Master Thesis

Are autonomous drones perceived as trustworthy? The effects of fire department resemblance and transparent information on trust in a drone

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Abstract

Speed, accuracy, and flexibility are of crucial importance in an emergency call for a fire department. A technology that might aid in life-threatening operations is a drone because it is cheap, versatile, and fast. Yet, people that encounter drones flying over their own homes often feel uncomfortable and violated in their privacy. To investigate the effect of drones flying over residential areas, 128 responses were collected from German citizens. The aim of the study was to investigate methods to increase feelings of trust in drones that are operated by the fire department. The 2x2 study design measures the effect of fire department resemblance of a drone and transparent information on trust in the drone. The results show that resemblance significantly improved trust ratings. Information yielded ambiguous results because it increases trust when no resemblance is present but shows no significant effect when it is combined with resemblance. However, both methods alone improved trust compared to a regular drone. Combining the two methods does not result in a higher trust rating which means that implementing one of the two proposed changes should be sufficient. Providing a suitable purpose for a drone flight appears to be an important determinant for trust and the results indicate trust transfer from an organisation onto technology is possible through design changes.

Introduction

The application areas of an unmanned and small aerial vehicle like a drone are plentiful. Drones can be equipped with specialized tools such as cameras, communication equipment, olfactory receptors (“Sniffer Drones”), or other payloads. These tools have proven to be useful in contexts like cartography, agriculture, safety and security, communication, firefighting and many more (Odido & Madara, 2013). Not only are they comparably cheap and easy to use but they can also reach speeds up to 100 to 160 km/h and are capable of delivering payloads to hard-to-reach locations (Skorup & Haaland, 2020). Altogether, drones can help to tackle difficult problems in a cheap and adaptable fashion, and they are readily available (Kugler, 2019).

Drones and the Fire Department. Consequently, drones become an increasingly attractive tool for emergency services to aid in firefighting, search and rescue missions, or in responses to natural disasters. They have already been deployed after earthquakes, floods, forest fires, gas leakages, and even nuclear emergencies (Restas, 2015). The common factor in all these situations is that they require prolonged observation in a dangerous environment. Since it would be more expensive and irresponsible to deploy a manned aircraft in these hazardous environments, drones provide a cheap, fast, and suitable source of information (Laszlo et al., 2018; McRae et al., 2019). Additionally, drones are often faster and more accurate than a person, which is highly valuable in crisis situations (Kugler, 2019).

With the help of additional equipment, drones can collect information that would otherwise be hidden from perception. They can be equipped with infrared or thermal sensors that give additional information on the causes and severity of a fire or the location of people in a burning building. There are also experimental situations in which drones are equipped with payloads such as fire-extinguishing balls, which contain heat-activated fire suppressants that can be safely dropped from the sky, that help fight the fire actively (Aydin et al., 2019). Furthermore, it is possible to take this one step further and deploy a drone swarm, which consists of drones communicating with each other autonomously and delivering real-time information from different angles to ensure improved efficiency and increase the safety of helpers on the ground (Roldán-Gómez et al., 2021).

Drones, however, are also used in a military context in which it is used as a large unmanned aerial vehicle to carry out airborne missile strikes (Hassanalian & Abdelkefi, 2017).

During a war, drones can cause unthinkable destruction remotely and it can be the reason for countless losses of life. Understandably, people do not want to encounter military drones. But there are also reasons why civil drones have not been widely introduced yet. People on the ground sometimes report feeling uncomfortable when they encounter drones (Chang et al., 2017). Consequently, the term “drone” could be interpreted ambiguously and contains negative implications as well.

To conclude it can be said that drones can be very useful for the fire department and aid in the prevention, monitoring and dealing with disasters. But whoever wants to introduce drones in a public area needs to consider the needs and concerns of the people that are affected by the drone deployment. The purpose of this study is to find ways to utilize autonomous fire department drones in Germany that take the fastest route available while decreasing undesired feelings as much as possible. Thus, the research question for this study will be:

Is it possible to influence the public acceptance of fire department drones over residential areas?

Theoretical Framework

The Public Image of Drones. To understand why and when people feel uncomfortable in the presence of drones, it is necessary to investigate how a drone is perceived and in which environments its usage is deemed acceptable. One of the key features of a drone is that it appears to operate autonomously. It is often remotely controlled, which results in the people encountering a drone, not being able to see the person that operates it (Odido & Madara, 2013). This, in addition to potentially being equipped with a camera, can result in feelings of being observed (Chang et al., 2017). Currently, there is no way to detect if the drone is recording, who is recording, and what will happen with the footage afterwards, which in general decreases the wellbeing of the recorded party (Chang et al., 2017). Sometimes, this discomfort can manifest as outbursts of aggression and violence against the drone (Cornett, 2015).

This violation of privacy is usually stated as the most concerning issue with drones that are not used in a military context. In an online survey, one-third of the participants indicated that they fear a loss of privacy through drones (Herron et al., 2014). This work is complemented by Eißfeldt et al. (2020), which also found the violation of privacy to be the most important issue. Other concerns include the potential misuse for criminal activities, safety issues, animal welfare and noise pollution (Eißfeldt et al., 2020; Lidynia et al., 2017). In general, elderly participants and women expressed more negative feelings towards civil drones (Eißfeldt et al., 2020). This finding is in line with other studies suggesting that males and young people are more interested in adopting new technologies (Hwang et al., 2019).

But the environment in which a drone is used can also contribute to how it is perceived. People raised concerns about flying drones in residential neighbourhoods because they may be used to spy on someone (Chang et al., 2017). With malicious intent, a drone can be used to fly over walls and spy on someone else's property or even inside of their house. The attacker could remain anonymous and decrease the risk of getting caught by using a drone (Birnbach et al., 2017).

To conclude, the unknown purpose of the drone flight and the environment can intensify uncomfortable feelings. Yet, the public does not entirely oppose drone usage. In Germany, the overall opinion on civil drone usage seems to be balanced with 42% of participants stating that they feel positive, 15% did not know, and 42% stating that they feel negative about it in a representative online survey (Eißfeldt et al., 2020). Furthermore, the results of Clothier et al. (2015) indicate that the public did, in large parts, not form a final opinion on drones. This might be due to drones being an emerging technology in a relatively new field and many people have not been exposed to it yet. Research on drone usage is relatively scarce and to better understand how a drone affects the people around it, the perception of similar technologies could be investigated.

The Feeling of Being Watched: CCTV and Drones. There is a more thorough scientific understanding when it comes to how people feel and react in the presence of CCTV (Closed-Circuit Television) and security cameras. Both technologies are designed with the purpose of observing an area remotely and in both cases, the observation can result in feelings of being watched (Wang et al., 2016).

There are, however, limitations directly linking CCTV to drones. The CCTV, which is often used in shops or public places is stationary and it is relatively easy to see the area that is captured by the cameras. A drone, in contrast, is able to move freely in an area and it is not easily comprehensible what is being recorded, which might intensify uncomfortable feelings.

Another limitation might be that the main purpose of CCTV is to ensure security and to prevent crime, while drones can be used for a more extensive range of purposes, for example, entertainment. Nonetheless, it is generally not possible to distinguish why a drone is used in a certain context and people often assume that their privacy is being violated (Herron et al., 2014). Therefore, both technologies might invade the privacy of the people that are being observed similarly. The analysis of CCTV might provide useful insights into how drones are perceived but due to the aforementioned limitations, the results should be interpreted with care.

First, the effectiveness of CCTV in the prevention of crime needs to be reviewed. It was found that CCTV is an effective tool to prevent and solve crimes (Welsh & Farrington, 2008). Piza (2018), on the other side, argues that the effectiveness of CCTV is conditional on the type of crime. For example, it was observed that CCTV cameras are highly suitable to prevent auto theft but less effective in preventing street crime (Piza, 2018). This effect could be explained by street crimes being more impulsive and not as thoroughly planned as car thefts. Another possible explanation could involve that a car thief faces a higher risk of getting caught because the vehicle could be tracked during the escape by other cameras.

