 20th century were most often considered either a "romance" or a "tragedy" (Hård and Jamison, 2005). In order to illuminate whether narratives and public perception of transport drones are of an equally dichotomous nature, the article is embedded in the theoretical framework of technology acceptance theory, which is especially suited to analyze public attitudes and intentions towards a technology. This framework comprises different approaches and models exploring the factors, structures and motivations influencing public acceptance of specific technologies (Fishbein and Ajzen, 1975; Davis, 1989; Lucke, 1995). General acceptance theory considers the relationship between acceptance *objects*, *subjects* and *contexts*. Technology acceptance theory specifically looks at acceptance objects of a technical or technological nature. Acceptance is defined as the moment in which someone (the acceptance *subject*) accepts something (the acceptance *object*) within the given circumstances (the acceptance *context*) (Schäfer and Keppler 2013, p. 16). Based on this relationship between subject, object and context, we can identify acceptance factors which have a positive or negative influence on the attitude of the acceptance subject towards the acceptance object (Schäfer and Keppler 2013, p. 25).

Most technology acceptance models follow a similar structure. Originated in 1975 the *theory of reasoned action* (TRA) proposed by Fishbein and Ajzen proposed that the main predictor for the use of a technology was the intention to use this technology. This assumption has since been shared by most technology acceptance models. In 1991 Ajzen then proposed the *theory of planned behavior* (TPB) which added the perceived control of the subject over the technology as another central factor. In 1989 the classical *technology acceptance model* (TAM) was proposed by Davis which completed the basic structure of technology acceptance models. This structure assumes that certain demographic variables

influence how subject-, -object- and context-related factors are perceived. The perception of these factors influences the attitude of the subject towards the object (the technology), this attitude influences the intention to use the technology and this intention ultimately determines the actual use of the technology.

Research on the public acceptance of drones is still limited, but there are a number of studies that have explored public acceptance of drones in interviews (Wang, Xian, Yao, and Huang, 2016; Yao, Xia, Huang, and Wang, 2017), focus groups (Boucher, 2016: Department for Transport, 2016), experiments (Chang, Chundury, and Chetty, 2017) or surveys (Nelson, Grubesic, Wallace, and Chamberlain, 2019; West, Klofstad, Uscinski, and Connolly, 2019; Lidynia, Philippsen, and Ziefle et al., 2018; Lidynia, Philippsen, and Ziefle, 2017; Soffronoff, Piscioneri, and Weaver, 2016; Eißfeldt et al., 2018; Dannenberger, Schmid-Loertzer, Fischer, Schwarzbach, Kellermann, and Biehle, 2020). However, only two studies are known to the authors which establish classic technology acceptance models to explain public acceptance of delivery drones (Yoo, Ju, and Jung, 2018; Chamata and Winterton, 2018). Factors included in these models encompass sustainability of the technology, perceived usefulness of the technology, speed of the technology, the environmental consciousness of the user and the users' media behaviour (Yoo, Ju and Jung, 2018), perceived risk of use and perceived ease of use (Chamata and Winterton, 2018).

The particular challenge posed by the analysis of public acceptance of delivery and passenger drones is the fact that the technology is not yet operable and thus people have had very limited experience (if any) with the technology. However, this does not make it any less pertinent to raise awareness at an early stage and to investigate the attitudes of the public towards the technology. On the contrary, once the technology has advanced sufficiently so that knowledge is sound and widespread it is often too late or economically no longer viable to stop the development and impede a use of the technology (Grunwald, 2012, p. 165).

3. METHODS

Focus groups are a specific type of qualitative group interview in which a group of participants are supplied with information on a topic and then guided through a group discussion by a moderator (Benighaus and Benighaus, 2012, p. 112). Focus groups are usually made up of eight to ten people who are selected according to predefined criteria. The discussions are usually recorded and transcribed. While single interviews are methodologically apt for biographic or personal questions, focus groups are especially suited to technological and societal matters. The group discussions can stimulate new effects, minimize moderator bias and generate results reaching beyond the individual knowledge of single participants (Schulz, 2012, p. 12-13). To the authors knowledge there are

only two studies which have used focus groups to explore public opinion on drones (Boucher, 2016; Department for Transport, 2016).

While the field of technology acceptance is traditionally dominated by quantitative methods of data collection and analysis (Wu, 2012), increasingly more studies are being published which use qualitative methods (Pikkarainen, Pikkarainen, Karjaluoto, and Pahnila, 2004; Wu, 2012; Cheng, Lou, Kuo, and Shih, 2013). Focus groups are a typical method of inquiry looking at a variety of technologies (Ziefle, 2013; Becker, 2018; Wichmann, Sill, Hassenstein, Zeeb, and Pischke, 2019).

The researchers in this study tasked the public opinion research institute *forsa* with conducting the focus groups. In order to be able to glean differences between bigger and smaller cities, as well as between East and West Germany, the cities of Berlin, Stuttgart and Erfurt were selected for the group discussions. The participants were chosen according to a Pre-Screening questionnaire established by *forsa* in accordance with the researchers' specifications. Participants who had never heard about drones before and those who worked in the drone industry were excluded from participation. Given that technology acceptance is often age-related (Arning and Ziefle, 2007; Jakobs, Lehnen and Ziefle, 2008; Niehaves and Plattfaut, 2014) the groups in Berlin Stuttgart were separated into a younger (18-44) and an older (45-65) age-group. The group in Erfurt was composed of participants of all age-groups. Given that some studies also show a relationship between technology acceptance and gender (Gefen and Straub, 1997; Venkatesh and Morris, 2000), it was taken care to assure the groups were gender balanced.

The focus group guide was written by the researchers in close collaboration with *forsa*. At the beginning of each group discussion a short 10-minute presentation was given by the moderator to give all participants a similar knowledge basis. The presentation defined the concept "drone" and showed different types and use cases. Two short video clips were shown which demonstrated what a parcel delivery by drone or a trip by passenger drone might look like in practice. The input was provided by the researchers in the form of a powerpoint presentation. The guide and the presentation are available from the authors on request.

On the 19th of September 2019 two focus groups were conducted in Berlin, on the 30th of September two were conducted in Stuttgart and the final group in Erfurt was conducted on the 2nd of October. At least one of the researchers was personally present during all focus groups. Discussions could be monitored from a separate room equipped with a one-sided mirror. This allowed the researcher to observe the discussion and atmosphere in the group directly and to give feedback to the moderator after each session.

All focus groups were recorded and transcribed. All data was analyzed by the researchers themselves. A preliminary report be *forsa* as well as notes taken during the focus groups were used as supplementary material for the analysis. The focus groups were analyzed within the framework of technology acceptance theory (see Schäfer and Keppler, 2013) through qualitative content analysis (Mayring, 2012). All transcripts were coded by one of the researchers with the help of the qualitative data analysis software Atlas.ti. A thematic analysis of the transcripts was conducted relying on an interplay between inductive and deductive codes (Fereday and Muir-Cochrane, 2006). In a first step, quotations were sorted into the large theory-based categories: attitudes, behavioural intentions, object- subject- and context-related acceptance factors (Crabtree and Miller, 1999). All these categories were created in duplicate, once applying to delivery drones and once to passenger drones. The different attitudes, intentions and acceptance factors, however, were generated inductively throughout the analysis of the transcripts (Boyatzis, 1999). This assured that also factors which had not been identified in previous studies could be analysed and discussed.

The fact that all the coding was done by only one member of the research team of course obstructed possibilities for inter-coder comparisons and broader reliability analysis. However, budgetary and personal constraints forced our hand in this matter. Results are interpreted and discussed tentatively in accordance with this limitation.

4. RESULTS

The results are first presented in a descriptive way. Therefore, we give a short overview of the personal experiences of participants with drones, followed by the most frequently discussed use cases. This serves to gain an insight into the previous experiences and the spontaneous associations the participants had with drones.

