THE ACCEPTANCE OF CIVIL DRONES IN GERMANY

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ABSTRACT

In recent years civil drones have become more and more visible in everydays life. Reports in the media are numerous, they cover a variety of aspects and technical developments, and everybody is used to bird-eye views being a common feature in television, movies and photography. However little is known how the public perceives this development. This article reports the results of a representative national study on the acceptance of civilian drones. In the presentation of the results, this article describes the social acceptance of civilian drones and thus helps to better understand the perception of civil unmanned aerial vehicles.

KEYWORDS

Aviation; drones; unmannd aerial vehicles (UAV); acceptance; telephone survey.

1. INTRODUCTION

Drones - understood here as unmanned aerial vehicles (UAV) of a civilian nature - 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 the fight against crime, and from the inspection of industrial facilities to the design of artificial fireworks. Almost monthly, the media report on new applications and patent applications. Drones help with the construction of ropeways and high bridges, inspect wind turbines, investigate whales on the high seas, and amongst others warn of sharks on the beach. Many drone applications such as precision farming are considered to have high potential for saving resources, and drone technology often is regarded as having disruptive quality for certain markets and industries. On a global level the International Transport Forum of the OECD has described chances and challenges of future drone usages in a recent report. National and international institutions are trying to keep up with the rules and procedures to be established with dynamic development. The European Commission plans to launch the “U-space” as an overarching system for unmanned aerial transport by 2019, ensuring safe and environmentally sound drone operations in the lower airspace. Furthermore EU-wide rules for safety of drones have recently been published as regulation (EU) 2018/1139 of the European Parliament and of the Council of 4th 2018. In Germany the Federal Ministry of Transport and Digital Infrastructure has issued the "Ordinance for the Regulation of the Operation of Unmanned Aerial Vehicles," (BMVI 2017) which already contained a number of the intended EU regulations including a driver's license, which is mandatory for flying a drone from 2 kilo or above since October 2017.

With the continued strong increase in the use of drones expected by all involved, there is also an increasing interest in the public's perception of this new element. As airport planning has repeatedly shown, a lack of public acceptance can be a limiting factor for further growth in aviation (e.g. Suau-Sanchez, 2011). Similarly, certain concerns among the population regarding the use of drones could restrict their wider dissemination. Likewise, existing positive expectations for the use of drones may promote the expansion of drones. This

article reports the results of a representative national study on the social acceptance of civilian drones. Therefore the results help to better understand the perception of civil unmanned aerial vehicles.

2. BACKGROUND

In February 2017 a dedicated Unmanned Aerial Systems (UAS) workshop was held at the DLR German Aerospace Center, Institute of Flight Guidance in Braunschweig. For the first time all DLR units who are involved in UAS research projects - six institutes and eight on-going projects - worked on the DLR strategy on the UAS airspace integration (Geister et al. 2017). Better knowledge about the acceptance of drones in the German population was identified as important factor for further proliferation of drones in daily life. Results of the study will be the basis for activities to increase the acceptance and to reduce reservations. Finally the results will help to develop new operational concepts for integrating UAS in the airspace with high acceptance of the general public.

Literature research yielded a number of studies published. In addition sometimes subsets of items embedded into larger online-surveys are reported, for instance from their American trends panel Pew Research reported 8% of panelists stated to own a flying drone themselves, and 59% stated to have seen someone operating a drone (Pew Research 2017). Miethe et al. (2014) published a national study using three different online survey platforms finding parcel delivery to be with 42% the least supported drone use of all areas of potential drone use in question. The only international study trying to reach representativeness in the context of drone acceptance was a study by the US postal service (OIG 2017). This study concentrated on the perception of drone delivery in the United States, finding the level of interest in drone delivery being different concerning age groups, genders, geographic regions, and aspects of residency.

For Germany four surveys were identified, two launched online explicitly in the aviation community and the other being online surveys published by the German Industries Aerospace Association (BDLI 2016) or its association for unmanned Aviation (VUL 2017). Whereas the first study concentrated on acceptance of different usages in regard to gender and age of respondents and the perceived need for regulation, the representative online survey launched in October 2017 showed acceptance concerning the civil usage of drones to be be evenly shared among participants with 42% positive and negative each and about 15% stating they do not know. Like the 2016 survey the study confirmed the potential violation of privacy being the highest concern of participants (84%) and showed older persons and women to be more critical towards civil usage of drones in general.

Lidynia, Philipsen and Ziefle (2017) investigated the acceptance of civil drones and perceived barriers for drone use conducting an online survey which was developed from previous focus group discussions with experienced drone users and laypeople. Among other things, their study showed that respondents having own experience with drones were less concerned about privacy but more concerned about the risk of accidents, whereas for non-users violation of privacy was the highest barrier. In another online survey the same authors (Lidynia et al., 2018) compared various levels of aviation background concerning drone acceptance, finding that both non-pilots and aircraft pilots without drone experience were slightly more negative (54%) about drones in general compared to participants with drone experience (including drone using aircraft pilots) showing high acceptance rates between 67 and 90%. Interestingly, the acceptance of overflight over one’s own real estate was below average for most of the reasons provided and did not differ with drone experience.

Building on these results a comprehensive telephone interview survey was proposed and found financing by the executive board of DLR.

3. METHOD

The study was conceptualized in a joint effort of two departments of DLR, flight guidance human factors (FL-SEG) in Braunschweig and aviation and space psychology (ME-PSY) in Hamburg and a prototype fielded February/March 2018 by infas Institute for Applied Social Sciences as 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 by specially trained employees in a telephone interview of about 20 minutes duration in a standardized manner. The answers were coded after appropriate template directly online. For quality assurance online supervision could be performed occasionally by listening in of senior staff. The study fully adhered to the professional code of conduct for telephone interviews agreed on in Germany (ADM 2016).