But even when there is no increased chance of being caught the feeling of being observed affects how people behave. For example, simple pictures of an eye called eye-cues have been used to decrease antisocial behaviour by up to 35% (Dear et al., 2019). The same effect of more prosocial behaviour can be observed with CCTV usage (Van Rompay et al., 2009).

Second, it needs to be considered how people feel in the presence of CCTV. A study conducted by Van Rompay et al. (2015) demonstrates that CCTV coverage can increase feelings of safety and thus the general wellbeing in comparison to an area without this coverage. In line with this finding, Gill and Spriggs (2005) found that people felt safer in the presence of CCTV and generally people do not avoid places in which it is used. On the other side, the public might not perceive CCTV as effective in fighting crime because it would not benefit them in the situation of need and only help with the investigation (Bennett & Gelsthorpe, 1996). Furthermore, widespread CCTV usage can be perceived as threatening and as an intrusion on privacy. According to Bennett and Gelsthorpe (1996), people fear the misuse of these systems which could be used to spy on people instead of ensuring their safety. A mitigating factor might be that there are strict legal regulations in Europe for CCTV usage. For example, CCTV recordings can only be stored for three days without an exception, which might contribute positively to its opinion (European Data Protection Board, 2019). A similar law does not exist for drones. In general, it can be said that the public is supportive of CCTV usage, but there are circumstances in which it is not regarded as acceptable (Gill et al., 2007).

The Location of CCTV. How people feel about CCTV depends on the location in which it is used. If it is located in a residential or private area, people are less supportive compared to a public area (Gill et al., 2007). People opposing widespread CCTV usage often refer to privacy concerns which could explain why acceptance is lower in private contexts (Hempel & Töpfer, 2004). A study conducted by Taylor (2010) showed that CCTV in schools was negatively viewed by the students. They described not feeling comfortable behaving normally or showing their emotions because they felt observed (Taylor, 2010). In general, CCTV is not deemed acceptable in private contexts because of privacy intrusions (Hempel & Töpfer, 2004).

Additionally, acceptance of CCTV differs between countries as well, which needs to be considered when implementing new systems. For example, a study conducted in Europe found that people in Britain appear to be the most supportive and participants in Germany and Austria are the least supportive and refer to a restriction of privacy (Hempel & Töpfer, 2004). This might have implications for the design and generalization of the current study since it can be assumed that German citizens might have more negative attitudes to drones compared to other countries as well.

In conclusion, CCTV may be an effective tool in some public areas to ensure safety and it can have beneficial effects on crime prevention, feelings of safety, and prosocial behaviour. However, CCTV also violates privacy to a certain degree, and it will only be accepted if the public values increased security as more important than the violation of privacy.

It can be expected that similar effects apply to drone usage, which is partly already investigated in scientific research. For example, the findings considering the location of CCTV are consistent with results from studies that investigated drone usage in a public and private setting which also showed that using drones in a private setting decreases acceptance of drone usage (Oltvoort, 2018). But acceptance cannot be taken for granted and, especially in Germany, the environment in which it is used needs to be considered carefully.

Cooperation with Drones - The TCC Model. The main goal for organisations that want to deploy drones is to achieve cooperation from the public. In this case, cooperation does not mean direct help but rather a lack of interference. Additionally, the public's needs and opinions should be considered. The main concern of drone flights, violations of privacy, should be addressed to increase public wellbeing.

The Model of Trust, Confidence and Cooperation (TCC model) developed by Earle et al., (2010) predicts that cooperation is in large parts determined by trust and confidence. Trust is a very nuanced concept and there is no consensus to its definition (McKnight & Chervany, 2001). For the purpose of this study, the definition of Lewicki and Wiethoff (2000) will be used which describes trust as "an individual's belief in, and willingness to act on the basis of, the words, actions, and decisions of another" (p.87). According to this definition, trusting someone makes oneself vulnerable to a certain extent. In the TCC model, trust is a social concept, influenced by shared values, which is often overlooked in similar models (Earle et al., 2010). Shared values could include similar perceptions of morality and integrity (Earle et al., 2010) as well as ingroup membership, which was shown to have a positive effect on trust (Foddy et al., 2009).

Confidence on the other hand is more calculative and describes the perceived certainty in which a future event will happen as expected. Mainly, past performances can influence how confident people are in someone or something else (Earle et al., 2010). Trust and Confidence, however, interact with one another. For example, increased trust can lead to increased confidence without considering past performances (Earle et al., 2010).

This model was developed to explain cooperation in risk communication and is one of the first to incorporate trust as a predictor for cooperation. In line with this theory, trust has the biggest influence on cooperation with drones as an emerging technology according to the literature (Luo et al., 2010; Nelson & Gorichanaz, 2019; Okamura & Yamada, 2020).

When the TCC model is applied to fire department drones it means that the public needs to have trust and confidence in not only the person or organisation controlling the drone but also the drone itself. In this context, trust means that people are aware that drones could be used for spying but trust the drone and its operator enough to believe that this will not happen. In exchange for this trust, people generally expect positive outcomes that result from the usage of the technology (Earle et al., 2010). The positive outcomes for fire department drones are often indirect and latent because the drone will often be deployed to help someone else and not the residents that feel violated by the drone. Still, people might be inclined to trust a fire department drone because they might profit personally from its usage at a later time.

But even if people trust the drone and the operator, cooperation will only occur if they have the confidence that the drone usage will happen as was previously promised and anticipated. Confidence is mainly influenced by the impression of the capabilities of the operator or past experiences. Both are hard to assess since drones are a relatively new technology and the operator can often not be seen. This means that people must rely on other past performances of the fire department and the overall trust needs to be even higher. But there may not be a reason to increase the trust in the fire department if it is already sufficiently established. It might be more important to transfer the existing trust onto the new technology.

Trust in the Fire Department. To decide if the goal is to increase the trust in the fire department and the drone itself or to transfer existing trust onto the drone, the public image of the fire department needs to be analysed. The fire department is generally regarded as the most trustworthy profession. In a survey of 27 countries, 80-99% of the people have high or very high trust in the fire department, depending on the country, which is higher than any other profession (Gaspar, 2020). Therefore, the top priority might not be to establish trust in the fire department but rather transfer the already existing trust onto the drones that are used by the fire department.

Trust is an important determinant of the acceptance of emerging technology and therefore the main focus of this study. When the fire department deploys drones, it is crucial that the fastest route is taken to minimize the travel time. Often the fastest route leads through residential areas. As described previously, drones above a private sector are the reason for the highest amount of discomfort (Nelson & Gorichanaz, 2019; Oltvoort, 2018). Hence, it is especially important to establish trust in these drones.

Influencing Trust. The literature review showed additional factors that might influence the trust of drones. Apart from trust, the antecedents that were mentioned most often are the purpose of the drone flight, the transparency with which information is accessible, and the perceived control, including the possibility to ask a responsible person about the necessity to use the drone in a certain situation. Other antecedents such as the height of the drone will not be investigated in this study because implementing changes may not be feasible due to regulations that limit the height of drone flights and time constraints.

Trust transference. It has been shown that the acceptance of a drone is dependent on its operator (Ahrendt, 2020). However, it remains unclear if trust from an already established institution can be transferred onto a drone. In certain technological contexts, such as mobile brokerage and websites, trust can be transferred by drawing connections from a familiar trusted scenario to an unfamiliar one (Lin et al., 2011; Stewart, 2003). For example, if a business or shop wants to create a website, a picture associating the online store with the physical, already known shopping channel was shown to increase trust and the intention to buy from it (Stewart, 2003). If the same process is applicable to drones, an association between the fire department and the drone might increase the trust in the drone.