The majority of participants had only ever seen drones from afar. Very few participants had operated a drone or knew someone personally who owned one. Only one participant in all five groups owned a drone himself. The use cases which were best known to the participants included the use in filming, agricultural use, industrial use and the use in emergency situations. Military use was also frequently mentioned. Most participants had heard about parcel delivery drones, but at the start of the discussion passenger drones were still quite hard to imagine for many: “I think it’s still too far away. It’s hard to imagine. Or at least I find it hard to imagine” [1: P7, Erfurt].

In the following, we provide an overview of the attitudes and intentions of the participants towards parcel delivery and passenger drones as well as the key acceptance factors mentioned. The factors which were selected here are those

discussed most frequently and intensely across all groups, but also those which proved especially controversial and surprising within the context of previous studies. The factors are grouped into theory-based categories, starting with object-related factors (section 4.2.1), followed by subject-related factors (section 4.2.2) and finally context-related factors (section 4.2.3).

4.1 Attitudes and intentions towards the use of drones in urban airspace

4.1.1 Delivery drones

Across all groups there was general agreement that delivery drones should be used in emergency situations especially for the transport of medication and organs in the future: "Quick response with medication. When it is about questions of life and death" [2: P5, Stuttgart 1].

There were some participants who were willing to use parcel delivery via drone once it was available. However, it was interesting to see that this was not accompanied by great enthusiasm. One participant explicitly said: "I am not really in favour of it, but I know that I would still use it" [3: P7, Berlin 2]. Some of the participants also expressed a measure of resignation towards technological progress: "If it was standard and there was nothing you could do against it anyway, then I think I would probably use it" [4: P3, Stuttgart 2].

Overall, it became clear that the majority of participants approved of the application of delivery drones in emergency situations more strongly than of their application for everyday consumption. Moreover, we saw that participants although willing to use delivery drones, were still quite sceptical towards them.

4.1.2 Passenger drones

Approval and disapproval of the inner-city use of passenger drones was represented quite evenly across groups. There were some participants who did think it would be possible to build drones in a "technologically sound" way and "regulate [their use] so that it works well"[5: P5, Berlin 1]. Other participants, however, found passenger drones an "appalling idea" [6: P6, Berlin 2] or saw them as "terrible" [7: P3, Berlin 1].

The intention to use passenger drones was expressed in very different tones from the intention to use delivery drones. While participants seemed reluctant to use delivery drones, the prospect of being able to use a passenger drone seemed to fascinate them: "it intrigues me, I would love to try it"[8: P1, Stuttgart 1].

However, it is important to note that this fascination seldomly appeared to be associated with the idea of using passenger drones as a permanently integrated

element of inner-city traffic. Participants rather thought of a flight with a passenger drone as something exceptional, an adventure almost: "I would love to fly over Stuttgart, just because it's cool, a different kind of sightseeing" [9: P8, Stuttgart 2]. At the same time, there were some participants who vehemently opposed the idea of using a passenger drone: "Nobody could make me set a foot into one of these flying soapboxes" [10: P1, Berlin 2].

Even though the focus groups were instructed to explicitly discuss the use of drones in cities, there was a notable number of participants who emphasized that passenger drones would first and foremost be of use for inter-city transportation:

> "I think what would make sense is to get from one city to the other, when they are not connected through public transportation, from here to Karlsruhe or Frankfurt for example" [11: P7, Stuttgart 2].

All in all, the discussion around passenger drones had a much more polarised character, which became especially apparent in the contrast of some participants' enthusiasm with other participants' vehement opposition. Nonetheless, even participants with more positive attitudes towards passenger drones rarely mentioned that they wanted to use them as their everyday transportation device. Passenger drones were rather associated with a fascination for flying and for seeing their own city from above.

4.2 Acceptance Factors

In the following we briefly outline the main considerations and criteria for either accepting or not accepting the use of drones as transportation devices in urban areas that were discussed by the participants. In line with technology acceptance theory these are divided into object-, subject- and context-related factors. Given that many of these are similar for delivery and passenger drones, the two applications will be discussed in conjunction, differences will be highlighted when applicable.

4.2.1 Object-related factors

Safety and security

One of the most frequently discussed factors was the safety and security of drone technology. The main concerns of the participants in this regard address two conceptual dimensions: dangers caused by accidents and malfunctions and dangers caused by intentional external manipulation.

The participants discussed a number of different potential causes for drone related accidents. Among these were crashes "when one drone crashes into

another or falls from the sky the death rate will be more extreme than it is for car crashes in Germany I think" [12: P8, Stuttgart 2]. One participant neatly summarized all the different causes for such crashes: "drone against drone, drone drops something, drone against bird, drone against house." [13: P2, Erfurt]. Intentional manipulation comprised that "you can be hacked" [14: P8, Stuttgart 1], but also "terrorist stuff [...] right now it's already possible to attach explosives to a drone" [15: P8, Stuttgart 2].

All in all it became clear that the majority of participants saw delivery and passenger drones as a potential risk.

Environmental friendliness

Across all groups, participants emphasized that they would only be willing to accept the use of drone technology if it was "environmentally sound in any way" [16: P7, Stuttgart 2]. The question whether or not drone technology conforms to environmental standards, however, was discussed quite controversially. Some participants believed that drones represented a sustainable alternative technology: "up to a certain size the ecological footprint is probably better than the one of traditional delivery vans" [17: P1, Stuttgart 2]. Other participants, on the other hand, doubted that drones would be able to satisfy requirements of environmental friendliness: "I think drones will perform less well than a DHL van because every parcel has to be delivered separately while a van transports many parcels at once" [18: P8, Erfurt].

> "Just as soon as they are able fly autonomously, the amount of processing power that will be required to calculate flight routes so that just 100 drones can fly within a certain area is so high that 30 or 40 diesel vans could easily drive through the city [instead]" [19: P1, Erfurt].

Even though the environmental friendliness of drones was a big concern of almost all participants it became clear that participants were uncertain whether drones were indeed an environmentally friendly technology. The debates also showed that in determining drones' environmental friendliness participants not only considered the ecological implications of a single drone flight but also the sustainability of supporting systems and infrastructures.

Traffic problems and extent of use

Regarding both transport related use cases of drones participants expressed the hope that through their use "traffic could be relieved" [20: P5, Berlin 1]. While this seemed an attractive prospect to many, others were much more sceptical. Doubts were especially raised concerning the amount of aerial vehicles which would be introduced: '"There would need to be such a massive amount of them in the air to notably change anything about the traffic situation" [21: P6, Berlin

2]. In addition to that, some participants questioned whether relieving ground-based traffic through air traffic would actually improve the overall traffic situation: "Maybe we would no longer have congestion on the ground but then it would really be crowded in the air. I am not sure that would improve the situation" [22: P2, Erfurt].

The idea of escaping the heavily congested streets in a passenger drone seemed attractive to many participants. At the same time participants were weary of potential consequences especially the possibility of traffic jams in the air. Relatedly they feared that congestion might not actually be relieved but only lifted onto another level of traffic. This was closely connected to the question of the extent of drone use in cities: "I can imagine quite well ordering something on the internet and a drone delivers it to me, but if 100,000 people in Stuttgart do the same, the sky will be full of drones. And that again is unattractive to me" [23: P2, Stuttgart 1]. This suggests that participants were not only concerned with the questions whether or not drones should be used for parcel delivery and passenger transportation, but also to which extent the technology would be used in the future.

