

Investigating attitudes towards drone delivery

Hinnerk Eißfeldt
Verena Vogelpohl
Albert End

DLR German Aerospace Center, Department of Aviation and Space Psychology, Hamburg, Germany.

In recent years, civil drones have become increasingly present in the media and in everyday life. There has been a high level of interest in drone delivery from the very beginning, yet public acceptance of drone delivery still seems limited, with acceptance rates usually ranging from 30 to 40%. The present paper reports findings of a representative national study about the acceptance of civilian drones in Germany. Several factors limiting public support of drone delivery are identified, such as concerns about traffic safety, noise, and animal welfare. In addition, gender effects are discussed, showing female respondents to be more critical about drone delivery in general. Moreover, an effect of NIMBYism is confirmed in the context of drone delivery: Even residents who envision using drones for delivering their own parcels frequently state that they would not agree to flights over their own homes. This particular effect is termed ‘NOMOH’ (‘Not Over My Own Home’).

INTRODUCTION

Drones are becoming increasingly visible in public perception. Applications are ranging from parcel delivery to animal welfare, from the production of live images of major events to law enforcement, and from the inspection of industrial facilities to the design of artificial fireworks. Many drone applications, such as precision farming, are considered to have high potential for conserving resources, and drone technology often is regarded as having a disruptive effect on certain markets and industries. In addition, the use of drones might reduce ground traffic, shorten travel time, and help achieve sustainable transportation. However, the question has been posed as to whether a vertical shift can truly solve existing problems or if it just transfers those problems into another dimension (Kellermann et al. 2020). On global level, the International Transport Forum of the OECD has described opportunities and challenges of future drone usage in a recent report (ITF 2018). National and international institutions are trying to keep up with the rules and procedures being established by developing dynamically. With the continued strong increase in the use of drones expected by everyone involved, there is also an increasing interest in the public's perception of this new element. Widespread public acceptance can promote the successful dissemination of new technologies. On the other hand, concerns of citizens about the use of drones in their daily environment could be potential barriers to the further proliferation of drones, especially in urban areas. Several surveys in different countries have studied the public support for drone delivery. A representative national survey (N = 2007) in the United States reported that 44% of respondents liked the idea of drone delivery while 34% disliked this concept, with strong effects of gender, age, region and rurality. Male millennials with an urban background in western regions liked the idea of drone delivery most (Soffronow et al, 2016). In Great Britain, a survey for the Royal Aeronautical Society conducted in 2016 reported support for drone delivery at 32% and opposition at 51% (Comres 2017). Another study reported 44% opposition to

drone usage for parcel delivery (Nesta 2017), and in a 2019 study (N = 2010), support for drone delivery was found to be only 23% (IME 2019).

In Germany, survey results for the public perception of drones have been published for the years 2017 and 2019 by the German Unmanned Aviation Association (VUL 2017, 2019). Results for parcel delivery were broken down into three geographical areas of service, with more support for drone delivery in remote areas (small villages in the mountains, or small islands in the sea) and rural areas, and the lowest levels of support in large cities. In the 2017 study, the results from respondents who ‘support’ vs ‘oppose’ online delivery were 67 vs 24% for remote areas, 46 vs 44% for rural areas, and 27 vs 64% for large cities. Exactly two years later, the respective results reported were 68 vs 23% for remote areas, 47 vs 43% for rural areas, and 30 vs 60% for large cities, showing a slight increase in support for drone delivery reported in each area over the two-year period.

Differences concerning rurality have also been reported for the United States. As opposed to the German survey, US study participants from urban areas liked the idea of drone delivery better (51% ‘like’ vs 27% ‘dislike’) than those from rural or remote locations (37 vs 41%; Soffronow et al, 2016).