3.1 Sample description

832 respondents took part in the study, which was conducted between March and May 2018, and answered all questions. Respondents were 51.8% male, 48.2% female, age ranged from 14 - 94 years (mean 51.5, Standard deviation SD 18.2), size of household (mean 2.5, SD 1.3). The response rate was calculated at 3.8 % following statistical procedures published by the American Association for Public Opinion Research (AAPOR 2016) meaning about every 25th eligible phone number led to a full interview. Following the same procedures the cooperation rate for the study was calculated with 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)).

3.2 Weighting

Educational background and income of the sample was somewhat higher compared to the German population, also the gender distribution according to census information should be exactly opposite. In order to compensate bias in the sample design, infas provided survey weights, which consisted of a probability weight and a calibration. The probability weight itself is composed of a dual frame weight, which basically integrates the two separate samples from two sample frames in one sample. Therefore it adjusts the proportion of landline and mobile phone numbers. Additionally, the probability weight controls the different sampling probabilities of persons using their different numbers of mobile phone numbers on the one hand, and the household size and the different number of landline phone numbers on the other hand.

Furthermore, the calibration of the survey data refers to recent census data available for Germany concerning age and gender, educational background, size of household, employment state, region and size of community. In consequence the data were adjusted to provide results generizable for the German population as whole (infas 2018). However, in this paper only raw data will be used to provide a common base for data description as well as for explorative analysis. Whenever reference is made to adjusted data this will be for the purpose of providing population estimates and clearly marked.

4. RESULTS

4.1 Associations with the term drone

After explaining the purpose of the study and gaining consent to participation, at the beginning of the interview the respondents were asked whether they knew the term ‘drones’ in aviation. All the 97% participants answering with: ‘Yes’ have been asked subsequently in an open question to indicate what they associate with a drone. 794 Participants gave answers reaching from one single word to several complex sentences, all being protocolled onsite by the interviewer. Later these qualitative data have been coded into 6 categories namely: Espionage/surveillance/observation (32%), film/video/photo (27%), leisure time/hobby (21%), parcel delivery/transport/air taxi (21%), danger/accident/threat (20%) and military/weapon with 19%.

About 18% were coded ‘other’ indicating a wide range of associations not being covered by the mentioned categories.

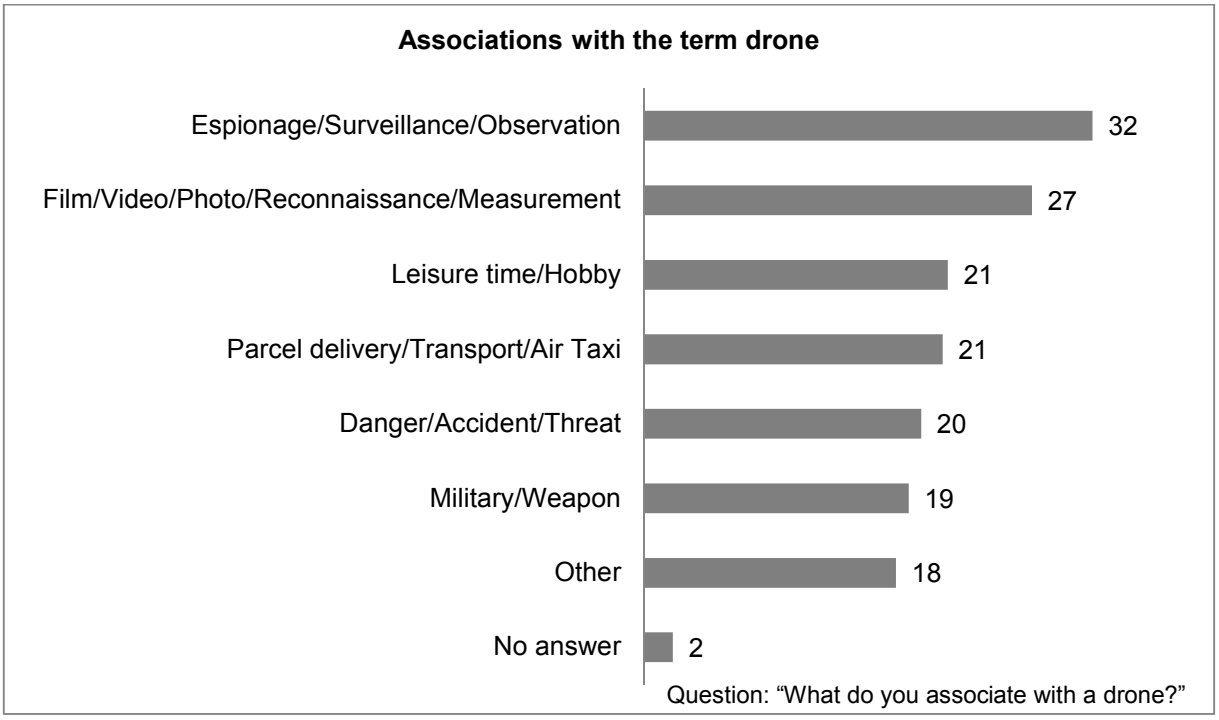

FIG. 1. Associations with the term drone. Results in percent (N = 794); multiple answers possible.

To provide a view of the diversity of associations figure 2 provides a word cloud of associations reported, showing the top 98 words with highest frequency out of 715 possible words in alphabetical order. The size and colour saturation represents the frequency.