Purpose. Herron et al. (2014) showed that knowing the purpose of a drone flight can increase the public acceptance of drone usage. This finding is in line with research about CCTV that showed that the attributed intent influenced the overall acceptance of CCTV coverage (Van Rompay et al., 2015). If the purpose is considered as worth supporting, the trust in the drone flight will increase. This is, for example, the case for search and rescue missions and for conducting scientific research and less for commercial usage or for supporting local law enforcement (PytlikZillig et al., 2018). Furthermore, people need to believe that the intentions of the footage that is being captured by the drones are genuinely meant to increase safety and not to be misused. But on the other hand, it needs to be considered that fire departments need to act extremely fast which makes it very hard to communicate the purpose of a drone flight beforehand. But enough information should be displayed as soon as possible to give a drone flight a suitable purpose

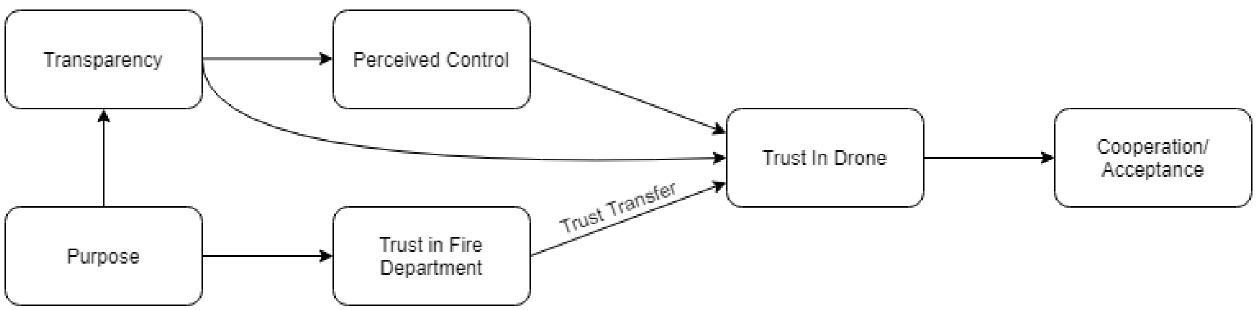
Transparency. Another possible method to increase trust is to increase the transparency of drone usage. By disclosing when, where, why, and how a drone is used, the trust in the whole project can be increased (PytlikZillig et al., 2018). New technology is often linked to uncertainty regarding its risks and transparent information can be used to increase knowledge about the topic (Li et al., 2008). Increasing the transparency of drone usage has been shown to increase the trust, perceived control, and general acceptance of drone usage (Oltvoort, 2018).

Perceived Control. Accountability is another important determinant for public acceptance (De Cremer et al., 2001). People need to be able to raise their concerns should they feel like their privacy is being violated or they do not feel safe when being in the presence of drones. There is a need for a platform or trustworthy representative that will listen to complaints (Smith, 2009). Thus, people that are directly affected by the drones would be able to shape the drone usage policy and feel like they are in control of the situation.

Four concepts have been discussed that could influence trust in drones. They are however not mutually exclusive and interact with each other. A coherent model of the influence on trust in drones can be seen in figure 1.

Figure 1

Model of Drone Acceptance derived from the TCC model and literature review.



Combining Influences. The aim of this study is to investigate two methods of increasing trust in a fire department drone. To increase the effectiveness of the proposed changes, the above-mentioned influences on trust will be grouped together.

The first method to increase trust relates to the drone being regarded as a part of the fire department to utilize the already existing trust in emergency services and transfer it onto the drone. By resembling the fire department, the drone is given an important purpose which should increase trust in addition to using the already established trust of the fire department. This could be achieved by painting the drone in typical fire department colours. But, in certain weather conditions, it may be hard to distinguish this redesigned drone from a similar-coloured private drone and it may cause confusion. Therefore, a siren and blue lights could be added that will be activated whenever the drone is deployed to assist emergency services.

The second method combines transparent information, perceived control, and purpose into transparency. Including information about the purpose of the drone flight, as well as the contact information of a responsible person, should further increase the trust in the drone according to the literature review. This could be realized through a website with collected data of all drones that are in the air in real-time in form of a live tracker. The effectiveness of transparent information of drone flights in public places compared to private environments has been documented by Oltvoort (2018). In a fire department context, however, it might not be feasible to provide details about the location of an accident to prevent gawkers from travelling to the accident area to take pictures and hinder the fire department. To circumvent this problem, an approximate location could be used which might still be beneficial for trust perceptions.

For simplicity, the two methods will be named Resemblance and Transparency, but they consist of a variety of trust alternating concepts. With that in mind, the hypotheses for this study are going to be:

H1: Increasing the fire department resemblance of a drone will increase the trust in the drone.

H2: Providing transparent information about the drone flight will increase the trust in the drone.

Methods

Participants and Design

A 2 (*Resemblance*: yes or no) x 2 (*Information*: yes or no) between-subjects study design was used with trust as the dependent variable. Trust is measured as a continuous variable. The participants were randomly allocated to one of the four groups.

The initial participant set for this study consisted of 80 residents of Gronau above the age of 16. The participants volunteered to take part in this study after being informed through official social media channels of the mayor of Gronau, the city marketing of Gronau and social media and website of the fire department of Gronau. While in theory, all residents of Gronau had access to the social media channels, it was less likely that older residents would answer the study. Furthermore, people outside of Gronau could have answered the social media posts. An initial power analysis showed that a power statistic of 0.8 can be achieved with a participant set of 25 to 30 per group. Since the number of collected responses was not yet sufficient for significant findings, a second stage of data collection was conducted. In the second stage, the participant group was widened to all German participants that were older than 16. An additional 128 responses were recorded, totalling 208 participants. Again, people were asked to fill out the study by private social media posts and were asked to distribute it further to others.

After the data collection was completed, 78 participants that did not finish the entire survey or were younger than the minimum age of 16 were excluded from the study. To ensure the validity of the data of the remaining 130 participants, the participants were asked who might have operated the drone. If the description fitted another condition the participant was moved accordingly. In 19 cases, the participants did not link the redesigned drone without information to the fire department. However, if the description of the operator fitted no condition, which is the case when for example the operator is identified as the police, the participant was excluded from the study. In the end, 123 participants remained in the final data set (*Resemblance* only: n = 25; *Information* only: n = 26; both: n = 26; neither: n = 46). The mean age of the participants was 36.02 (*SD*= 15.15) years. The participant set consisted of 62 male participants, 55 female participants, and 6 missing answers.

Measures

The dependent variable trust was measured with the use of self-report data. A 7-point Likert scale measured the trust in the drone in which 1 represents strongly disagreeing and 7 strongly agreeing. The trust measurement scale that was used in this study is based on the work of Rawlins (2008) with changes made by Oltvoort (2018) and Ahrendt (2020). Since Rawlins' (2008) study focused on trust between organisations and employees, changes were made by Oltvoort (2018) to adapt the scale to drones and Ahrendt (2020) added the item: *I trust the drone operator not to disclose any personal information about me."* to further tailor the measurement to the purpose of the study.

The trust measurement scale consisted of 15 items which were divided into four subcategories: overall trust, benevolence, integrity, and competence.
The subscale overall trust consisted of five items, an example being: "*I am willing to let the operator make decisions for people like me.*". Benevolence, the second subscale consisted of three items such as: "*I believe that the operator is interested in the well-being of people like me, not just themselves.*" The third subscale, integrity was measured by four items, for instance: "*The operator treats people like me fairly and justly.*". Lastly, the competence subscale had three items like: "*I feel very confident about the skills of the operator.*". The trust definition that was used in this scale includes the confidence aspect of the TCC model which made it suitable for accessing cooperation and acceptance.

The Cronbach's alpha and Lambda 2 scores of the scale in the previous study ranged from from $\alpha = .69$ and $\lambda_2 = .69$ for benevolence to $\alpha = .88$ and $\lambda_2 = .88$ for integrity (Ahrendt, 2020).

The Cronbach's alpha for the entire trust measurement scale of this study was $\alpha = .96$ and $\lambda_2 = .96$. While this shows high internal consistency, values exceeding .90 or .95 might suggest that the test items are redundant (Tavakol & Dennick, 2011). Hence, a factor analysis was conducted to check for multicollinearity.