Noise

Another key factor was the "noise pollution" [24: P5, Stuttgart 1] caused by drones. Some participants were concerned by "how loud these things are" [25: P3, Berlin 1]. Nonetheless, this seemed to largely depend on how many drones participants thought were likely to be in use at once:

> "We already have such a massive noise pollution in the city, mostly through traffic and then that on top. That would be really loud for sure. And then there will be so many in the sky, if the pharmacy and DHL and Hermes and everyone can deliver with them." [26: P5, Stuttgart 2]

Price and Exclusivity

A central factor which influenced participants' intention to use drone technology was the price of the respective service. The participants were relatively convinced that the option of fast delivery by drone would be first and foremost a question of price: "The people who pay more get their things delivered to the front door and normal Amazon users get it delivered to a delivery center" [27: P7, Berlin 1]. Much more decisive and also more intensely discussed was the price of passenger drones. Here the price clearly dictated intentions to use the technology: "It should be a little less pricy then I would use it more frequently" [28: P8, Erfurt]. Some were convinced that the price of passenger drones would be "comparable to a taxi" [29: P1, Berlin 1], others thought that "it is so expensive that you don't do it often" [30: P6, Stuttgart 1]. The question of the price was closely connected to that of the target group of the technology. Participants suspected that passenger

drones would mostly be used by those well-off, "who think they are better and can afford it" [31: P4, Stuttgart 1].

Participants seemed to be keen on ascertaining whether they would be able to afford using drone technology. They seemed to want to know whether it would even be an option worth considering for them. This was closely connected to the question of whether they would even form part of the target group of the technology or whether the technology would remain an exclusive offer to a select few able to afford it.

Usefulness

Another key factor in determining the acceptance of the technology was the usefulness of the technology and the benefit it could potentially bring to the consumer. There were a series of factors connected to the participants' perception of the usefulness of the technology. These illustrate the broad array of criteria central to the participants' perception of whether they could potentially benefit from the technology. Most important for the participants was the option for consumers to direct delivery drones in a way that would allow them to optimally fulfill their needs:

> "very precise regarding time and space of the delivery. I direct it. I specify I will be at Rolf's window tomorrow and it delivers it there. Not only to my home but it does it exactly the way I need it. Or to the bank or wherever" [32: P7, Stuttgart 1]

Furthermore, participants wanted to be able to "determine the time of delivery exactly plus minus one or two minutes" [33: P8, Erfurt], or simply to specify "I am at home now, send it to me now" [34: P1, Berlin 1]. The participants requested this on the basis that they believed drones were extremely flexible "independent from the working hours of public transport" and "independent from opening hours" [35, 36: Stuttgart 2].

This desire for a precise determination of deliveries by the consumer seemed to have its roots in a deep frustration with traditional delivery services: "What really annoys me about ordering things is that it never arrives at my place, because I am not usually home, because I work, yes I do not only have freetime, even though I don't have two kids, but then it's with my neighbours, then I have to ring at my neighbours' door, then they aren't home, then I need to go to the delivery center. So the parcel is theoretically delivered but I still have to organise how to get it. That's the most annoying thing for me. And whether the parcel was delivered by a Hermes delivery man or by a drone is really not important to me" [37: P2, Berlin 1].

Transport volume

It is very interesting to look at the controversially discussed question of what and how much a delivery drone would be able to carry. Most participants made clear that they thought drones would very likely be able to transport only light and small things: “it will surely be an issue that drones can never transport large items” [38: P1, Stuttgart 2]. Some participants also argued that heavy deliveries might be too dangerous: “I have to be honest, if I order a carpet, the carpet falls down and hits a child, the child is hurt and I know it’s due to my delivery, that would really trouble me” [39: P8, Berlin 1].

At the same time across all groups there was a tendency to argue that deliveries by drone would only really pay off if heavy items could be delivered: “I also thought about gardening utensils. I only have a small car and it is really difficult to transport large, heavy items home from the hardware store. It would really be a relief if there was another option.” [40: P3, Erfurt]. The question of the transport capacity of drones illustrates the discrepancy between the needs of the participants and their assumptions about the technology. The participants wanted to drones to carry larger items because they felt that would benefit them, but at the same time they did not believe drones would be able to do so at least not without considerable risk.

Time

The factor time seemed to play a key role in influencing attitudes and intentions towards both delivery and passenger drones. In the case of delivery drones this mainly concerned the speed of the delivery and the shorter waiting times: “30 minutes from placing the order to the delivery is really crazy” [41: P6, Erfurt]. Looking at passenger drones, on the other hand, the discussion centered much more around the potential time saving in everyday commutes. This was closely connected to discussions about the current traffic situation:

> “That really is an enormous time saving, especially at rush hour through the inner-city here, you need half an hour or 45 minutes from one place to the hour and with [the drone] it would be over within 5 minutes” [42: P8, Stuttgart 2].

It is interesting to note that the aspect of time saving through passenger drones was discussed a lot more frequently in both groups in Stuttgart than in Berlin and Erfurt. The aspect of price, however, was hardly discussed in Stuttgart compared to the other two cities. Nonetheless, there were also a number of participants who doubted that passenger drones could effectively save time:

> “I have to be honest, I don’t know whether it’s worth it, because first off it costs you, then you have to get there in the first place, and then when

> you get there, you aren't where you actually wanted to go only somewhere in the vicinity, then you have to get there again and I also think honestly that's like in a plane, they don't wait there ready for take-off, there is a security check and I just don't know whether it will really be worth it for a 10-minute flight or whatever" [43: P4, Stuttgart 2].

Even though the possibility to save time seemed a decisive factor for many participants to use the technology, it also became clear that they were unsure of whether the technology would really save much time.

Summative overview

In all, a number of object-related factors central to attitude and intention formation can be identified. It is interesting that the importance of the factors as such was usually shared quite evenly across the groups. However, participants did not always agree in their judgement on the performance of drones in regard to each of these factors. For instance, most participants agreed that drones posed a safety risk, however, the question whether they were a sustainable technology alternative or not was discussed intensely. While participants were unanimously convinced that drones would be very noisy there were very different opinions on whether they would relieve inner-city traffic or cause even more congestion. The price of using drones seemed decisive in determining whether participants would use drones or not but opinions on how high the price would be differed quite strongly. It became clear that participants would only consider using drones if they had an advantage over traditional technologies and services. Participants as consumers wanted a direct benefit from using drones, which was expressed in a desire for high flexibility, dependability and absolute control of the consumer to direct the drone according to their wishes. Delivery drones posed a conundrum here, as participants wanted to be able to order large and heavy delivers by drone but at the same time were weary of the potential safety risks caused by such deliveries. Finally, the potential for time saving was regarded as attractive by many participants but there were also strong doubts that the technology could effectively lead to time saving.

4.2.2 Subject-related factors

Generally, emotions, general attitudes, character traits and psychological traits are among the most commonly identified subject-related acceptance factors (Schäfer and Keppler 2013 26).

Technological optimism vs. scepticism

It became clear that attitudes towards both use cases of drone technology tended to be influenced by participants' opinions about technology in general. On the one hand, there were participants who expressed enthusiastic technological optimism, often coupled with a fascination for new technologies:

> "I mean I just really love it and it would be fine if it came true, zap! the door opens, you take the elevator up and fly somewhere, so what? I'm really just the type for that" [44: P4, Berlin 2].

In stark contrast to that stood the technological scepticism expressed by other participants: "I don't know whether I want to give myself over to the technology like that" [45: P1, Berlin 1]. This was connected to the fact that many participants felt uneasy about drone technology: "Somehow this is all very strange to me. I'm already afraid of this little helicopter and the cat is too" [46: P3, Berlin 2]. Some participants also felt resigned in the face of the technological development: "I don't think we can cut ourselves off like that either, it will just happen the way that it happens" [47: P8, Berlin 2].

Looking specifically at the intention to use passenger drones, a fascination with flying in general formed the basis for a positive intention to use passenger drones: "I just love flying and everyone always wants to try the newest stuff after all" [48: P4, Stuttgart 2]. On the other hand participants who generally had "fear of flying" [49: P3, Berlin; P5, Stuttgart 2] did not intend to use passenger drones.

Attitudes towards online shopping

Participants attitudes towards delivery drones seemed greatly influenced by their attitude towards online shopping in general. Participants who disapproved of online shopping were also often less inclined to use delivery drones: "I don't think I would use it regularly because I don't really order much online" [50: P8, Stuttgart 2].