Exploring factors affecting attitudes to drone delivery, Yoo et al. (2019) report differences when comparing urban and suburban/rural groups in an online survey among US citizens. While speed and ease of delivery were significant factors for both groups, performance risk was an additional negative factor for the urban group, whereas for the suburban/rural group, environmental friendliness and personal innovation both had significant positive effects on their attitude towards drone delivery.

In order to shed further light on people's attitudes towards drone delivery, this paper reports findings of a representative national study about the acceptance of drones in Germany, which considers both the attitude to parcel delivery by drones in general and how respondents anticipate their own usage of drone delivery.

METHOD

The study was conceptualized at DLR and a prototype fielded early in 2018 by infas Institute for Applied Social Sciences as a Computer Assisted Telephone Interview (CATI). Using a dual frame technique with 70% landline and 30% mobile phones, a random digital-dial design was used with the aim of reaching conclusive results representative for the German population.

The questions were asked in a standardized manner by specially trained employees in a telephone interview with a duration of about 20 minutes. The answers were coded according to the appropriate template directly online. For quality assurance, online supervision could be performed occasionally by senior staff listening in on the calls. The study fully adhered to the professional code of conduct for telephone interviews agreed on in Germany (ADM 2016).

832 respondents took part in the study, which was conducted between March and May 2018, and answered all questions. Respondents were 51.8% male and 48.2% female, with ages ranging from 14 to 94 years ($M = 51.5$ years, $SD = 18.2$ years), and the average size of household was 2.5 persons ($SD = 1.3$ persons). The response rate was calculated at 3.8% following statistical procedures published by the American Association for Public Opinion Research (AAPOR 2016). This means that about every 25th eligible phone number led to a full interview. Following the same procedures, the cooperation rate for the study was calculated to be 9.4% (defined as percentage of interviews completed, divided by sum of interviews completed (832), plus sum of partial interviews (5), plus sum of refusals (6.952), and sum of other nonresponses (1.048)).

RESULTS

After explaining the purpose of the study and gaining consent for participation, at the beginning of the interview, subjects were asked whether they knew of the term ‘drones’ in aviation. The 95% of participants who answered ‘yes’ were subsequently posed an open question that invited them to mention what they associate with a drone. 794 participants gave answers ranging from single-word responses to several complex sentences, all of which were transcribed by the interviewer on-site. Participants mentioned between 1 and 9 different aspects, with a majority mentioning 2 aspects ($M = 2.44$, $SD = 1.26$). Terms were automatically translated into English using standard software. A total of 1926 words underwent translation, of which the term ‘parcel delivery’ (comprising brand names and service descriptions) was mentioned most frequently ($N = 119$), followed by ‘surveillance/monitoring’ ($N = 105$), ‘toy’ ($N = 98$), with the terms ‘military’ and ‘dangerous’ being mentioned 89 times each. 7 subjects just responded with the word ‘nothing’.

After being asked for their associations with the term drone, study participants were informed that the drones to be discussed in the remainder of interview were unmanned aircraft that look like small helicopters with several rotors, typically four or more, and that only civil applications were

relevant for this study. They were then asked how they would describe their general attitude towards civil drones (‘rather positive’ vs. ‘rather negative’). If they could not decide, the answer was coded as ‘undecided’. Results ($N = 832$) revealed an attitude slightly more in favor of drones: 49% of the participants responded ‘rather positive’, 43% ‘rather negative’, and about 8% were ‘undecided’. (For further information regarding the influence of sociodemographic factors such as gender, age, income, and place of residence in the context of the present study, see Eißfeldt et al., 2020).

During the telephone interview, 7 different areas of concern that had been identified from the literature were asked in randomized order so as to avoid sequence effects. When asked whether they are ‘rather concerned’ or ‘rather unconcerned’ about certain aspects of civil drone usage, most of the respondents indicated their concern about misusing drones for criminal purposes (91%), followed by privacy concerns (86%). Issues related to accidents (liability and insurance, traffic safety, as well as damages and injuries) all raised concerns in the range of 72 to 75%, followed closely by concerns about animal welfare (68%). Concerns about noise were mentioned less frequently (53%). On the whole, a large majority of respondents named at least three or more subjects of concern regarding civil drone usage (91%). However, the number of aspects mentioned varied with respondent age and gender, with women and older respondents being more concerned than younger or male respondents.