Factor Analysis

The initial factor analysis showed that there was one factor with an eigenvalue greater than 1 which was desirable for this trust measurement scale. However, three items showed a significant overlap with correlation values greater than .8 which indicates multicollinearity. Hence, the content of the questionable items was reviewed. The item: "The operator can be relied on to keep its promises." showed a high correlation with two other items of the subscale integrity: "The operator treats people like me fairly and justly." and "The operator does not mislead people like me.". Since the content was similar, the correlation was too high, the items belonged to the same subscale, and was not the only item in this subset, two out of these three items were removed for further analysis.

Another pair of questionable items with high correlations belonged to the subset of competence and contained: "I feel very confident about the skills of the operator." and "The operator has the ability to accomplish what it says it will do.". The previously described criteria were applied again, and one item was removed from the analysis.

These changes made it less likely that one of the subsets biased the outcome because it was more important than other subscales. After all, multiple items measured the same underlying construct before. Additionally, the Cronbach's Alpha and Lambda 2 scores dropped from $\alpha = 96$ to $\alpha = 94$ and from $\lambda_2 = .96$ to $\lambda_2 = .94$ after the removal of these items.

Procedure

The participants were recruited through social media posts of official and private channels which posed the question of whether drones are dangerous or useful and asked participants to fill out a study to help a master thesis. However, the introductory text did not mention the cooperation with the fire department but rather only the intent to investigate drone usage to not bias the results. The potential participants were asked to follow a link to start the study. The participants used their own devices to take part in the study. The use of a computer or laptop has been recommended but participating with a phone was also possible. First, a quick introduction about the purpose of the study was shown to the participants, followed by the ethical consent form. Contact information of the researcher and the ethics committee of the University of Twente, which approved this study, were displayed. During the manipulation of the study, the participants were shown a short informational text as well as a video of a drone flyover which was different depending on the condition the participant was assigned to. The informational text was different for each condition and explaining for example who to contact in case of drone misuse.

The video was filmed from a first-person perspective to increase relatability. In the first section of the video, the participant was sitting in a backyard, which resembles a private context.

Afterwards, a drone flew overhead which was designed differently depending on the condition. The drone approached the backyard, made a quick stop for orientation while not directly looking at the participant, and then continued on its original trajectory. Once the drone was sufficiently far away, the video ended. Participants were asked who might have operated the drone.

During the next part, information about how to obtain information via a website was shown and the participant was directed to a live-tracking website with transparent information about the drones. Depending on the condition, the information changed or was missing entirely.

After the manipulation, the participant was directed to the next pages that contained the trust measurement scales, questions about demographics, followed by additional questions for further exploratory analyses such as questions about experiences with drones and which drone operators are deemed acceptable. At the end of the study, the participants were debriefed that the study was part of an initiative to design drones for the fire department.

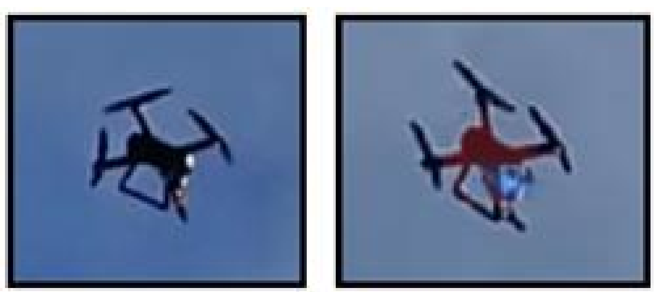
Independent Variables

The two independent variables *Resemblance* and *Information* determined which video was shown to the participant and which information they received. Both variables had two levels.

Resemblance. In the no *Resemblance* condition, the participants were shown a standardized black drone and in the *Resemblance* condition, participants were shown a drone that was painted in red to resemble the fire department and had a loud siren and a flashing blue light attached to it (see figure 2).

Figure 2

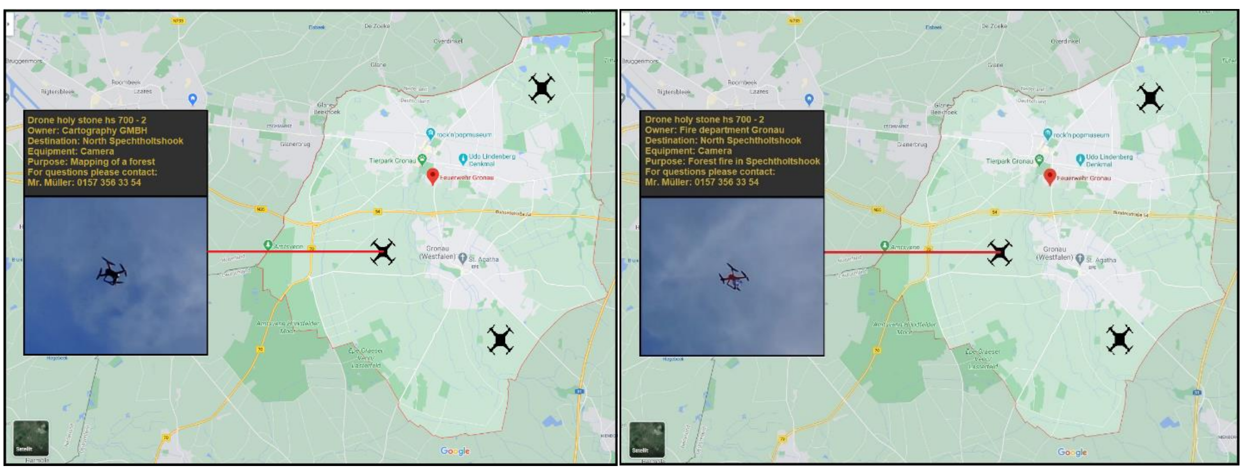
Picture of the standardized (left) and redesigned (right) drone from the videos for the normal and increased fire department resemblance group.



Information. In the *Information* condition, a website that presented transparent information, as well as the drone's location, was shown to the participants. The information that was shared included the owner/ organisation, destination, equipment, purpose, and the contact person (see figure 3). In the no *Information* condition, no website was shown to the participants. The information about the organisation referred to the fire department when it was combined with the *Resemblance* condition and information about a private cartography business in the no *Resemblance* condition. The information changed to a non-fire department context in the no *Resemblance* to investigate if only transparent information from a private organisation affected trust perceptions.

Figure 3

An example of the live tracking website with fictitious data of a private organisation (left) and with fictitious fire resemblance data (right).



Measures for further explorative analysis

For further analysis, additional questions were asked. First, demographic data concerning age, gender, and the location was collected. Second, the experience with drones was sampled by asking how often they experienced a drone flying by in the past (never, 1 time, 2-5 times, 6-20 times, >20 times). Lastly, the participants were asked how they would rate the trustworthiness of different operators of the drone (fire department, police, package delivery, food delivery, private business, private person).

Results

General Results

The correlations of the main variables trust, age, gender, experience with drones, and each of the four subscales can be found in table 1 as well as means, and standard deviations. Increasing age negatively correlated with trust which means that older people are generally less trusting towards drones than younger people. Gender and experience, on the other hand, did not show a significant correlation. The four subscales of trust significantly correlated with each other as could be expected as a result of the factor analysis.

Table 1

Correlational table with age, gender, experience, Trust, and the four subscales of Trust (General Trust, Benevolence, Integrity, Competence) including means (M), standard deviations (SD) for n = 123

Variables	*M*	*SD*	*Trust*	*Age*	*Gender*	*Expe-rience*	*General Trust*	*Benevol-ence*	*Integrity*
Mean Trust	3.45	1.35							
Age	36.02	15.15	-.31**						
Gender	.47	.50	-.08	.15					
Experience	2.71	1.15	.03	.04	-.18				
General Trust	3.03	1.49	.92**	-.27**	-.11	.07			
Benevolence	3.10	1.53	.90**	-.28**	-.03	.08	.78**		
Integrity	3.76	1.54	.90**	-.31**	-.10	.00	.74**	.80**	
Competence	4.10	1.45	.83**	-26**	-.04	-.08	.66**	.67**	.76**

Note. The variable gender is coded 0 for male participants and 1 for female participants.
General Trust is one out of four subscales of Trust
Significant correlations: p = <.05 are marked with *, and p = <.01 are marked with **.