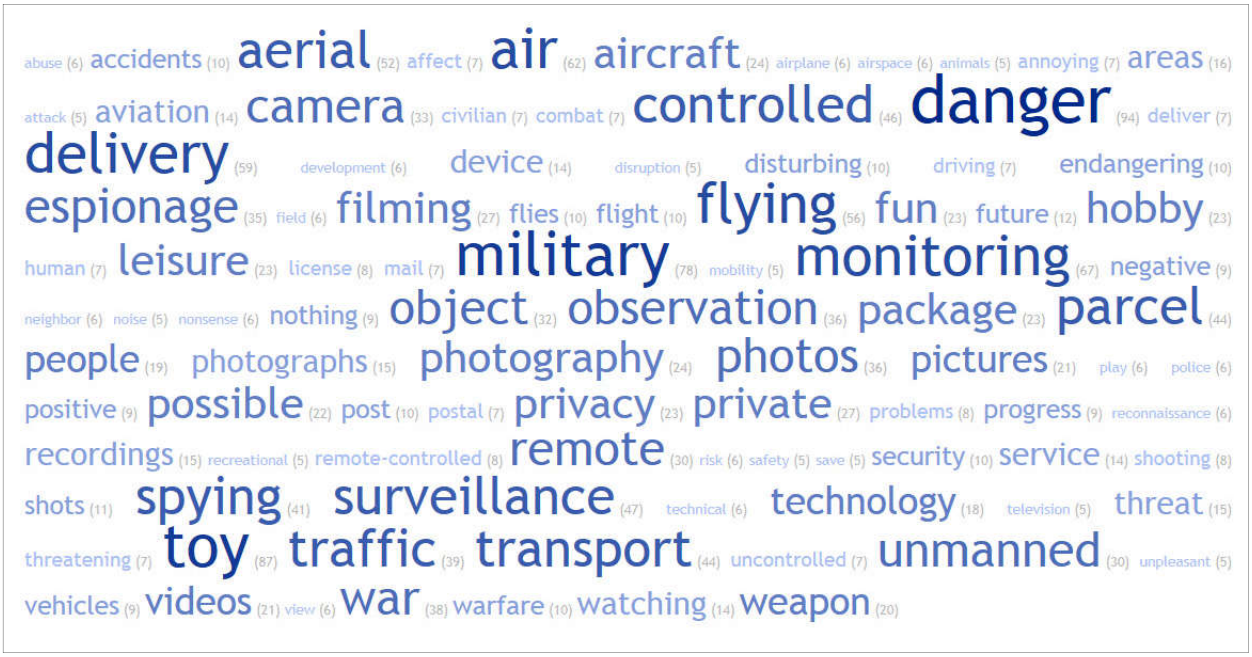

FIG. 2. Associations with the term ‘drone’. Word cloud based on frequency.

4.2 Drone acceptance in German population

After being asked for their associations with the term drone study participants were instructed that the drones asked for in the remainder of interview were unmanned aircraft looking like small helicopters with several rotors, typically four or more, and that only civil applications were relevant for this study. They then were asked how they would describe their general attitude towards civil drones, whether it was rather positive or rather negative? In case they could not decide the answer was coded as ‘do not know’.

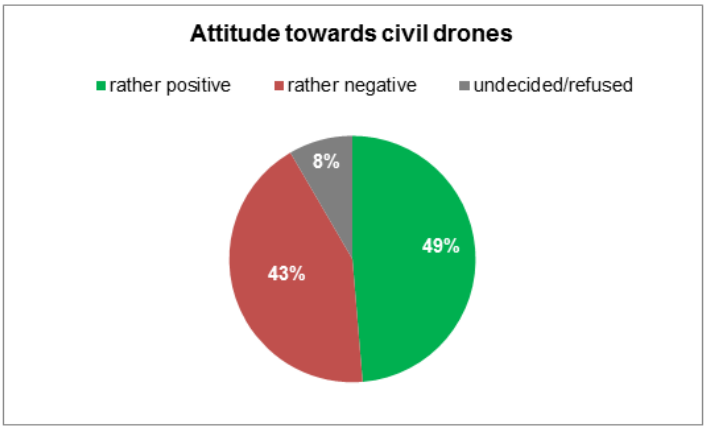

FIG. 3. Attitude towards civil drones;

Being overall a somewhat evenly distributed portion of negative or positive responses to civil drones with a slight advantage for the positive side (43% rather negative, 49% rather positive and about 8% do not know), the results vary with several sociodemographic factors like gender, age, income and place of residence.

4.3 Sociodemographic factors of drone acceptance

As can be seen in Figure 4 subjects who describe themselves as better informed about drones in general have more positive attitude towards civil drones. The same reveals for subjects who describe themselves as having higher interest in technical matters in general (see Figure 5).

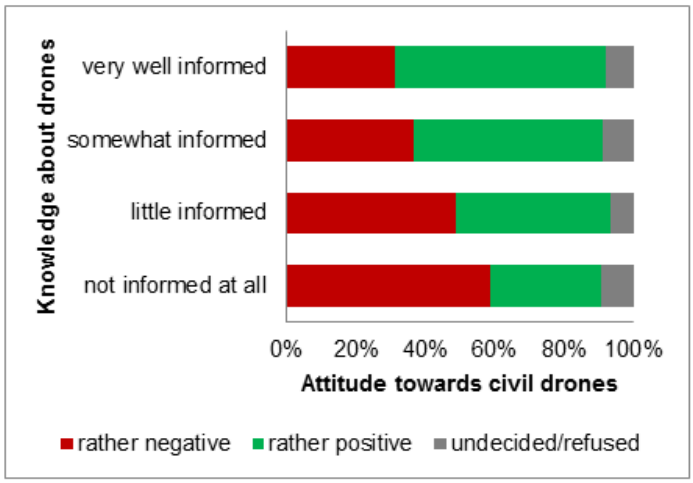

FIG. 4. Attitude towards civil drones on different levels of knowledge about drones