About half of the participants (47%) reported having prior experience with drones in their personal lives (37%), on the job (4%), or in both contexts (6%). All areas of concern were reported at higher rates by participants who had no experience with civil drones. Chi-square tests at the 10% level revealed significant differences for concerns about damages and injuries, $\chi^2(1) = 3.09$, $p = .08$, $OR = .76$, animal welfare, $\chi^2(1) = 4.29$, $p = .04$, $OR = .73$, and traffic safety, $\chi^2(1) = 3.39$, $p = .07$, $OR = .75$.

During the interview, the respondents were also asked to what extent they would accept various drone applications in general. Answers were given on a 4-point Likert scale ranging from 1 (totally agree) to 4 (totally disagree). The questions regarding acceptance of the various purposes were asked in a randomized order so as to avoid sequence effects.

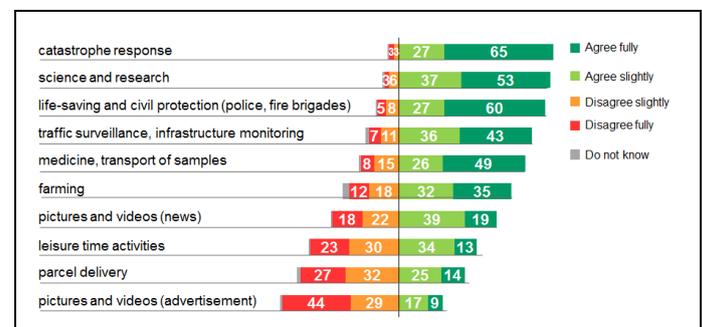


FIG. 1: Acceptance of various drone applications (%)

Acceptance was the highest for official uses such as ‘catastrophe response’ ($M = 1.43$), ‘life-saving efforts and rescue operations’ ($M = 1.56$), and ‘science and research’ ($M =$

1.59). Medium acceptance levels were reported for ‘medicine sample transport’ ($M = 1.83$), ‘monitoring of infrastructure’ ($M = 1.82$), and ‘agriculture’ ($M = 2.07$). There were low acceptance levels for ‘photo and video recordings for news media’ ($M = 2.40$), ‘leisure time activities’ ($M = 2.62$), and surprisingly for ‘parcel delivery’ ($M = 2.73$) as well. ‘Photo and video recordings for advertisement’ ($M = 3.09$) received the least acceptance (see also Figure 1).

For 9 out of these 10 applications, the agreement varies according to gender, with females being substantially less supportive of drone applications; only for the purpose of ‘medicine, sample transport’ was the acceptance slightly higher among female respondents.

A subsequent question asked respondents for which purposes they would agree to have a drone used for themselves: for ‘leisure time activities’, ‘first aid’, ‘parcel delivery’, ‘police and fire services’, or as an ‘unmanned taxi’. Answers were given on the same 4-point scale mentioned above. Again the purposes were asked in randomized order.

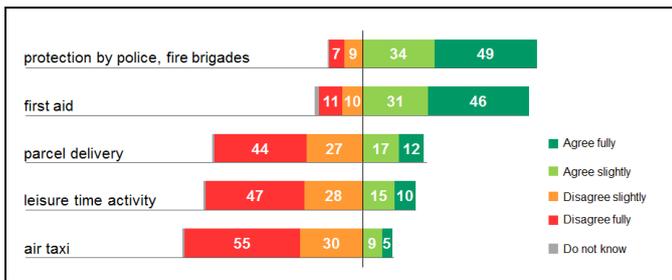


FIG. 2: Acceptance of drone use for own purposes (%)

Interestingly, the willingness to use a drone personally is low for the applications that have the highest economic interest (‘parcel delivery’, $M = 3.03$) and are featured most prominently in the news (‘air taxi’, $M = 3.37$, see also Figure 2). The two applications that receive the highest acceptance levels are ‘protection by police and fire brigades’ ($M = 1.74$) and ‘first aid’ ($M = 1.87$), which the urban population is already accustomed to because of helicopter overflight.