Hypothesis Testing

The hypotheses were analysed with a two-way analysis of variance. The assumptions for two-way ANOVA's were checked and for each combination of independent variables, the dependent variable was normally distributed and there were no outliers. However, Levene's test indicated that variances are not equally distributed ($F = 3.73$, $p = .01$). This significant result shows that the variance of the dependent variable was not equal across the groups and therefore violates the assumption of homogeneity of variance. Violating this assumption might cause over or underestimations of the *F* statistics and corresponding *p*-values. Marshall and Boggis (2016) recommend using the threshold of $p < .01$ instead of $p < .05$ since there is no reliable way to correct for violations of homogeneity of variance in two-ways ANOVAs. Hence, the analysis was continued but the results need to be interpreted carefully as they can be biased.

The means, standard deviations, and the number of participants of each condition can be found in table 2.

Table 2

Mean Trust scores (M) and standard deviations (SD) as a function of Resemblance and Information (n=123).

	Information								
	No Information			Information			Total		
Resemblance	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*	*N*
No Resemblance	2.41	0.80	46	3.48	1.37	26	2.80	1.15	72
Resemblance	4.31	1.16	25	3.94	1.31	26	4.12	1.24	51
Total	3.08	1.31	71	3.71	1.35	52	3.35	1.35	123

A two-way analysis of variance was conducted on the influence of two independent variables (*Resemblance*, *Information)* on the continuous variable trust. *Resemblance* and *Information* have two levels each. The main effect of *Resemblance* was statistically significant [F (1,119) = 31.54, $p = <.01$], indicating that there is a significant difference between *No Resemblance* ($M = 2.80$, $SD = 1.15$, 95% CI = 2.53, 3.07) and *Resemblance* ($M = 4.12$, $SD = 1.24$, 95% CI = 3.78, 4.46). Thus, the null hypothesis for H1 can be rejected.

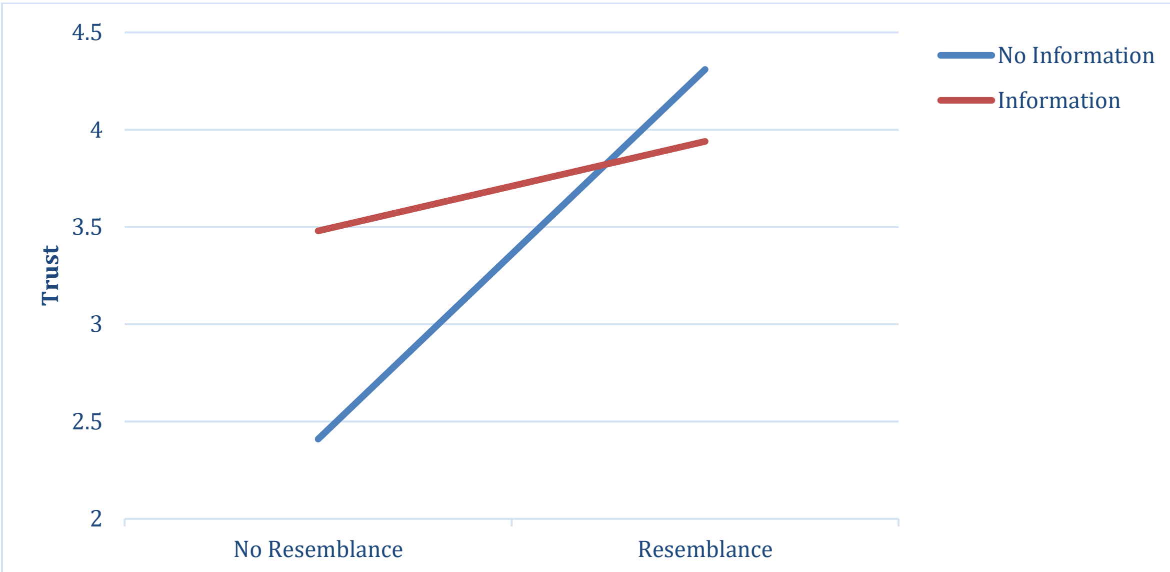
The main effect of *Information* on the other hand was not statistically significant [*F* (1,119) = 2.70, *p* = .10], indicating that there is no difference between *No Information* (*M* = 3.08, *SD* = 1.31, 95% CI = 2.77, 3.39) and *Information* (*M* = 3.71, *SD* = 1.35, 95% CI = 3.34, 4.08). The fact that the information changes depending on if it is in the only *Information* condition or if *Information* is combined with *Resemblance* might affect the results. Therefore, a t-test to compare the means of the conditions: no *Information* and no *Resemblance* (*M* = 2.41, *SD* = 3.48, 95% CI = 1.60, 3.23) and only *Information* (*M* = 3.48, *SD* = 1.37, 95% CI = 3.16, 3.80 was conducted and showed a significant effect of information t(70) = 3.65, p < .01, when no equal variances are assumed. Nonetheless, due to these ambiguous results, H2 still must be rejected.

The interaction effect of *Resemblance* and *Information* was significant [*F* (1,119) = 11.83, *p* = < .01]. The visualization can be found in figure 4.

Planned comparisons showed that in the *No Resemblance* condition, participants reported significantly higher levels of trust when *Information* was provided compared to *No Information* ($M_{\text{No Information}}$ = 2.41 *SD* = 0.80, 95% CI = 2.18, 2.64 versus $M_{\text{Information}}$ = 3.48 *SD* = 1.37, 95% CI = 2.95, 4.01; *F* (1,119) = 31.54, *p* = <. 01), whereas in the *Resemblance* condition, the difference between *Information* and *No Information* was non-significant ($M_{\text{No Information}}$ = 4.31 *SD* = 1.16, 95% CI = 3.10, 5.52 versus $M_{\text{Information}}$ = 3.94 *SD* = 1.31, 95% CI = 3.44, 4.44; *F* (1,119) = 2.70, *p* = .10).

Figure 4

Plot of the interaction effect of Resemblance and Information on trust.



Dividing the trust measurement scale. The trust measurement scale was designed to measure trust in the drone in four subsections: general trust, benevolence, integrity, and competence. To evaluate whether the effect of *Resemblance* and *Information* only affected a subset of trust or the entirety, the measurement scale was split up and four more two-way ANOVAs were conducted. The results for the first three subgroups are congruent with the results of the main analysis. The effect of *Resemblance* was significant for the first three subscales: general trust [F (1,119) = 22.39, $p < .01$], benevolence [F (1,119) = 36.51, $p < .01$], and integrity [F (1,119) = 23.52, $p < .01$]. The effect of *Information* was not significant on general trust [F (1,119) = 1.81, $p = .18$], benevolence [F (1,119) = 1.07, $p = .30$], and integrity [F (1,119) = 1.82, $p = .18$]. The interaction effect was significant for all three groups: general trust [F (1,119) = 11.64, $p < .01$], benevolence [F (1,119) = 9.12, $p < .01$], and integrity [F (1,119) = 8.57, $p < .01$].