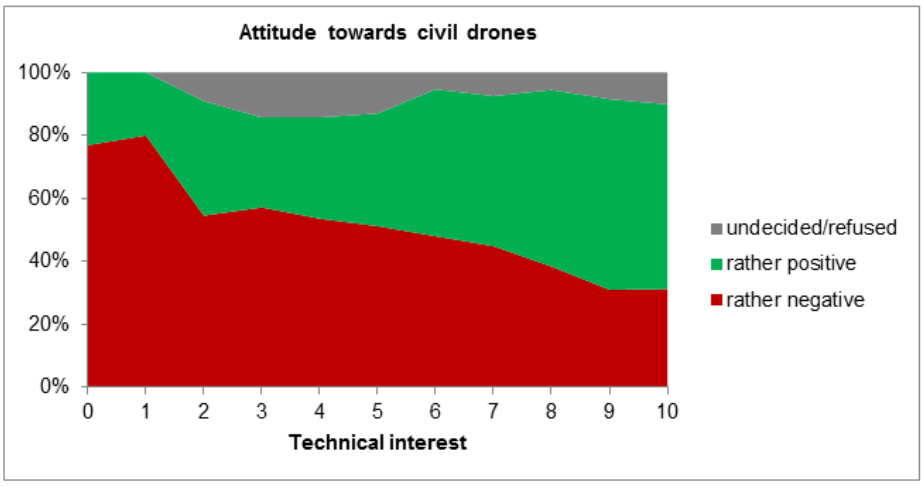

FIG. 5. Relationship between respondent's technical interest and attitude towards civil drones; scale for technical interest ranging from 0 = "not interested" to 10 = "very interested"

As reported above, statistical methods have been applied to adjust raw data for representativity. In the case of the general attitude towards civil drones its variation with age and gender will be shown in the adjusted way representative for the German population (Figure 4). The adjustment has been made to reflect age and gender, educational background, size of household, employment state, region and size of community of the German population. Note that the positive attitudes in the adjusted sample reach 53% and are thus 15% higher than the negative ones.

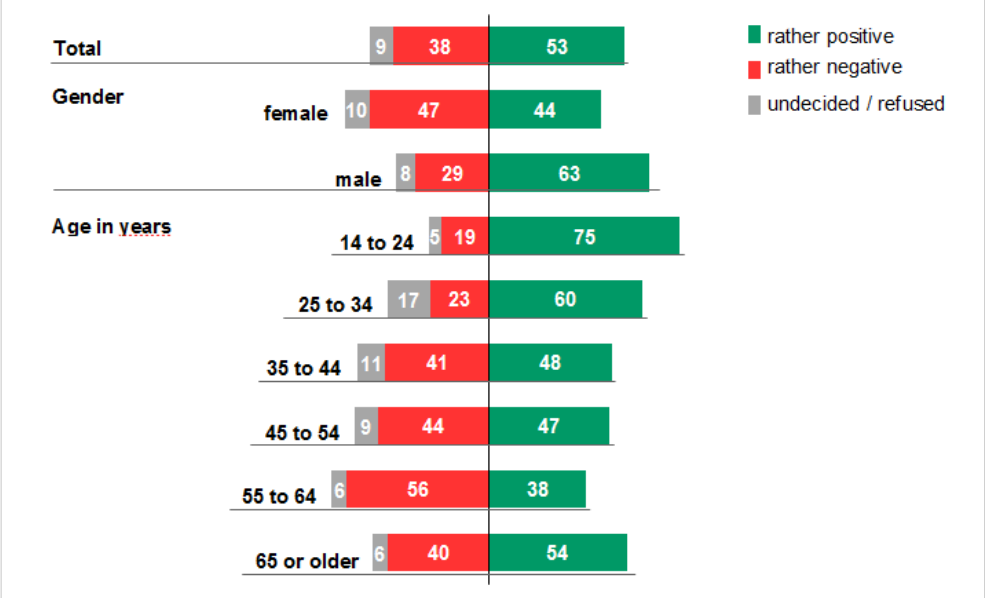

FIG. 6. Attitude towards civil drones. Values in percent; adjusted for representativity

Male respondents are more positive toward civil drones compared to females. Younger study participants show higher acceptance than older ages. Interestingly for senior citizens aged 65 or above the acceptance reaches a level similar to the total sample again.

4.4 Areas of concern

4.4.1 Areas of concern with civil drones

When asked how far they are concerned about civil drone usage subjects, most of the respondents mentioned the possibility of abusive use of drones for criminal purposes (91%, see also figure 7), followed by privacy concerns (86%). Concerns about noise were mentioned less frequently (53%). As a whole, a large majority of respondens named at least three or more subjects of concern about civil drone usage (91%). However the number of mentioned aspects varied with age and gender, being women and older respondents more concerned than younger or male respondents.

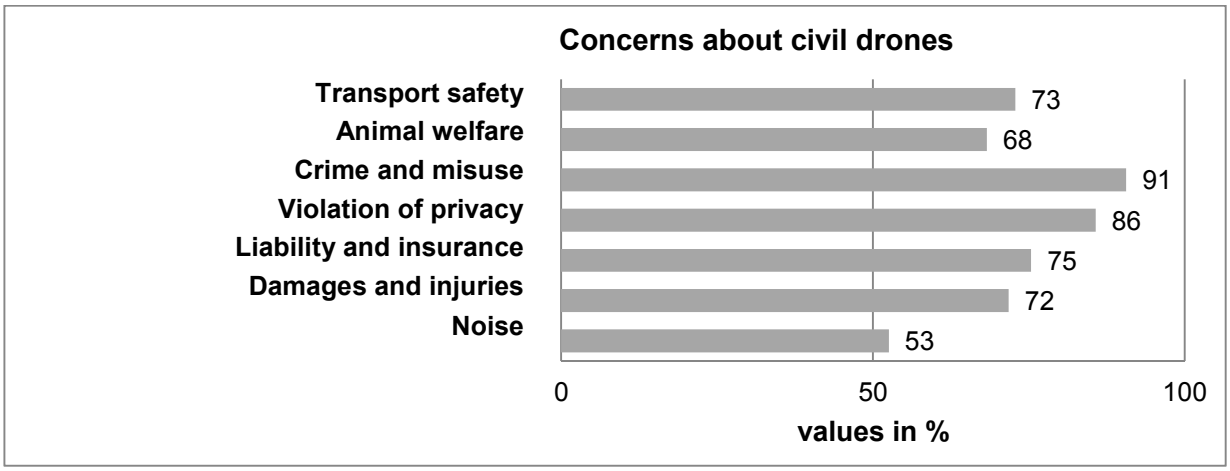

FIG. 7. Concerns about civil drones

4.4.2 Experience and concerns

About half of the participants (47%) report having some experiences with drones in private (36,4%), job (4%) or both (6,1%) contexts. Looking into the concerns expressed by this group reveals that concerns about accidents, about animal and traffic risks are significantly less for those having some kind of experience with drone compared to those having no experiences. CHI square tests at the 10%-level reveal significant values for concerns about damages and injuries χ^2 (1) = 3.09, p = .08, OR = .76; animal welfare χ^2 (1) = 4.29, p = .04, OR = .73 and transport safety χ^2 (1) = 3.39, p = .07, OR = .75.