When asked about their own potential use of drones, the agreement among females is significantly lower for all the applications listed in Figure 2. For ‘air taxi’, ‘leisure time activity’, ‘parcel delivery’ and ‘protection by police, fire brigades’, these differences are significant at $p < 0.01$, whereas for ‘first aid’ the difference is significant at $p < .05$.

Taking a closer look at the acceptance of drones for one’s own ‘parcel delivery’, not only does gender make a significant difference, $\chi^2(1) = 8.77$, $p = .004$, $OR = 1.58$, but the corresponding distributions (see Figure 3) seem to indicate that male and female distribution in general show the same linear pattern from ‘agree fully’ to ‘disagree fully’. However, the disapproval from the female respondents seems to be more distinctive.

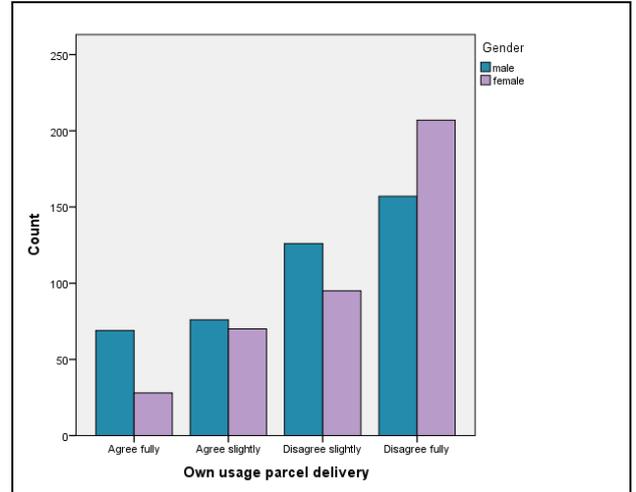


FIG. 3: Acceptance of drone usage for delivery of respondents’ own parcels by gender

According to the regulations in Germany, any overflight of people’s homes is prohibited unless the owner has provided prior consent. The same is valid for flying over groups of people, industrial facilities or public institutions. However, among the public, there is concern about how such an overflight ban could be enforced. When the respondents of the present study were asked about their general acceptance of flights over their own homes during the daytime using the same 4-point scale, results showed slight disagreement ($M = 2.8$, $SD = 1.0$). Overflight at night was even less accepted, with an average rating of 3.1 ($SD = 0.9$), which reflects clear disagreement. However, for the official functions of rescue and protection, respondents agreed slightly with home overflight of drones ($M = 2.2$, $SD = 0.9$). For all three conditions mentioned above, women were significantly more critical towards home overflight than men were (all $p < .001$).

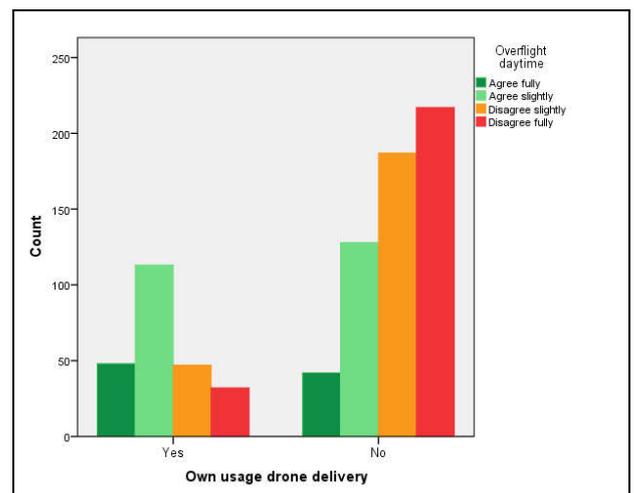


FIG. 4: Own usage of drone delivery envisioned and acceptance of home overflight at daytime.