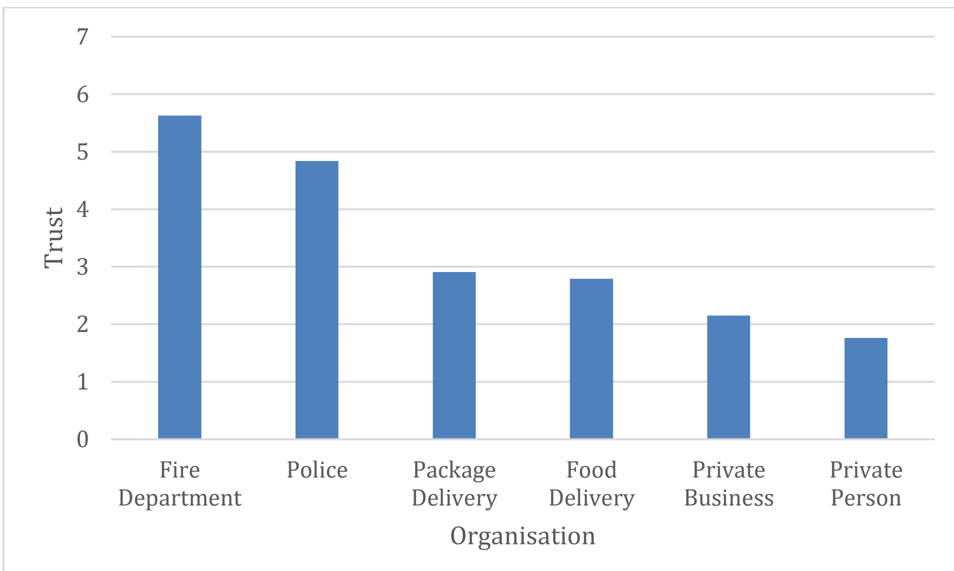
But the competence subscale showed different results. *Resemblance* still has a significant effect on the competence subscale [F (1,119) = 12.43, $p < .01$]. But, providing *Information* also seemed to have a significant effect on competence [F (1,119) = 5.08, $p = .03$]. Furthermore, the interaction effect of both variables on competence was insignificant [F (1,119) = 3.87, $p = .05$].

Further Explorative Analysis

User and purpose of drone flight. Additional questions have been answered by the participants that were not directly related to the hypotheses but might provide valuable information. First, the participants were directly asked how they would rate certain drone operators such as the fire department, the police, or a package delivery company. The results can be seen in figure 5. Most notably, the highest mean trust scores are achieved by fire department drones (5.63) followed by police drones (4.84). Private drone usage of a private business (2.15) or a private person (1.76) score the lowest.

Figure 5

Bar chart of the acceptance of drones operated by different organisations.



Experience. Next, it might be interesting to see if repeated exposure to drone flights increases trust over time. Therefore, participants were asked about the times they have experienced drones flying overhead at the end of the study. Thus, the two-way ANOVA with *Resemblance* and *Information* as independent variables and trust as a dependent was repeated with *Experience* as an additional factor. *Experience* was split into two subgroups, low *Experience* (0-5 times) and high *Experience* (<6 times). The significance values of the ANOVA can be found in table 3. *Experience* did not have a significant effect on trust [F (4,109) = 0.89, p

= .35]. Furthermore, it did not interact significantly with *Resemblance* [F (4,109) = 0.15, p = .90] and the interaction effect with *Information* was close to the cut-off point but still not significant [F (4,109) = 3.9, p = .51]. The interaction effect of all three factors was also insignificant [F (4,109) = 0.01, p = .93].

Table 3

F and p values of the Two-Way ANOVA with Experience as a Covariate.

Variable	F	*p*
Resemblance	34.09	< .01
Information	3.58	.06
*Resemblance*Information*	13.84	< .01
Experience	0.81	.37

Note. Experience is coded as low (0-5 times) and high (> 6 times) experience.

Potential Purposes from comments. Additionally, participants were asked to name possible purposes of the drone flight. A summarized word cloud can be found in Appendix C in German. Recurring themes that were suggested included purposes like fun, curiosity and trying something new. To analyse the comments, they were coded into three groups, namely important purpose, neutral, and violated privacy (see table 4). Some of these responses included scenarios from an emergency response to violations of privacy and preparations for committing a crime in their description of possible motives. These participants were coded for more than one group.

A chi-square test was performed to investigate the relationship between each combination of the independent variables and the comments that were made about the expected *Purpose* of the drone flight. The relation between the variables was significant, X^2 (1, N = 113) = 63.73, p = < .01, indicating that a relationship existed between the condition a participant is placed in and the perceived purpose. These findings were in line with the analysis of the main effects' influence *Resemblance* and *Information* on trust. However, in this analysis, it could be seen that the association with the fire department not only moved the purpose away from a negative violation of privacy to a neutral purpose as is the case with the provision of *Information*. It shifted the purpose to an important emergency which further elevates the trust level.

Table 4

Crosstabs of each combination of the independent variables and the coded comments that were made about the expected purpose of the drone flight.

	Important purpose (Emergencies …)	**Neutral purpose** (Used for fun, curiosity, was in the flight path …)	**Negative purpose** (Violated Privacy, Spying, Stalking …)
No Resemblance/ No Information	5	29	13
Resemblance / No Information	21	2	0
No Resemblance/ Information	1	17	2
Resemblance/ Information	16	6	1

Note. If a participant mentioned multiple examples, they can be reflected in more than 1 column.

Additional analysis with all cases included

In the initial dataset, participants who did not correctly identify the condition they were placed in were moved to a better fitting condition or were deleted from the study. To estimate the effect of this restructure, the main analysis was repeated with the entire dataset. Only people that did not finish the study or were younger than 16 were deleted from the study. No participants were moved to another category. Another ANOVA with *Resemblance* and *Information* as independent variables and trust was performed. The results can be found in table 5.

Table 5

Descriptive statistics of the two-way ANOVA with Resemblance and Information as independent variables and Trust as dependent variables including means (M), standard deviations (SD) and the total number of participants per condition (N) for <u>*all cases*</u> *(N=134).*

	Information								
	No Information			Information			Total		
Resemblance	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*	*N*
No Resemblance	2.41	0.82	31	3.31	1.40	30	2.80	1.15	61
Resemblance	4.31	1.16	44	3.94	1.31	29	4.12	1.24	73
Total	3.08	1.31	75	3.71	1.35	59	3.35	1.35	124

The grand mean of trust was lowered from M_{ex}= 3.54 and M_{in} = 3.27 with all cases included. When comparing Table 3 with Table 6 *No Resemblance* and *No Information* show identical trust ratings (M_{ex}= 2.41 and M_{in} = 2.41). *Resemblance* had overall lower trust ratings (M_{ex}= 4.12 and M_{in} = 3.64). *Information* on the other hand yielded slightly lower results (M_{ex}= 3.71 and M_{in} = 3.56).

As in the main analysis, *Resemblance* has a significant effect on trust [F (1,133) = 13.18, p = <.01]. Interestingly, contrary to the main analysis *Information* had a significant effect on trust as well [F (1,133) = 6.98, p = <.01]. Moreover, the interaction effect of *Resemblance* and *Information* was not significant [F (1,133) = 2.06, p = .15], which also differs from the main analysis.

Discussion

The main purpose of the study was to investigate the effect of drone usage over residential areas on the trustworthiness of the drone and its operators. Furthermore, the influence of fire department *Resemblance* and transparent *Information* on trust was investigated. 123 participants took part in an online study in which they were randomly assigned to a video (*Resemblance*: yes or no) and depending on the condition were able to investigate the drone online (*Information*: yes or no). The collected data might reveal insights into the underlying psychological principles that facilitate or hinder the trustworthiness of emerging technologies. The study intends to contribute to the design of drones for the fire department in Gronau that can be used in emergencies without creating undesired feelings in residents.

It was hypothesized that fire department *Resemblance* would increase trust in the drone compared to a neutrally designed drone (H1). This assumption was confirmed by the results of this study.

Next, the same increase of trust in the drone resulting from providing *Information* about the purpose, the equipment, and the responsible person was expected (H2). This, however, could not be supported by the analysis. When only *Information* was provided without *Resemblance,* there was a significant increase in trust. On the other hand, if *Information* was combined with *Resemblance* the trust rating was lower than when only *Resemblance* was present.