Convenience

Participants were convinced that the convenience of delivery drones would encourage the laziness of consumers:

> "I think laziness will increase. I saw that recently, my neighbour switched from Amazon to Amazon Prime in order to get Same Day Deliveries and the second that she had that option she started ordering nonsense, and she was so happy that it arrived on the same day, but she also ordered stuff

> where I thought 'you could just as well have gotten on your bike and gone to the shop around the corner'. She was beaming with joy. That's what I mean. And I think if you then have the option to get it delivered to your window [...] the laziness would increase to an unprecedented extent" [51: P2, Berlin 1].

All in all, we can see that subject-related factors discussed by the participants are two-fold. On the one hand, attitudes towards other related areas such as flying in general and online shopping play a big role. On the other hand, emotions such as uncertainty and fear seem to impact attitudes as well.

4.2.3 context-related factors

The analysis of the group discussions shows that there are two different kinds of context-related factors which seemed to of importance to the participants. One group of factors was concerned with the necessary contextual changes and adaptations which would need to take place in order to make the integration of drones into urban airspace viable in the first place. The other group of factors centered around contextual changes and adaptations which would result from the integration of drones into urban airspace. In brief, participants considered both changes to enable the technology and changes brought by the technology.

Contextual adaptations: enabling technology

Participants regarded urban airspace management, effective regulation and supporting infrastructure as essential in order to introduce drones into urban airspaces. It is, however, important to note that many participants were skeptical whether satisfying adaptations in all three areas would be possible.

Airspace management was discussed intensely across all groups. Participants mostly agreed that air lanes would be needed to structure air traffic: "Well you will need some sort of air lanes, you can't just if Amazon or McDonalds or Burger King all switch at once and then they all fly through the air like crazy" [52: P7, Stuttgart 2]. However, they also critically debated how fixed air lanes could be compatible with a precise delivery to any location specified by the consumer: "The other question is if everyone can specify where they want their stuff delivered to, then they have to deviate from the main lane - and then they are still going to fly to the individual houses" [53: P6, Erfurt].

Especially interesting are the diverse perspectives on regulation discussed by the participants. Most often "regulation" was discussed as an abstract concept not related to a specific area of regulation. Many participants regarded regulation as something hampering technological progress: "I think theoretically the technology would be ready within one or two years, but regulation is the problem

I think" [54: P7, Stuttgart 2]. At the same time some participants feared that regulation might be overburdened by drone technology. In Berlin and in Stuttgart participants made comparisons with the recently introduced E-scooters: "The problem is, it all moves so fast that regulation can never catch up. If I imagine that it would be similar to the E-scooters that are now standing around everywhere I would find that rather alarming" [55: P3, Berlin 1].

All in all, we can see that the groups had an ambivalent view on regulation. On the one hand, they were concerned that regulation might block technological progress, on the other hand, they feared that regulation could prove unable to cope with the new challenges posed by drone technology.

Looking at infrastructure, the central question posed by participants was whether and in how far existing infrastructure might be adapted to accommodate drone technology:

> "Will I then have to have an adapter attached to my apartment's outer wall so that the thing can land there. [...] it won't be cheap such a thing that a drone is able to navigate to and in addition to that you will have to check with the landlord whether you are even allowed to stick such a thing to the wall" [56: P8, Stuttgart 2].

Contextual adaptations: caused by the technology

The contextual changes participants addressed mainly concerned economic issues and the impact of the quality of life in cities.

Potential economic impacts were discussed intensely in all groups. Participants mostly worried about "the disappearance of traditional retail" [57: P5, Stuttgart 1] and "job losses" [58: P5, Erfurt]. There were a few participants who argued that "most likely new jobs will be created as well" [59: P8, Stuttgart 2]. However, this line of argumentation was viewed rather critically by others: "I think the problem is that the jobs that are lost, those people do not get the newly created jobs because those will be higher qualified jobs" [60: P3, Erfurt].

The anticipated impact on the quality of life was closely connected to other topics. The key issues were the noise pollution caused by drones, the change of the city aesthetics and the impact of the use of drone technology on the social fabric of the community. Participants worried that it would "increase the stress level if these things buzz around all the time" [61: P2, Stuttgart 2]. They also feared that "if there are drones flying around constantly there will be no places of retreat anymore, no peace and quiet" [62: P4, Stuttgart 1]. In addition to that, they were worried that the skies above the cities might change: "It's not enough that our cities are full of trash, soon everything above will also be full of trash and

then we really live on a trash planet" [63: P2, Berlin 2]. This concern was discussed a lot more intensely in the groups in Stuttgart and Berlin than in the group in Erfurt.

Regarding the impact on the social fabric of the community, participants feared that drones might reduce social interactions even further: "social contacts are lost, I am at home, I no longer go to the city. Not even to the delivery station. I am just the consuming couch potato at home." [64: P8, Stuttgart 1].

> "The most concerning thing about all this ordering is that all social interactions in society are lost. My social contacts, friends, girlfriend, work, I am outside, I go shopping, I go to eat something, I walk around, [when I do that] I constantly meet other people. If I work from home, order my food from home, order everything, I no longer have any interaction, I am completely cut off, then I am old, need medicine, and there is no person who comes to see me but only a f***ing drone. I think that's the worst. Extremely impersonal. All humanity is lost this way." [65: P3, Berlin 1].

It becomes very clear that participants feared that using drone technology specifically in the delivery sector might intensify trends of increased social isolation especially of the elderly already prevalent today. However, it was striking to observe that the younger groups hardly addressed the topic at all, while it was intensely discussed in the two older groups. The group in Erfurt did not mention the topic at all.

In a nutshell, participants regarded regulation (especially air space management) and infrastructure the central adaptations that needed to be performed in order to be able to integrate drones into urban airspace. The main adverse impacts of drone technology discussed by the participants were job losses and the disappearance of local retail companies, the deterioration of the quality of life in cities and the diminishing of social interactions.

5. DISCUSSION

The analysis of the focus group discussions identified main factors for either accepting or not accepting the use of drones as transportation devices in urban areas. In the following, the public discourse around these specific factors will be contrasted with the current scientific discourse. It will be highlighted where and how scientific knowledge of these factors differ from public expectations expressed in the focus groups and where expectations seem to align. This juxtaposition is followed by a discussion of transport drones' potential social implications.

5.1. Contrasting public acceptance factors with scientific findings

The object-related factor of **safety and security** was one of the most frequently discussed factors among focus group participants and similarly forms a key aspect of drone-related research. As drones are mobile physical objects supposed to fly in altitudes of up to 150 meters, they entail the potential danger of crashes with other aircraft or falling to the ground in case of malfunctions. Though most drones have to be considered lightweight, a crashing drone generates considerable kinetic energy (Gregg, 2019) that increases with the square of the respective velocity. Consequently, the bulk of present research efforts is dedicated to find ways of securing and safeguarding drones' trouble-free flight. More precisely, this aim is addressed on three levels: the development and provision of technical systems, the establishment of traffic management systems, as well as through regulation and certification.

Technical solutions comprise the development of detect and avoid systems that prevent the collision with other flying or static objects without human interaction (Airbus, 2018), the integration of redundant or backup systems that are activated in case of technical outages (Petritoli, Leccese, and Ciani, 2017) or the installation of parachute systems that prevent the drone from falling to ground promptly (UAV Coach, 2019).