As Figure 2 shows, 71% of the respondents indicated they would not use drone delivery. However, even having a positive attitude towards using drones for parcel delivery does

not necessarily mean accepting drones flying above one's own dwelling. Among the 29% of respondents who agreed either fully (12%) or slightly (17%) with the prospect of using drone delivery themselves, only two out of three (67%) would accept drones flying above their home at daytime (Figure 4), and less than half (44%) would agree to night-time flyovers.

Whereas parcel delivery is the most prominent association when asked about drones, respondents tend to disagree with this application. To further analyze this attitude, the influence of the various concerns about civil drones on the agreement to drone delivery for oneself was analyzed using Chi-square Automatic Interaction Detection (CHAID). This method partitions a contingency table produced from cross-tabulation by using a semi-hierarchical, sequential procedure (Perreault et al. 1980) and can be used with non-parametric survey data. In the resulting model, the envisioned own usage of drone delivery was the parent group variable to be split up by the different categories of the various areas of concerns. Of all areas of concerns that were assessed, being rather concerned or rather unconcerned about traffic safety best explained the attitude towards civil drones among all respondents, $\chi^2 (1) = 69.3, p < .001$, and entered the analysis first. Concerns about noise among those concerned about traffic safety followed on the second level. On the third level of the CHAID model, concerns about animal welfare entered the analysis among those who were concerned about traffic safety and noise. Overall the analysis yielded groups of 49% agreement (node 1) down to 14% agreement (node 5) to the use of drone delivery for one's own parcels.

In comparison, a decision tree for agreement to the use of drone delivery in general revealed a nearly identical model, with slightly higher agreement at each node (node 1: 59%; node 5: 23%). Again, traffic safety entered the analysis first, with noise following on the next level for those concerned with traffic safety, and animal welfare further explaining concern among those who were also concerned about noise and about traffic safety. Agreement to parcel delivery in general and own usage of parcel delivery were highly correlated (Spearman rho = .76).

To analyze gender differences concerning attitudes toward own usage of drone delivery, the sample was divided into two subsamples. Interestingly, the tree model for the male sample mirrored the model for the full sample, with concerns about traffic safety being most important, followed by noise concerns. For the female sample, concerns about animal welfare entered the analysis first, followed by noise concerns. For both tree models, no third level element entered the solution. Due to the reduced sample size, the requirements for minimum case numbers did not allow a further split. However, reducing the required minimum case numbers by half did not alter the resulting tree models.