Noise concerns and direct experience

Somewhat surprising was the rather low level of concerns about drone noise, as this has been discussed as being a potential barrier before: '*One potential outcome of scaled-up drone operations is an increase in urban noise volume exceedances above legal or desired limits' (ITF 2018, p.39).* However, when looking into information about whether a respondent has or has not reported having heard a drone yet, a higher percentage of noise concerns was revealed: χ^2 (1) = 3.29, p = .07, OR = 1.45 for those having heard a drone.

In further χ^2 oriented analysis using Chi-square Automatic Interaction Detectors (CHAID) it was found that when looking into the concerns reported by the total sample the attitude about civil drones at the begin of the interview could best be explained on the first level by concerns about noise, on the second level by concerns about transport safety among those concerned abouit noise and concerns about violation of privacy among

those not concerned about noise and on the third level by concerns about damage and injury among those being concerned about noise and transport safety.

4.4.3 Knowledge about drones and concerns

Towards the end of the interview respondents have been asked how far they felt informed about drones in general. Answers were given on a 4-point-Likert-scale ranging from 1 = very well informed to 4 = not informed at all. This subjective level of information has been shown to be positively correlated with the general attitude toward civil drones, the higher the subjective knowledge, the higher the acceptance and vice versa (see Figure 4). Here the focus is on whether people who are concerned about drones or not differ in their subjective level of information or – in short – their knowledge about drones. For comparing the two groups the t-Test was used.

Table 1
Degree of different drone-related concerns and knowledge about drones, t-test

topic of concern	group (1 = rather concerned, 2 = rather not concerned)	M	SD	T	p	effect size
noise	1	2.59	0.88	3.56	> .001	0.25
	2	2.37	0.86			
transport safety	1	2.52	0.88	1.05	.294	-
	2	2.44	0.86			
animal welfare	1	2.58	0.86	3.96	> .001	0.30
	2	2.32	0.88			
liability and insurance	1	2.55	0.87	3.55	> .001	0.29
	2	2.29	0.88			
crime and misuse	1	2.53	0.86	3.14	.002	0.39
	2	2.19	0.92			
violation of privacy	1	2.53	0.87	2.34	.019	0.24
	2	2.32	0.85			
damages and injuries	1	2.57	0.88	4.03	> .001	0.31
	2	2.30	0.84			

Results reveal significant group differences for concerns on noise ($t(799) = 3.56$, $p < .001$), animal welfare ($t(819) = 3.96$, $p < .001$), liability and insurance ($t(812) = 3.56$, $p < .001$), crime and misuse ($t(820) = 3.14$, $p = .002$), violation of privacy ($t(821) = 2.34$, $p < .019$) and damages and injuries ($t(822) = 4.03$, $p < .001$). In each case respondents who are less informed about drones feel more concerned about these issues than those who are not concerned. Only in terms of drones being a potential threat to transport safety no significant group differences were found ($t(810) = 1.05$, $p < .294$).

4.5 Acceptance of varying purposes of drone usage

During the interview the respondents have been asked how far they in general would accept various applications of drones, resulting in different levels of agreement. Answers were given on a 4-point-Likert-scale ranging from 1 = totally agree to 4 = totally disagree. The different purposes were asked for in randomized order to avoid sequence effects. Agreement was highest for official uses as catastrophe response and life-saving efforts, but also for police and security activities. It was low for leisuretime activities, and surprisingly low for transport and parcel delivery. Table 2 shows the results in ranked order.

Table 2
Agreement towards different applications of civil drones, highest agreement on top

Purposes of drone usage	Average agreement (max = 1, min = 4)	Standard Deviation (SD)
Catastrophe response	1.43	.70
Rescue operations, lifesaving efforts, civil defense	1.56	.83
Research purposes	1.59	.74
Monitoring of infrastructure (transport or energy)	1.82	.90
Medicine (transport)	1.83	.98
Agriculture	2.07	1.02
Photo and video recordings for news	2.40	.99
Leisure time activities	2.62	.98
Parcel delivery	2.73	1.02
Photo and video recordings for advertising	3.09	.99

In a further question the respondents have been asked for what purposes they would agree to use a drone themselves: For leisure time activities, for first aid, parcel delivery, police and fire service or as unmanned taxi. Answers were given on the same 1-4 scale mentioned above. To analyze whether this willingness is affected by the general attitude toward drones mean values were compared between three groups: participants with attitude toward drones being rather positive, not sure, or rather negative. For this purpose a univariate ANOVA was conducted.

For every type of use results reveal significant differences between the groups. When using drones for first aid, participants with a positive attitude (M = 1.59, SD = 0.82) are more likely to make use of it than those with a negative attitude (M = 2.21, SD = 1.10), ($F(2, 814) = 38.71$, $p < .001$, $\eta^2 = .08$). Furthermore respondents who were not sure about their attitude towards drones were more willing to use them in terms of first aid than persons with a negative view. No significant between participants with a positive attitude and those who are undetermined were found.