In parallel with object-related technical developments aiming for a safe flight of unmanned aircraft, current research addresses the build-up of an organizational and infrastructural scheme to allow for future drone traffic. Termed as Unmanned Traffic Management (UTM) or U-Space in the particular European context, these systems can be understood as a highly digitized, automated control system that shall enable safe and efficient access to lower airspace for a large number of drones (SESAR Joint Undertaking, 2018), including the recognition of no-fly zones and predefined flight corridors. Moreover, the potential of using drones for criminal or terrorist purposes is supposed to be confined by technical measures comprising the installation of geo-fencing systems that automatically block the drone from flying into certain areas (e.g. airports) or the installation of remote identification of flying drones including immediate identification of drone owners. In addition, the prevention from physical harm shall be safeguarded through strict regulation. Historically, safety marks a top priority for the aviation sector, illustrated by the fact that aviation represents the statistically safest way of travelling (ICAO, 2019). Aiming to maintain this status in the case of integrating drones into urban airspaces institutions like the European Aviation Safety Agency (EASA) or the US Federal Aviation Administration (FAA) are defining safety standards for unmanned aircraft that are comparable to those of smaller commercial aircraft (Straubinger, Rothfeld, Shamiyeh, Büchter, Kaiser, and Plötner, 2020). Given the regulation

that is translated into standards for certification processes the problem of public safety and security concerns regarding the integration of delivery drones and air taxis seems to be approached with high a level of problem awareness that is likely to meet public expectations of this particular acceptance factor. However, as any technology in today's 'risk society' (Beck, 1992) also the highly digitized ecosystem for drone flights cannot guarantee for total safety and security as drone technologies may create new and unpredictable vulnerabilities.

While an obvious scientific problem awareness for safety and security is actively seeking to dispel public concerns, there seems to be less scientific certainty regarding the evaluation of drones' **environmental friendliness**. Though the future of drones is strongly advertised as generating a reduction of carbon and noise footprints (Kellermann, Biehle, and Fischer, 2020), e.g. in comparison to conventional fossil-fueled vehicles or helicopters (European RPAS Steering Group, 2013), a profound assessment of transport drones' environmental benefits is complex and strongly depends on the respective deployment scenario. In the case of a delivery drone carrying a light load, the fully electrically operated aircraft has been confirmed to have a significantly higher energy efficiency compared to conventional diesel vans (Figliozzi, 2017; Goodchild and Toy, 2018). However, once a diesel van carries more parcels, the van remains more energy efficient as conventional delivery drones are not able to carry loads exceeding 2-3 kilograms on a limited operational range. Hence, based on pioneering studies, the most suitable (logistics) scenarios from an energetic and emission point of view would suggest the direct substitution of conventional delivery vehicles with drones in the case of carrying specific express or medical items. As a consequence, generalized claims for drones' environmental friendliness have to be considered with caution and future research has to proof and define environmentally feasible deployment scenarios, which follows a holistic approach of assessing the environmental effects including an appropriate life cycle assessment of battery-powered drones as well as the consideration of the entire supply chain (Shavarani, Nejad, Rismanchian, and Izbirak, 2018). Moreover, scholars pointed to the fact of recognizing the need for supplementary infrastructures such as warehouses, charging stations, controlling stations (Stolaroff, Samaras, O'Neill, Lubers, Mitchell, and Ceperley, 2018) that may have significant influence on drones' comprehensive assessment of environmental friendliness. Given the uncertainties regarding a proper assessment of drones' environmental friendliness the public demand for a 'green' transport technology is likely to be unfulfilled. While this particular acceptance factor may be accomplished in the case of substituting conventional one-trip-per-item deliveries, environmental benefit of other transport scenarios has to be questioned.

In addition, an environmental assessment on transport drones will have to take into account the implications for wildlife (Nentwich and Horwáth, 2018).

Except from a few studies that analyzed animals' behavioral and psychological responses to drones (Pomeroy, O'Connor, and Davies, 2015; Barnas et al., 2018; Ditmer et al., 2019), there's a lack of knowledge in understanding the entirety of consequences among the diverse species if urban airspace would become a third layer of transport. Even though some animals may have the ability to habituate to repeated exposure to unmanned aircraft (Ditmer et al., 2019), there's reason to believe that despite cardiac accustomization to drone traffic, noise levels may facilitate other chronic psychological effects or the reduction of wariness of other human threats.

Another central factor for accepting drone deployment articulated by focus group participants was the hope for **benefiting effects on the urban transport situation** enabled through bypassing of traffic jams and the reduction of the same as a result of using urban airspace instead of road space. Again, this aspiration is found to be prominently articulated as a key benefit of drone deployment by industrial and political stakeholders. However, as most studies have modelled an estimated the maximum modal share for passenger drones around 4% of the total transport demand (Syed, Rye, Ade, Trani, and Hinze, 2017; Kreimeier and Stumpf, 2017; Rothfeld, Balac, Plötner, and Antoniou, 2018) systemic effects are expected to remain very marginal. Consequently, the public's aspiration for significant ground traffic reduction will most likely be sobered, not least because air taxis will have a maximum capacity of carrying 2-4 passengers. Moreover, as demand for urban air mobility is highly dependent on relative service costs (Balać, Rothfeld, and Hörl, 2019), hub density, distances travelled or boarding times (Al Haddad, Chaniotakis, Straubinger, Plötner, and Antoniou, 2020), there is reason to believe that benefitting effects on the urban transport situation will either remain spatially selective regarding actual flight corridors (e.g. transfers between airports and city centres) or will be experienced by just a very small percentage of users thus letting benefits of passenger drone flights remain socially exclusive. Though focus group participants tended to accept passenger drones in case of beneficial effects for the urban transport situation, from a current research point of view urban air mobility cannot be expected to become a mass passenger transport service (Straubinger et al., 2020). Hence, public expectations for beneficial effects for the overall urban transport situation may hardly materialize.

In addition to the potential reduction of traffic congestion focus groups participants also considered **travel time savings** another beneficial effect that would positively influence the acceptance of drone technologies. However, these effects have to be relativized in light of current research results. According to a study by Rothfeld, Fu, and Constantios (2019) that modelled potential travel time savings in the greater Munich area through introduction of passenger drone services, time savings are not to be realized unless the drone would be able to fly with velocities of 250km/h or more and being accessible within 7 minutes. Modelling a 'slow' scenario with passenger drones flying 150km/h including a

(credible) process time of 20 minutes would even result in the increase of travel time thus strongly limiting the potential of time savings to a few exceptional locations. In most scenarios for the respective case study area, the car or existing public transport systems would remain the most time-efficient transport modes. Consequently, public expectations for travel time savings that were identified in the focus group discussions would only be met in very few cases. Though highly depending on local transport infrastructural conditions and process times, travel time savings are likely to exclusively put into effect for people living close to infrastructural hubs and predominantly seeking to reach destinations outside the city.

Finally, focus group participants were unanimously convinced that drones would contribute to the urban **noise** level, which, as a consequence, may form a major impediment for accepting the technology. In concordance to this finding also recent studies have emphasized the significance of noise levels for public acceptance (Vascik and Hansman, 2018; NASA, 2019; Al Haddad et al., 2020). Accordingly, various research and development efforts aim for minimizing drones' noise footprint. Technical solutions comprise the noise-related optimization of electric engines and rotors and have created a competitive industrial atmosphere in which each manufacturer seeks to develop the quietest aircraft. Given drones' electrically powered engine and technical progress in analyzing and thus minimizing noise emissions, passenger drones will most likely have a far better noise footprint compared to fossil-fuelled helicopters. However, these technical advantages of a comparably quite flight may be relativized and overcompensated by the mere quantitative increase of flights, e.g. in case of deploying drone fleets. Moreover, there's uncertainty regarding the distribution of sound waves once the aircraft is flying in low altitudes over urbanized landscapes, which impedes the absorption of sound waves by walls or vegetation. Because of limited capabilities of technical solutions, the regulation of flight altitudes in combination with strict standards for allowed noise levels are considered additional tools of mitigating drones' noise impact. However, given these technical uncertainties and lacking experiences of numerous and regular drone flights, public expectations of a 'quiet' utilization of urban airspaces may be sobered or even rendered illusory.