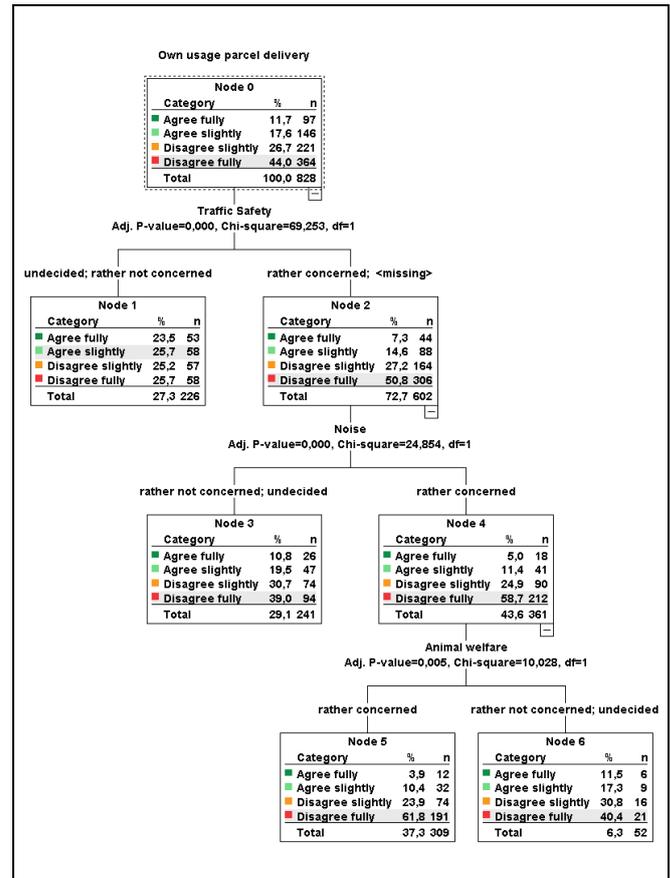


FIG. 5: CHAID decision tree model for own usage of drone delivery partitioned by areas of concern.

DISCUSSION

The attitude towards drone delivery among the German population is critical, 59% of respondents disapprove of this application in general, and 71% do not envision using it themselves. This is well in line with findings for other western countries and has been quite stable over the years. The disapproval rates are higher among females than males, with the gender dimension being again well in line with other countries. An important aspect is that this could be related to an underrepresentation of women in e-commerce. However, in recent years, females statistically pulled even with men in online shopping, as two thirds of both men and women have ordered products or services online in Germany (Statista 2020). Gender differences can be found throughout nearly all aspects of drones, women display lower acceptance levels, have more and higher concerns, are more critical of different applications in general and home overflight in particular. This attitude might be driven by the technology used and the impacts anticipated, however, it seems fair to state that in addition to the weak support for drone delivery, there is a gender dimension with the public perception of drones in general. For the population as a whole, the attitude toward drone delivery in general and for one's own purposes is based on concerns about traffic safety, noise, and animal welfare. When looking at the female subsample, concerns about animal

welfare are the strongest predictor, followed by concerns about noise. For men, concerns about traffic safety play the dominant role, followed by noise concerns.

The imbalance between a generally supportive attitude towards a new, often technological development and the lack of acceptance of change in one's direct environment connected with it has been described as the NIMBY ('Not in my backyard') effect in literature. According to Pol et al. (2006), 'Different factors can generate a NIMBY effect, especially fear of loss of the perceived quality-of-life status and economic value of property' (p.44). This effect is considered to be somewhat 'normal' and seems to be relevant in the context of drone delivery too. Even among those who support drone usage and would consider using drone delivery themselves, the motivation to accept drones as part of their personal environment is limited. As is the case with other new developments that are accepted in general, Nimbyism will be a factor when it comes to the acceptance of drones flying over one's own dwelling. In this special setting however, the term NOMOH ('Not over my own home') seems more appropriate. There is hope that providing transparent information and careful communication can limit the influence of such phenomena on the acceptance of civil drones in daily life.

After years of limited trials of drone delivery services, the start of large-scale services authorized by the government is coming. An online survey conducted late in the year 2019 among 528 online shoppers reports that 31% of the respondents are feeling 'excited', 19% are 'anxious', and 50% 'uncertain' about drone delivery (Panko 2020). As another survey has shown, residents do not support a general right to drone deliveries ('agree' 24%, 'disagree' 31%) whether or not people in their area have agreed before. Instead, they largely agree (73% 'agree', 16% 'disagree') that communities should be consulted on drone deliveries (IME 2019).

Therefore, the results of this study attest to the need for regulation. Besides defining certain areas where drone delivery is allowed, time restrictions can also be a viable measure to increase support. In addition, installing measures of noise control or providing tools for participatory noise sensing to residents (Eißfeldt 2020) could increase agreement. If the acceptance level among residents remains in the range of below one third, drone delivery will not become a successful service in western cities.

Thus, further research should closely monitor drone delivery services and their perception in the public, while taking into account relevant aspects including gender, in order to avoid undesirable developments and to foster community agreement.

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