With regard to the usage for leisure time activities the statistics show that people thinking positive (M = 2.74, SD = 1.07) about drones are more willing to use them for leisure time activities than people having negative (M = 3.50, SD = 0.78) or undetermined positions (M = 3.25, SD = 0.90), ($F(2, 825) = 61.59$, $p < .001$, $\eta^2 = .13$). Similar results are found for using drones as unmanned taxis. Also in this case participants with a positive attitude (M = 3.08, SD = 0.91) towards drones are more likely to use them as taxi than those with a negative (M = 3.69, SD = 0.60) or undetermined one (M = 3.42, SD = 0.86), *(*$F(2, 814) = 56.08$, $p < .001$, $\eta^2 = .12$).

In terms of parcel delivery there are significant differences between study participants with positive (M = 2.65, SD = 1.04) and negative attitude (M = 3.44, SD = 0.87) and between those thinking negatively about drones and people who are not sure (M = 3.21, SD = 1.02), *(*$F(2, 824) = 64.20$, $p < .001$, $\eta^2 = .13$). Findings for drones in police and fire service are similar. Results also reveal significant differences between persons with positive (M = 1.54, SD = 0.73) and negative positions (M = 2.02, SD = 1.02) as well as between participants with negative and neutral view (M = 1.52, SD = 0.75), *(*$F(2, 816) = 31.17$, $p < .001$, $\eta^2 = .07$).

Table 3
Drone acceptance and respondents willingness to use drones for different purposes

	group 1	M	SD	group 2	M	SD	F	p	effect size
first aid services	*between groups*	-	-		-	-	38.71	< .001	0.08
	rather positive	1.59	0.82	rather negative	2.21	1.10	-	< .001	0.64
	rather positive	1.59	0.82	not sure	1.76	0.97	-	.354	-
	rather negative	2.21	1.10	not sure	1.76	0.97	-	.003	0.42
leisure time	*between groups*	-	-		-	-	61.59	< .001	0.13
	rather positive	2.74	1.07	rather negative	3.50	0.78	-	< .001	0.81
	rather positive	2.74	1.07	not sure	3.25	0.90	-	< .001	0.49
	rather negative	3.50	0.78	not sure	3.25	0.90	-	.091	-
parcel delivery	*between groups*	-	-		-	-	64.20	< .001	0.13
	rather positive	2.65	1.04	rather negative	3.44	0.87	-	< .001	0.82
	rather positive	2.65	1.04	not sure	3.21	1.02	-	< .001	0.54
	rather negative	3.44	0.87	not sure	3.21	1.02	-	.188	-
police and fire service	*between groups*	-	-		-	-	31.17	<.001	0.07
	rather positive	1.54	0.73	rather negative	2.02	1.03	-	< .001	0.55
	rather positive	1.54	0.73	not sure	1.52	0.75	-	.983	-
	rather negative	2.02	1.02	not sure	1.52	0.75	-	< .001	0.51
Air taxi	*between groups*	-	-		-	-	56.08	< .001	0.12
	rather positive	3.08	0.91	rather negative	3.69	0.60	-	< .001	0.78
	rather positive	3.08	0.91	not sure	3.42	0.86	-	.013	0.38
	rather negative	3.69	0.60	not sure	3.42	0.86	-	.044	0.42

Note. Small mean values imply that people would like to use drones for that purpose whereas large ones mean they would not. For between group comparisons Eta² is given as effect size, for pairwise comparisons Cohen's d.

In sum we can see that in every case respondents with a positive attitude towards drones are more willing to use them for different purposes compared to respondents with rather negative attitudes. Also respondents who are undetermined often are more likely to make use of drones than persons thinking in a negative way about civil drones. Mean values overall indicate that the use of drones for first aid (M = 1.87, SD = 1.01) and police and fire service (M = 1.74, SD = 0.90) is most favorable whereas the use as unmanned taxi is rated as least favorable (M = 3.37, SD = 0.84).

4.6 Overflight acceptance

Concerning the new regulations in Germany, similar to flying over groups of people, industrial facilities or public institutions, any overflight of peoples homes is prohibited as long as the owner has not indicated prior concent. In a previous study, Lidynia et al. (2017) investigated the acceptance of civil drones and perceived barriers for drone use in Germany. For those 77.5 % of their sample not having used drones the violation of privacy was the most important barrier to drone acceptance. In their 2018 sample participants showed disagreement with most of the reasons for drone's overflight over one's own property. The current study shows similar results: The participants were concerned about drones flying over their own homes, especially at night. However for previously accepted purposes of drone usage (see Table 2), mainly official functions of rescue and protection, drone overflight was rather agreed with.

Table 4
Overflight acceptance for different conditions

Overflight Acceptance	average agreement	Standard Deviation
for accepted purposes	2.2	0.9
during the day	2.8	1.0
at night	3.1	0.9

Agreement: 1 =totally agree, 4 = totally disagree, undecided/refused/ very different excluded

When asking for overflights in general at daytime results showed less acceptance (M = 2.8; SD = 1.0) compared to asking for flight reasons accepted before (M = 2.2; SD = 0.9) overflight at night was accepted least, with an average agreement of 3.1 reflecting clear disagreement. A somewhat indifferent picture was revealed concerning overflight heights: Regardless of three different heights of overflight (8-10m, 10-20m, >20m, operationalized as buildings of different amount of floors) respondents showed a clear preference for official functions as rescue or police. Leisure time activities or parcel delivery found rather no acceptance for overflight of own property at any height.

4.6.1 Population size and overflight acceptance

Furthermore, the population size of people's residence affects their acceptance of drones overflying their house was addressed. Participants were asked for their acceptance of overflights regarding those drone flight purposes they had agreed to beforehand. In addition they were asked for their acceptance of overflights in general by day and by night. Answers for acceptance were given on a 4-point-Likert-scale ranging from 1 = totally agree to 4 = totally disagree.