Summing up the brief contrastation of identified public acceptance factors with the present scientific debate, we can state that research and regulatory bodies show awareness for all of these factors. While security and safety issues are more likely to meet public expectations the proposed benefits of providing an environmentally friendly, time saving and quietly transport alternative that reduces congestion in urban road space may less likely materialize or will remain marginal thus negatively influencing public acceptance of drone technologies. These various uncertainties regarding the technology's usefulness may become a critical condition for creating an acceptable future of drone transport, which at

current state is already under pressure since representative survey results have revealed clear opposition towards the use of transport drones, except for the use of medical emergencies (Eißfeldt et al., 2018; Dannenberger et al., 2020). Participants of our focus group discussions seemed to generally coincide with these sceptical survey results by articulating ambivalence rather than decidedness towards the use of transport drones. However, referring back to the question of positioning the status of public drone perception within the dualistic frame of either a 'romance' or a 'tragedy' the focus group discussions revealed a status of 'betwixt and between'. Except from participants' rather polarized subjective assessments concerning the use of air taxis that fluctuated in the spectrum of enthusiasm and strict opposition, the discussions about delivery drones illustrated that thinking about this technology offers appears less dualistic than compared to other technological discussions. Despite a general tenor of scepticism almost all of the participants could at least potentially imagine the benefits of transport drones.

5.2. Social implications of drone transport

Discussions among the focus group participants about the potential introduction of transport drones not only revealed major acceptance factors but also comprised the discussion about social consequences of drone transport, which touch upon a wider sociotechnical discourse on automation.

One of these consequences addressed by participants was the danger of **job losses** in the logistics sector. Indeed, the idea of introducing transport drones is inseparably linked and motivated by realizing cost savings achieved through automated processes in last mile delivery. In this sense, the future of drone-based logistics is aimed at drastically reducing workforce through automated and self-adjusting transport devices that fly in a highly digitized control environment (U-Space, UTM), supervised by limited personnel. This may have drastic consequences for employment in the logistics sector, which represents a labor-intensive industry and is considered an important labour market for blue collar workers (McKinnon, Floethmann, Hoberg, and Busch, 2017). Though currently facing a lack of workforce due to fast-growing eCommerce markets and corresponding demand for more drivers, in the long term the logistics sector may no any longer need the current quantity of drivers or commission merchants. Once eCommerce giants' dream (Amazon in particular) of a fully automated delivery process is installed, the already high level of automation inside warehouses will finally be escalated to the physical delivery process. Against this background, current discussions about revolutionizing the transport and logistics sector through the help of drones need to involve a stronger consideration of labour market implications. While political support for drone technologies is slightly

accelerating (BMVI, 2020; European Commission, 2019), socio-political considerations of implementing drones are however not yet found to be existent.

Another potential social implication of drone deployment raised by focus group participants addressed the **abolition of personal contact** with drivers and deliverers. Sometimes of a friend-like relationship due to long-standing regular exchange, the contact with delivery personnel represents an underestimated social tie that for some citizens - especially for older people in rural and periurban areas - can be considered an important facet of daily social interaction and thus societal inclusion (Applin, 2016). As drone-based logistics strive for fully-automated delivery these ties might disappear. Even if such relationships are not being experienced by the majority of urban citizens, this aspect may add to the various social consequences induced by on-going automation processes. The logistics sector's intention to achieve a higher level of automation including the last-mile deliveries may thus add to what sociologist Georg Simmel more than one century ago considered as modern cultures' "aesthetic value" (Simmel, 2004, p. 70) of successively cancelling individual coincidences by a more and more systematic and machine-like organization of life.

Lastly, focus group participants addressed the acceptance factor of service costs, which were considered decisive aspects for participants whether to use drones or not. Beyond the influence of price for subjective technology acceptance, this mentioned factor of service costs also indirectly hints to drones' potential of creating an **elite mobility regime** as air taxi services will most likely be more expensive than regular taxi services. Critical geography has already pointed out the tendency among the group of super rich members of society to establish and use infrastructures that successively render the necessity of ground level use obsolete (Graham, 2016; Kakaes et al., 2015). Enabled by exclusive air corridors, high rise apartment and commercial buildings with private vertiports and corresponding property rights, drone transport may become a catalytic force for elite mobilities including the possibility of a subtle privatization of urban airspaces (Fish and Garret, 2016) that would contradict the status of airspace as a natural commons (Ostrom, 2015).

Aside from addressing the above-mentioned social implications of drone transport most interestingly focus group participants didn't mention the issue of **privacy concerns**. In contrast to privacy concerns marking a core aspect of qualitative and quantitative studies on the subject of drones in previous years (Rao et al. 2016; Jensen, 2016; Lydinia et al., 2017; Lydinia et al., 2018; Nelson et al., 2019) the potential danger of drones collecting, storing and transferring personal data did not seem to be a major concern here. This could may be explained by the specific focus of group discussions on transport drones that were not primarily considered to collect data but rather to transport parcels or passengers. However, even in cases where drones are exclusively used as transport devices, they would technically need sensing and surveillance

technologies to prevent collisions and facilitate the landing/package drop-off and take-off process (Nentwich and Horváth, 2018). As a result, it is also delivery drones that technically bear the potential of (intentionally or unintentionally) causing privacy infringements when deployed close to private spaces.

Summing up these potential implications, the use of drones from a sociological perspective points to the technology's potential of amplifying social disparities if the benefits of transport drones may only be exploited by few while the externalities, e.g. being exposed to overflights, noise or visual pollution, are carried by the majority (Lidynia et al., 2018). Given the potential for intensifying and showcasing social imbalance, there is also reason to believe that transport drones may become another object of protest and social activism if technological benefits and associated costs are unequally distributed.

6. CONCLUSIONS

The use of delivery and passenger drones in urban airspace is no longer science fiction but is becoming an increasingly realistic scenario for the near future. Companies and politicians alike show an increased interest in enabling a new era of mobility that is lifted to 'the third dimension'. At the same time the public has had scarce opportunities to express their opinion and participate in the decision-making process on the future use of the technology. Against this background, this article has presented results of a series of five focus groups conducted in Germany in September and October 2019. The results illuminate attitudes and intentions and explore potential trends of technology acceptance in the context of transport drones. As such, the results can form the basis for further in-depth representative studies taking into account other countries and world regions.

The analysis of focus group discussions demonstrates that attitudes towards delivery and passenger drones have to be described as ambivalent and complex. Few participants expressed clear approval or disapproval. On the contrary, it was apparent that a series of object-, subject- and context-related factors influenced the public's attitude to whether and to what extent drone technology should be used in the future. The main object-related factors were safety and security, the environmental friendliness and the usefulness of the technology. The main subject-related factor was the attitude of a person to technologies in general. Context-related factors were infrastructure, regulation and airspace management on the one hand and the impact of the technology on quality of life and the social fabric in the cities on the other hand. In a nutshell, the hope that drones will be able to compensate present problems in logistics and transport processes was confronted with great scepticism as to how this technology would affect the life of city populations. Furthermore, the

contextualization of public expectations within the scientific discourse on transport drones revealed a potential amplification of the public's general scepticism as the materialization of many of the proposed benefits at present state remain vague or marginal.

It goes without saying that the presented results face the limitation of having explored attitudinal insights of just one particular country, which marks a significant disadvantage and somewhat restricts the conclusions that can be drawn. However, the exploratory research approach of analyzing focus group discussions was intended to form a starting point for further transnational studies. In support of deliberative decision-making future research should aim at comparing attitudes in different countries and especially at discerning whether there are significant national differences in the public's attitudes to transport drones. For that purpose, quantitative studies with representative samples of different national populations should ultimately be conducted.

Bearing in mind the increasing efforts to open markets for commercial drone use in the transport sector there is a strong need for further research on attitudes and the role of the public. While from a research point of view it is key to identify the main areas of concern and expected benefits, from a more political point of view it is key to pave the way for public contribution to decision-making processes. This article aimed to contribute to these efforts as the drone technology is of an obviously disruptive nature, bearing the potential of drastically changing our notion of urban spaces and urban societies. The here presented qualitative results may help to create awareness that drones are an innovative technology offer that nevertheless enforces the need for prescient socio-political and ecological analysis, cautious and responsible regulation, and, not least, stronger integration of the general public in order not to let drones become another technological 'tragedy'.

REFERENCES

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T.