The significant result of *Resemblance* shows that is it possible to transfer the pre-existing trust in the fire department onto drones. This finding is in line with and expands the research of trust transfer on other emerging technologies (Lin et al., 2011; Stewart, 2003).

Furthermore, the association with the fire department gave a purpose to the drone flight. The analysis revealed that most participants categorized the drone flight of the fire department as important. Previous research showed that knowing the purpose of a drone flight and agreeing with its importance increases trust (Herron et al., 2014; PytlikZillig et al., 2018). This study extends this notion because while people might not know the exact purpose, it seems to be sufficient to know that fire department work is something worthy of support. Hence, a range of possible purposes may be accepted if they are all deemed important.

The additional analysis of the comments on potential purposes supports that *Resemblanc*e shifts the purpose. In the no *Resemblance* and no *Information* condition, the comments were mostly neutral and negative. *Information* only shifted the comments to almost exclusively neutral. Both only *Resemblance* and *Resemblance* combined with *Information* shifted the purpose mostly to something important.

The insignificant result of *Information* as a main effect is not in line with previous research (Li, Hess, & Valacich, 2008; Oltvoort, 2019; PytlikZillig et al., 2018). One possible explanation for this finding might be that too much information was provided. The information included contained specifics about the owner, destination, equipment, purpose, and responsible person for the drone including a phone number. Not only might people get bored and stop paying attention to the details but there is also evidence that providing too much information can negatively influence trust (Bannister & Connolly, 2011). According to Kizilcec (2016), the information needs to be balanced because providing too little or too much information will lower the amount of trust people have.

A further possibility would be that people see all the recorded information stored for the drone and connect it to the privacy fears that their own data might be stored in a similar fashion. It could also be the case that the information itself was not deemed trustworthy. Since providing information increased the trust levels compared to no intervention it might still be advisable to provide a certain amount of information. However, due to the ambiguous findings and the aforementioned, unstudied effects, more research needs to be conducted.

Further exploration of the data shows that with increasing age people reported less trust in drones which matched the results of Eißfeldt et al. (2020). But Eißfeld (2020) also found that gender played a significant role with women expressing more negative feelings towards drones. This study contradicts these findings because it does not show a significant effect of gender. This could be partly explained by the mean age of the participant set which is younger than the general population and therefore more inclined to trust drones. Next, the fire department seems to be the most trustworthy operator of a drone which is in line with the results of Gaspar (2020). Plus, there seems to be a slight but non-significant trend that people are more trusting the more often they are exposed to drones.

Limitations and Future Research

This study was intended as a proof of concept. Prerequisites of the study included that the identification of a fire department drone was correct. Data of participants that did not correctly identify the condition they were placed in were deleted and thus was not used for the main analysis. To account for a potential bias, the analysis was performed a second time with all cases included. If the cases, with participants who did not correctly identify the drone, would have been kept in the data set, the overall trust levels would have dropped. Interestingly, *Information* had a significant effect in this data set and the interaction between *Resemblance* and *Information* was not significant. Upon closer inspection, it can be seen that the main difference is the *Resemblance* without *Information* condition. In the analysis with excluded cases, this condition shows a significant increase of trust while the others stay approximately the same. This trust increase diminishes the effect of information and introduces a new interaction effect.

People volunteered to take part in this study, which might bias the results. If people follow an online announcement for a study about drones, they might already have a strong attitude about them in one direction or the other. On the other side, people who have never heard of the term drone may be less inclined to participate. This might have led to more extreme opinions of drone usage which could affect the results in either direction.

Additionally, the representativeness of the participants might have been biased. The average age of the participants was 36.0, which is lower than the average of the general population in Germany 44.5 (Statista, 2020). Consequentially, trust might be overestimated because younger people are more accustomed to new technologies and are generally more trusting towards them (Blank, & Dutton, 2012). In line with this, the results of this study showed a significant decrease in trust as people get older it might have biased the trust ratings. The study might have reached more younger respondents because it was online. Moreover, only German participants were used since it was the target group of affected people for drones of the fire department Gronau. Other countries might differ in their acceptance of new technologies such as drones or their acceptance of the fire department. The general trust in the fire department might change the effectiveness of the intervention. While the study was initially published on official social media channels to appeal to all ages, the efficacy was limited. In future studies, additional distribution methods should be considered.

Additionally, ideal requirements should not be taken for granted in real-life scenarios, but it shows that these changes could be feasible if they are perceived as intended. Watching the video of the drone flight on a mobile device might make it difficult to recognize the changes made to the drone to resemble the fire department. It was not distinguishable if the drone was not recognized due to a technical complication or due to its design. On the other hand, real drones might fly higher than shown in the video or they might not be easily recognizable due to bad weather. Consequently, people might not identify the operator of the drone in a real-life situation which will, in turn, decrease the trust ratings. One possible way to accurately measure this effect would be to create studies in a virtual environment or using a real drone flyover. While this was the initial design for the study, it could not be implemented due to an ongoing pandemic.

Moreover, the study only focused on residential areas in which trust is generally lower than in public areas such as business areas or festivals (Oltvoort et al., 2019). While it could be expected that the observed effect of *Resemblance* and *Information* occur in different contexts as well with overall elevated trust levels, more research needs to be conducted to investigate the effect of different environments on trust in drones.

Lastly, the analysis of the data set revealed that the group sizes were not equally distributed between the groups. This may have caused the analysis to be biased. The significance values, however, were far below the threshold and the risk of obtaining false results was relatively low due to the method of analysis. But a future study with equal and overall larger group sizes might increase the power of the results.

Future research could expand the target group internationally and include more drone operators. Besides this, additional variables and their effects on drone trustworthiness could be analysed in future studies. For example, specific positive or negative experiences with drones and their effect on overall trustworthiness could lead to insight into trust violations and trust repair in technologies. Next, the difference between drone operators being visible or not or how high a drone flies might affect how a drone is perceived and could potentially be used to increase trust even more. Additionally, campaigns to inform people about drone applications and their dangers could be offered to educate people and investigate how this would affect trust towards drones. Finally, future research could investigate the effects of a fire department drone with a turned-off siren and blue light on trust which might indicate that it is not an emergency while it is still operated by a trustworthy organisation.

Conclusion

Despite these limitations, there are still important conclusions that can be drawn from this study. First, it was shown that pre-existing trust from an organization can be transferred onto drones through design changes. The results of this study could contribute to the design of drones and other emerging technologies for example self-driving cars or robots.

Providing additional *Information* was shown to have an insignificant effect in the main study but a significant effect when all cases were included in the analysis. It is advisable to repeat this study with a larger sample size and an improved way to provide the information to make sure that this is not a random effect. For example, Oltvoort (2018) showed that giving people access to information but letting them decide which specific information they wanted to know, significantly increased trust perceptions.

But even in the improved trust condition, it could be seen that participants still did not fully approve of the drone over their private property. This shows that despite being provided with a plausible cause and understanding that it is an emergency, people still do not fully trust the drone. This means that drones should only be used in emergencies and whenever possible, they should avoid residential areas. *Resemblance* and *Information* might also benefit trust perceptions in public environments with overall elevated trust levels (Oltvoort et al., 2019).

Based on the findings of this study, the fire department Gronau should make sure that people understand the purpose of a drone flight when it is necessary to use it over a residential area. For the fire department, a simple redesign of the drone significantly improves the trust and consequently the acceptance of the drone. For other organisations, it might not be that easy to replicate this effect. Not only are they most likely not as trustworthy as the fire department but not many organisations have colours associated with them that everybody knows, and a logo might be harder to spot in the sky. Additionally, only emergency services are allowed to use a blue light and a siren.

For organisations other than the fire department, it might be the only feasible option to provide information to increase trust. But an additional effort must be made to not only provide information but to show people where it can be found. If the results of this study can be generalized, the drone operator always needs to provide a sufficient purpose for the flight and make sure that people know about it, when there is no other way than to fly over a residential area.