Table 5
Population size of residence and peoples acceptance for drones overflying their house

acceptance of overflight	group 1	M	SD	group 2	M	SD	F	p	effect size
for accepted purposes	*between groups*	-	-	-	-	-	1.86	.085	-
during the day	*between groups*	-	-	-	-	-	2.38	.027	0.02
	between groups	-	-	-	-	-	3.29	.003	0.02
at night	5.000 to 20.000	3.26	0.84	100.000 to 500.000	2.87	1.03	-	.013	0.43
	20.000 to 50.000	3.27	0.86	100.000 to 500.000	2.87	1.03	-	.020	0.43

Note. Small mean values imply that people accept drones overflying their house and large ones mean they do not. For between group comparisons Eta² is given as effect size, for pairwise comparisons it is Cohens d.

Results of an univariate ANOVA reveal significant between group differences for overflights by day ($F(6, 769) = 2.38$, $p = .027$, $\eta^2 = .02$) and by night ($F(6, 772) = 3.29$, $p = .003$, $\eta^2 = .02$). However, pairwise comparisons for overflights during day time indicate no significant differences between individual groups. For

overflights by night significant differences between people living in small towns of 5.000 to 20.000 citizens (*M* = 3.26, *SD* = 0.84) and people living in cities of 100.000 to 500.000 citizens (*M* = 2.87, *SD* = 1.03) were shown. People who live in small towns counting 5.000 to 20.000 citizens also significantly differ from those who live in towns with a population size between 20.000 and 50.000 citizens (*M* = 3.27, *SD* = 0.86). In both cases participants from larger towns show a higher acceptance than participants from smaller towns. For the general acceptance of drones overflying houses for previously agreed purposes no significant between group differences were found ($F(6, 753) = 1.86$, $p = .085$).

4.6.2 Population size and acceptance of flying in urban areas

Additionally it was analyzed how population size influences the acceptance of drones flying in different urban areas. Answers were given on a 4-point-Likert-scale and ranged from 1 = totally agree to 4 = totally disagree.

For drones flying in city centers univariate ANOVA reveals significant between group differences ($F(6, 754) = 4.13$, $p < .001$, $\eta^2 = .03$). Respondents who live in villages counting less than 2.000 citizens (*M* = 3.43, *SD* = 0.69) significantly differ from those who live in higher populated towns of 50.000 to 100.000 citizens (*M* = 2.90, *SD* = 0.98), 100.000 to 500.000 citizens (*M* = 2.71, *SD* = 0.98) and with more than 500.000 citizens (*M* = 2.76, *SD* = 0.94). Study participants from smaller towns would accept drones in city centers less compared to inhabitants of larger cities.

Table 6
Population size of residence and respondents acceptance for drones flying in different urban areas

urban area	group 1	M	SD	group 2	M	SD	F	p	effect size
city center	*between groups*	-	-	-	-	-	4.13	< .001	0.03
	less than 2.000	3.43	0.69	50.000 to 100.000	2.90	0.98	-	.045	0.60
	less than 2.000	3.43	0.69	100.000 to 500.000	2.71	0.98	-	.001	0.78
	less than 2.000	3.43	0.69	more than 500.000	2.76	0.94	-	.001	0.78
housing area	*between groups*	-	-	-	-	-	4.51	< .001	0.03
	5.000 to 20.000	3.03	0.81	100.000 to 500.000	2.65	1.00	-	.005	0.43
	5.000 to 20.000	3.03	0.81	more than 500.000	2.71	0.91	-	.021	0.35
	20.000 to 50.000	3.04	0.94	100.000 to 500.000	2.65	1.00	-	.013	0.42
	20.000 to 50.000	3.04	0.94	more than 500.000	2.71	0.91	-	.048	0.35
commercial area	*between groups*	-	-	-	-	-	2.73	.012	0.02
	5.000 to 20.000	2.40	0.94	more than 500.000	2.09	0.87	-	.015	0.36
industrial zone	*between groups*	-	-	-	-	-	1.37	.225	-

Note. Small mean values imply that people feel well informed about drones and large ones mean they do not.

In respect of drones flying in housing areas significant differences between the groups can be reported ($F(6, 759) = 4.51$, $p < .001$, $\eta^2 = .03$). Respondents living in small towns with a population size between 5.000 and 20.000 citizens (*M* = 3.03, *SD* = 0.81) differ significantly from those living in larger towns counting between 100.000 and 500.000 citizens (*M* = 2.65, *SD* = 1.00) and cities with more than 500.000 citizens (*M* = 2.71, *SD* = 0.91). Furthermore results indicate significant differences between participants living in towns of 20.000 to 50.000 citizens (*M* = 3.04, *SD* = 0.94) and 100.000 to 500.000 (*M* = 2.65, *SD* = 1.00) as well as in cities counting more than 500.000 citizens (*M* = 2.71, *SD* = 0.91). Again acceptance from larger town inhabitants is higher than those from smaller ones. Further significant group differences are found for drones flying in commercial areas $F(6, 754) = 2.73$, $p < .012$, $\eta^2 = .02$. In this case the acceptance of people living in small towns of 5.000 to 20.000 citizens (*M* = 2.40, *SD* = 0.94) is significantly lower than the acceptance of people living in large cities counting more than 500.000 citizens (*M* = 2.09, *SD* = 0.87).

For drones flying in industrial zones findings reveal no significant group differences ($F(6, 759) = 1.37$, $p < .225$).

4.7 Effect of interview - slightly positive trend of acceptance

For many participants of this survey the interview will have been the first time of talking about drones for about 20 minutes in detail. Touching a variety of positive and negative aspects the general aim of conduct was neither to scare nor to overly convince respondents of drone usage. To control potential effects a follow up question was placed at the end asking for a potential change of opinion towards drones due to the interview content.