Applin, S. A. (2016). Deliveries by Drone: Obstacles and Sociability. In B. Custers (Ed.), *The Future of Drone Use* (Vol. 27, pp. 71–91). T.M.C. Asser Press. https://doi.org/10.1007/978-94-6265-132-6_4.

Arning, K., & Ziefle, M. (2007). Understanding age differences in PDA acceptance and performance. *Computers in Human Behavior*, *23*(6), 2904–2927. https://doi.org/10.1016/j.chb.2006.06.005.

Barnas, A., Newman, R., Felege, C. J., Corcoran, M. P., Hervey, S. D., Stechmann, T. J., Rockwell, R. F., & Ellis-Felege, S. N. (2018). Evaluating behavioral responses of nesting lesser snow geese to unmanned aircraft surveys. *Ecology and Evolution*, *8*(2), 1328–1338.

Beck, U. (1992). *Risk Society: Towards a New Modernity*. Sage.

Becker, H. (2018). Robotik in der Gesundheitsversorgung: Hoffnungen, Befürchtungen und Akzeptanz aus Sicht der Nutzerinnen und Nutzer. In O. Bendel (Ed.), *Pflegeroboter* (pp. 229–248). Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-22698-5_13.

Benighaus, C., & Benighaus, L. (2012). Moderation, Gesprächsaufbau und Dynamik in Fokusgruppen. In M. Schulz, B. Mack, & O. Renn (Eds.), *Fokusgruppen in der empirischen Sozialwissenschaft* (pp. 111–132). VS Verlag für Sozialwissenschaften. https://doi.org/10.1007/978-3-531-19397-7_6.

Boucher, P. (2016). 'You Wouldn't have Your Granny Using Them': Drawing Boundaries Between Acceptable and Unacceptable Applications of Civil Drones. *Science and Engineering Ethics*, *22*(5), 1391–1418. https://doi.org/10.1007/s11948-015-9720-7.

Boyatzis, R. E. (1998). *Transforming qualitative information: Thematic analysis and code development*. Sage Publications.

BMVI - Bundesministerium für Verkehr und digitale Infrastruktur. (2020). *Unbemannte Luftfahrtsysteme und innovative Luftfahrtkonzepte: Aktionsplan der Bundesregierung*. https://www.bmvi.de/SharedDocs/DE/Anlage/DG/aktionsplan-drohnen.pdf?__blob=publicationFile.

Chamata, J. (2017). Factors Delaying the Adoption of Civil Drones: A Primitive Framework. *The International Technology Management Review*, *6*(4), 125–132. https://doi.org/10.2991/itmr.2017.6.4.1.

Chamata, J., & Winterton, J. (2018). A Conceptual Framework for the Acceptance of Drones. *The International Technology Management Review*, *7*(1), 34. https://doi.org/10.2991/itmr.7.1.4.

Chang, V., Chundury, P., & Chetty, M. (2017). Spiders in the Sky: User Perceptions of Drones, Privacy, and Security. *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems - CHI '17*, 6765–6776. https://doi.org/10.1145/3025453.3025632.

Cheng, Y.-M., Lou, S.-J., Kuo, S.-H., & Shih, R.-C. (2013). Investigating elementary school students' technology acceptance by applying digital game-based learning to environmental education. *Australasian Journal of Educational Technology*, *29*(1). https://doi.org/10.14742/ajet.65.

Christen, M., Guillaume, M., Jablonowski, M., Lenhart, P., & Moll, K. (2018). *Zivile Drohnen—Herausforderungen und Perspektiven*. vdf. http://vdf.ch/zivile-drohnen-herausforderungen-und-perspektiven-e-book.html.

Clarke, R. (2014). The regulation of civilian drones' impacts on behavioural privacy. *Computer Law & Security Review*, *30*(3), 286–305. https://doi.org/10.1016/j.clsr.2014.03.005.

Crabtree, B. F., & Miller, W. F. (1992). A template approach to text analysis: Developing and using codebooks. In B. F. Crabtree & W. F. Miller (Eds.), *Research methods for primary care, Vol. 3—Doing qualitative research* (pp. 93–109). Sage Publications.

Dannenberger, N., Schmid-Loertzer, V., Liliann Fischer, Schwarzbach, V., Kellermann, R., & Biehle, T. (2020). *Traffic solution or technical hype? Representative population survey on delivery drones and air taxis in Germany*. http://rgdoi.net/10.13140/RG.2.2.17542.40003

Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, *13*(3), 319. https://doi.org/10.2307/249008.

Department for Transport. (2016). *Public dialogue on drone use in the UK*. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/579550/drones-uk-public-dialogue.pdf.

Ditmer, M. A., Werden, L. K., Tanner, J. C., Vincent, J. B., Callahan, P., Iaizzo, P. A., Laske, T. G., & Garshelis, D. L. (2019). Bears habituate to the repeated exposure of a novel stimulus, unmanned aircraft systems. *Conservation Physiology*, *7*(1), coy067.

Eißfeldt, H., Vogelpohl, V., Stolz, M., Papenfuß, A., Biella, M., Belz, J., & Kügler, D. (2020). The acceptance of civil drones in Germany. *CEAS Aeronautical Journal*. https://doi.org/10.1007/s13272-020-00447-w.

European RPAS Steering Group. (2013). *Roadmap for the integration of civil Remotely-Piloted Aircraft Systems into the European Aviation System: Final report from the European RPAS Steering Group*. https://uvs-international.org/wp-content/uploads/2016/04/European-RPAS-Roadmap_130620.pdf.

EASA. (2019). *EU wide rules on drones published*. https://www.easa.europa.eu/newsroom-and-events/press-releases/eu-wide-rules-drones-published.

European Commission. (2019). *European Commission adopts rules on operating drones*. https://ec.europa.eu/transport/modes/air/news/2019-05-24-rules-operating-drones_en.

Fereday, J., & Muir-Cochrane, E. (2006). Demonstrating Rigor Using Thematic Analysis: A Hybrid Approach of Inductive and Deductive Coding and Theme Development. *International Journal of Qualitative Methods*, *5*(1), 80–92. https://doi.org/10.1177/160940690600500107.

Figliozzi, M. A. (2017). Lifecycle modeling and assessment of unmanned aerial vehicles (Drones) CO 2 e emissions. *Transportation Research Part D: Transport and Environment*, *57*, 251–261. https://doi.org/10.1016/j.trd.2017.09.011.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: An introduction to theory and research*. Addison-Wesley Pub. Co.

Gefen, D., & Straub, D. W. (1997). Gender Differences in the Perception and Use of E-Mail: An Extension to the Technology Acceptance Model. *MIS Quarterly*, *21*(4), 389. https://doi.org/10.2307/249720.

Goodchild, A., & Toy, J. (2018). Delivery by drone: An evaluation of unmanned aerial vehicle technology in reducing CO 2 emissions in the delivery

service industry. *Transportation Research Part D: Transport and Environment*, *61*, 58–67. https://doi.org/10.1016/j.trd.2017.02.017.

Gregg, P. (2019). *Risk in the Sky? Impact tests prove large aircraft won't always win in collision with small drones*. https://udayton.edu/udri/news/18-09-13-risk-in-the-sky.php.

Grunwald, A. (2012). *Technikzukünfte als Medium von Zukunftsdebatten und Technikgestaltung*. KIT Scientific Publishing.

Hård, M., & Jamison, A. (2005). *Hubris and hybrids: A cultural history of technology and science*. Routledge.

ICAO. (2019). *State of Global Aviation Safety*. https://www.icao.int/safety/Documents/ICAO_SR_2019_final_web.pdf.

Jakobs, E.-M., Lehnen, K., & Ziefle, M. (2008). *Alter und Technik: Studie zu Technikkonzepten, Techniknutzung und Technikbewertung älterer Menschen*. Apprimus-Verl.

Kellermann, R., Biehle, T., & Fischer, L. (2020). Drones for parcel and passenger transportation: A literature review. *Transportation Research Interdisciplinary Perspectives*, *4*, 100088. https://doi.org/10.1016/j.trip.2019.100088.

Lidynia, C., Philipsen, R., & Ziefle, M. (2017). Droning on About Drones—Acceptance of and Perceived Barriers to Drones in Civil Usage Contexts. In P. Savage-Knepshield & J. Chen (Eds.), *Advances in Human Factors in Robots and Unmanned Systems* (Vol. 499, pp. 317–329). Springer International Publishing. https://doi.org/10.1007/978-3-319-41959-6_26.

Lidynia, C., Philipsen, R., & Ziefle, M. (2018). The Sky's (Not) the Limit—Influence of Expertise and Privacy Disposition on the Use of Multicopters. In J. Chen (Ed.), *Advances in Human Factors in Robots and Unmanned Systems* (Vol. 595, pp. 270–281). Springer International Publishing. https://doi.org/10.1007/978-3-319-60384-1_26.

Lucke, D. (1995). *Akzeptanz: Legitimität in der „Abstimmungsgesellschaft"*. Leske & Budrich.

Mayring, P. (2012). Qualitative Inhaltsanalyse—Ein Beispiel für Mixed Methods. In M. Gläser-Zikuda, T. Seidel, C. Rohlfs, A. Gröschner, &

Deutsche Gesellschaft für Erziehungswissenschaft (Eds.), *Mixed methods in der empirischen Bildungsforschung* (pp. 27–36). Waxmann.

McKinnon, A., Floethmann, C., Hoberg, K., & Busch, C. (2017). *Logistics Competencies, Skills, and Training: A Global Overview*. The World Bank. https://doi.org/10.1596/978-1-4648-1140-1.

NASA. (2019). *Urban Air Mobility (UAM) Market Study*. https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20190001472.pdf.

Nelson, J. R., Grubesic, T. H., Wallace, D., & Chamberlain, A. W. (2019). The View from Above: A Survey of the Public's Perception of Unmanned Aerial Vehicles and Privacy. *Journal of Urban Technology*, *26*(1), 83–105. https://doi.org/10.1080/10630732.2018.1551106.

Nentwich, M., & Horváth, D. M. (2018). *Delivery drones from a technology assessment perspective*. Institute for Technology Assessement Vienna (ITA). http://epub.oeaw.ac.at/ita/ita-projektberichte/2018-01.pdf.

Niehaves, B., & Plattfaut, R. (2014). Internet adoption by the elderly: Employing IS technology acceptance theories for understanding the age-related digital divide. *European Journal of Information Systems*, *23*(6), 708–726. https://doi.org/10.1057/ejis.2013.19.

Petritoli, E., Leccese, F., & Ciani, L. (2017). Reliability assessment of UAV systems. *2017 IEEE International Workshop on Metrology for AeroSpace (MetroAeroSpace)*, 266–270. https://doi.org/10.1109/MetroAeroSpace.2017.7999577.

Pikkarainen, T., Pikkarainen, K., Karjaluoto, H., & Pahnila, S. (2004). Consumer acceptance of online banking: An extension of the technology acceptance model. *Internet Research*, *14*(3), 224–235. https://doi.org/10.1108/10662240410542652.

Pomeroy, P., O'connor, L., & Davies, P. (2015). Assessing use of and reaction to unmanned aerial systems in gray and harbor seals during breeding and molt in the UK. *Journal of Unmanned Vehicle Systems*, *3*(3), 102–113.

Rao, B., Gopi, A. G., & Maione, R. (2016). The societal impact of commercial drones. *Technology in Society*, *45*, 83–90. https://doi.org/10.1016/j.techsoc.2016.02.009.

Rothfeld, R., Mengying Fu, & Constantinos Antoniou. (2019). *Analysis of Urban Air Mobility's Transport Performance in Munich Metropolitan Region*. Unpublished. http://rgdoi.net/10.13140/RG.2.2.15444.42886.

Schäfer, M., & Keppler, D. (2013). *Modelle der technikorientierten Akzeptanzforschung*. Zentrum Technik und Gesellschaft, TU Berlin. https://depositonce.tu-berlin.de/handle/11303/4758.

Schulz, M. (2012). Quick and easy!? Fokusgruppen in der angewandten Sozialwissenschaft. In M. Schulz, B. Mack, & O. Renn (Eds.), *Fokusgruppen in der empirischen Sozialwissenschaft* (pp. 9–22). VS Verlag für Sozialwissenschaften. https://doi.org/10.1007/978-3-531-19397-7_1.

SESAR Joint Undertaking. (2016). *European Drones Outlook Study Unlocking the value for Europe*. https://www.sesarju.eu/sites/default/files/documents/reports/European_Drones_Outlook_Study_2016.pdf.

SESAR Joint Undertaking. (2018). *European ATM Master Plan—Roadmap for the safe integration of drones into all classes of airspace*. https://www.sesarju.eu/sites/default/files/documents/reports/European%20ATM%20Master%20Plan%20Drone%20roadmap.pdf.

Simmel, G. (2004). *The philosophy of money* (D. Frisby, Ed.; 3rd enl. ed). Routledge.

Soffronoff, J., Piscioneri, P., & Weaver, A. (2016). *Public Perception of Drone Delivery in the United States* (RARC Report Report Number RARC-WP-17-001). https://www.uspsoig.gov/sites/default/files/document-library-files/2016/RARC_WP-17-001.pdf.

UAV Coach. (2019). *Drone Parachute Systems Provide a Path to Flights Over People*. https://uavcoach.com/drone-parachute-system/.

University of Surrey, & Wu, P. (2012). A Mixed Methods Approach to Technology Acceptance Research. *Journal of the Association for Information Systems*, *13*(3), 172–187. https://doi.org/10.17705/1jais.00287.

Vascik, P. D., & Hansman, R. J. (2018, June 25). Scaling Constraints for Urban Air Mobility Operations: Air Traffic Control, Ground Infrastructure, and

Noise. *2018 Aviation Technology, Integration, and Operations Conference*. 2018 Aviation Technology, Integration, and Operations Conference, Atlanta, Georgia. https://doi.org/10.2514/6.2018-3849.

Venkatesh, V., & Morris, M. G. (2000). Why Don't Men Ever Stop to Ask for Directions? Gender, Social Influence, and Their Role in Technology Acceptance and Usage Behavior. *MIS Quarterly*, *24*(1), 115. https://doi.org/10.2307/3250981.

Wang, Y., Xia, H., Yao, Y., & Huang, Y. (2016). Flying Eyes and Hidden Controllers: A Qualitative Study of People's Privacy Perceptions of Civilian Drones in The US. *Proceedings on Privacy Enhancing Technologies*, *2016*(3), 172–190. https://doi.org/10.1515/popets-2016-0022.

West, J. P., Klofstad, C. A., Uscinski, J. E., & Connolly, J. M. (2019). Citizen Support for Domestic Drone Use and Regulation. *American Politics Research*, *47*(1), 119–151. https://doi.org/10.1177/1532673X18782208.

Wichmann, F., Sill, J., Hassenstein, M. J., Zeeb, H., & Pischke, C. R. (2019). Apps zur Förderung von körperlicher Aktivität: Einstellungen, Nutzungspräferenzen und Akzeptanz bei Erwachsenen im Alter von 50 Jahren und älter: Ergebnisse von Fokusgruppendiskussionen. *Prävention und Gesundheitsförderung*, *14*(2), 93–101. https://doi.org/10.1007/s11553-018-0678-6.

Yao, Y., Xia, H., Huang, Y., & Wang, Y. (2017). Free to Fly in Public Spaces: Drone Controllers' Privacy Perceptions and Practices. *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*, 6789–6793. https://doi.org/10.1145/3025453.3026049.

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. https://doi.org/10.1016/j.tele.2018.04.014.

Ziefle, M. (2013). Ungewissheit und Unsicherheit bei der Einführung neuer Technologien. In S. Jeschke, E.-M. Jakobs, & A. Dröge (Eds.), *Exploring Uncertainty* (pp. 83–104). Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-00897-0_5.