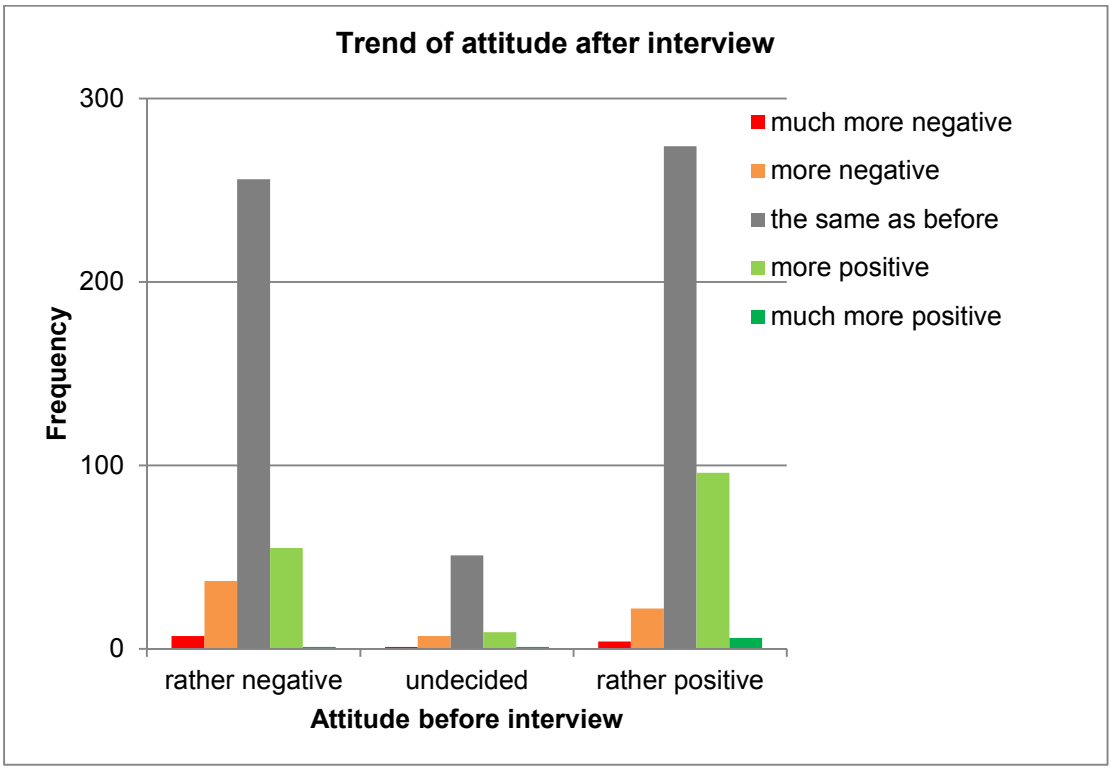

FIG. 8. Trend of attitude towards civil drones after interview

Evaluation revealed a majority (70%) of stable opinions at the end of the interview and a slightly higher percentage of subjects with an opinion becoming more positive (20%) than a more negative (10%). This was the same regardless what has been the initial statement of acceptance, rather negative, rather positive opinion or undecided concerning the civil usage of drones.

5 DISCUSSION

The results of the study provide an overview of the acceptance of civil drones in the German population. The term “drone” is well known to the population and associations are manifold. The impression however is that the necessary distinction between military and civil use of drones can be and is being made by many of the respondents.

Similar to comparable studies a somewhat consolidated pattern of acceptance was found with slightly more than four out of ten respondents beeing rather negative about civil drones, four to five indicating rather positive attitude towards drones and the rest being undecided yet. Being a bit more on the positive side than the national survey of VUL 2017 might be due to the the CATI method used which could be more interactive than filling in an online survey, however it could also be an effect of recent national and international legislation. A more detailed look revealed that the attitude towards drones in civil usage context has a complex pattern of origins. Amongst other things, it depends on gender, age, housing situation, but also on existing interest in technical matters and the individual level of information about civil drones.

Civil drones have various possible applications: They can be used for leisure time activities and parcel delivery, but also for life-saving efforts, catastrophe response or police and security activities. Interestingly the willingness to use a drone personally is lowest for those usages having the highest economic interest behind (parcel delivery) and the highest reflection in the news (air taxi). The two reasons finding highest acceptance are rescue and public safety, applications which at least the urban population is used to already at present from helicopter overflight. As analysis has shown respondents with a positive attitude towards drones are more willing to use them for different purposes than those being more negative. Also respondents who are undetermined often are more likely to make use of drones than persons thinking in a negative way about that issue. This aspect could indicate that those currently undecided about drone acceptance will over time rather change to a positive attitude than to the opposite, as concerning own usage at least the barrier from undecided to negative attitude seems stronger.

Technical interest in general and knowledge about drones play an important supportive role for acceptance. This finding is in line with prior research: The better people are informed about possible chances and risks the more they accept the use of drones (Mac-Sweene George, (2003), Rothier (2015)). Most likely this aspect is also being reflected by the positive trend found with this telephone interview: Providing information on drones led to more positive than negative changes of attitude. However this trend also shows that the issue of drones is still young and attitudes can still be influenced and to some degree changed to any direction.

According to models of technology acceptance (eg Davis, Bagozzi and Warshaw (1989)) the attitude toward using a technology is dependent on the perceived usefulness (subjective perception that the application of the technology improves the performance) and the perceived ease of use (the perception of the necessary effort to learn how to use the application/ technology. Both aspects could be enhanced through increased knowledge and experience. The results presented have shown that having own experience with drones can have significant effects on subjective concerns and overall acceptance, not always in the form that own drone experience reduces concerns and improves acceptance. Providing regulations is one way to shape experiences positively, for instance by issuing an overflight ban. However, as recent research has indicated, there are more aspects requiring attention as potential influences on drone acceptance in the society including design, noise, and movement patterns (Chang et al. 2017).

It is likely that the German public is still forming its opinion about civil drones. One way to lead it positively and further increase the overall acceptance of civil drones could therefore be the encouragement of information campaigns tailored to specific target groups identified in this study. Further research should focus on the future development of the public’s acceptance of civil drones, to foster a successful development of the U-space and its applications in Germany.

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