To conclude, it can be said that if drones must fly over residential areas, it is important that the purpose of the flight is known by the residents. This could be achieved by simple design changes to resemble an already trustworthy organisation or by providing transparent information. Results show that in the case of the fire department, one of these changes suffices to achieve an increase in trust and applying both changes might not lead to better results.

Drones are undoubtedly useful for the fire department. But trust in drones should not be taken for granted. Sufficient effort needs to be invested to build and maintain the complex dynamic of trust and acceptance in emerging technologies.

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Appendix A

Factor analysis of the trust measurement scale

Correlation Matrix[a]

		Q13_1	Q13_3	Q13_4	Q13_5	Q14_1	Q14_2	Q14_3	Q15_1	Q15_2	Q15_3	Q15_4	Q16_1	Q16_2	Q16_3	Q13_2_REVERSE
Correlation	Q13_1	1.000	.642	.786	.678	.628	.559	.586	.676	.641	.613	.618	.615	.595	.503	.372
	Q13_3	.642	1.000	.712	.768	.703	.513	.626	.627	.578	.522	.516	.531	.483	.460	.270
	Q13_4	.786	.712	1.000	.694	.759	.573	.685	.735	.720	.617	.715	.662	.627	.536	.390
	Q13_5	.678	.768	.694	1.000	.735	.600	.637	.645	.606	.593	.639	.566	.564	.462	.411
	Q14_1	.628	.703	.759	.735	1.000	.665	.762	.787	.727	.620	.762	.652	.614	.534	.319
	Q14_2	.559	.513	.573	.600	.665	1.000	.735	.705	.655	.458	.610	.567	.573	.442	.261
	Q14_3	.586	.626	.685	.637	.762	.735	1.000	.741	.724	.524	.660	.585	.540	.492	.277
	Q15_1	.676	.627	.735	.645	.787	.705	.741	1.000	.811	.657	.795	.758	.711	.601	.395
	Q15_2	.641	.578	.720	.606	.727	.655	.724	.811	1.000	.616	.845	.723	.716	.614	.363
	Q15_3	.613	.522	.617	.593	.620	.458	.524	.657	.616	1.000	.621	.538	.537	.440	.310
	Q15_4	.618	.516	.715	.639	.762	.610	.660	.795	.845	.621	1.000	.759	.740	.568	.361
	Q16_1	.615	.531	.662	.566	.652	.567	.585	.758	.723	.538	.759	1.000	.826	.685	.283
	Q16_2	.595	.483	.627	.564	.614	.573	.540	.711	.716	.537	.740	.826	1.000	.697	.324
	Q16_3	.503	.460	.536	.462	.534	.442	.492	.601	.614	.440	.568	.685	.697	1.000	.245
	Q13_2_REVERSE	.372	.270	.390	.411	.319	.261	.277	.395	.363	.310	.361	.283	.324	.245	1.000
Sig. (1-tailed)	Q13_1		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	Q13_3	.000		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.001
	Q13_4	.000	.000		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	Q13_5	.000	.000	.000		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	Q14_1	.000	.000	.000	.000		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	Q14_2	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000	.000	.000	.000	.002
	Q14_3	.000	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000	.000	.000	.001
	Q15_1	.000	.000	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000	.000	.000
	Q15_2	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000	.000
	Q15_3	.000	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000
	Q15_4	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000	.000	.000
	Q16_1	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000	.001
	Q16_2	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000
	Q16_3	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000		.003
	Q13_2_REVERSE	.000	.001	.000	.000	.000	.002	.001	.000	.000	.000	.000	.001	.000	.003	

Appendix B

Word cloud of described possible purposes of the drone flight in German

Appendix C

Trust scale for drones (Ahrendt, 2020)

Please indicate how much you agree with the following statements

Agree completely	Agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Disagree	Completely disagree
○	○	○	○	○	○	○

General trust:

1. I am willing to let the operator make decisions for people like me.
2. I think it is important to watch this operator closely so that it does not take advantage of people like me.
3. I trust the operator to take care of people like me.
4. I trust the operator to make decisions for people like me.
5. I trust the drone operator not to disclose any personal information about me.

Benevolence:

6. . I believe that the operator is interested in the well-being of people like me, not just themselves.
7. I believe the operator takes opinions like mine into account when making decisions.
8. Whenever the operator makes a decision, I know it will be concerned about people like me.

Integrity:

9. The operator treats people like me fairly and justly.
10. The operator can be relied on to keep its promises.
11. Sound principles seem to guide the behavior of the operator.
12. The operator does not mislead people like me.

Competence:

13. I feel very confident about the skills of the operator.
14. The operator has the ability to accomplish what it says it will do.
15. The operator is known to be successful at the things it tries to do.

Appendix D

Study in Script in German

Studie Drohnenakzeptanz

Vielen Dank, dass Sie sich bereit erklärt haben an dieser Studie teilzunehmen! Diese Umfrage ist Teil einer Masterarbeit der Universität Twente und möchte herausfinden, wie der Drohneneinsatz über privatem Gelände innerhalb Gronaus wahrgenommen wird. Die Teilnahme dauert in der Regel zwischen 10 und 15 Minuten. Im Folgenden werden Sie gebeten sich einige Informationen durchzulesen, ein Video anzuschauen und einige Fragen zu beantworten. Die Informationen und Videos verändern sich, entsprechend der Gruppe, der Sie zugelost worden sind.

- Die Teilnahme ist nur möglich, wenn Sie 16 Jahre oder älter sind.
- Diese Studie ist Teil einer öffentlichen Masterarbeit
- Die gesammelten Daten könnten eventuell für weitere Studien und Veröffentlichungen verwendet werden
- Alle gesammelten Daten werden anonym gespeichert, nach den Datenschutzrichtlinien der University of Twente
- Es wird nicht nach Ihrem Namen oder anderen Informationen gefragt, die es möglich machen würden, Sie zurückzuverfolgen
- Es werden nur Durchschnittswerte aufgelistet. es werden keine einzelnen Antworten des Fragebogens veröffentlicht.
- Die Teilnahme an dieser Studie ist freiwillig und Sie können jederzeit ohne Nennung von Gründen aufhören.
- Nehmen Sie sich bitte etwas Zeit, um das Material gründlich zu lesen/ zu schauen. Es gibt keine richtigen/ falschen Antworten

Sollten Sie Fragen oder Bedenken bezüglich der Studie haben kontaktieren Sie mich (Lars Meiländer) gerne: l.meilander@student.utwente.nl

Kontaktinformationen des Ethikkomitees der Universität Twente
Sollten sie Fragen bezüglich Ihrer Rechte als Studienteilnehmer haben, Informationen erfragen möchten, oder ethische Bedenken über die Studie haben, die Sie nicht mit dem Forscher klären können/möchten wenden Sie sich gerne an das Ethikkomitee der Fakultät Behavioural, Management and Social Sciences an der Universität Twente: ethicscommittee-bms@utwente.nl

Ich bin 16 Jahre oder älter
Ja/ Nein

Ich habe die obenstehenden Informationen gelesen und verstanden und nehme freiwillig an dieser Studie teil
Ja/ Nein

Videos

Drohnen werden immer verbreiteter und werden schon heutzutage in verschiedensten Bereichen eingesetzt. Einige Drohnen sind dazu in der Lage autonom (von selbst) zu ihrem Bestimmungsort zu fliegen.
Im Folgenden werden Sie gebeten sich ein Video anzuschauen. Bitte schalten Sie Ihren Ton an. Bitte stellen Sie sich vor Sie wären die Person, die das Video gefilmt hat und der gezeigte Garten wäre Ihr eigener. Sie können sich das Video gerne mehrmals anschauen. Es werden später einige Fragen zu Ihren Eindrücken während des Videos gestellt.
Einteilung in 4 Gruppen:

Kontrollgruppe: (Eine schwarze Drohne fliegt über einen privaten Garten)

Umgestaltungsgruppe: (Eine Drohne in Feuerwehrfarben + Sirene und Blaulicht fliegt über einen privaten Garten)

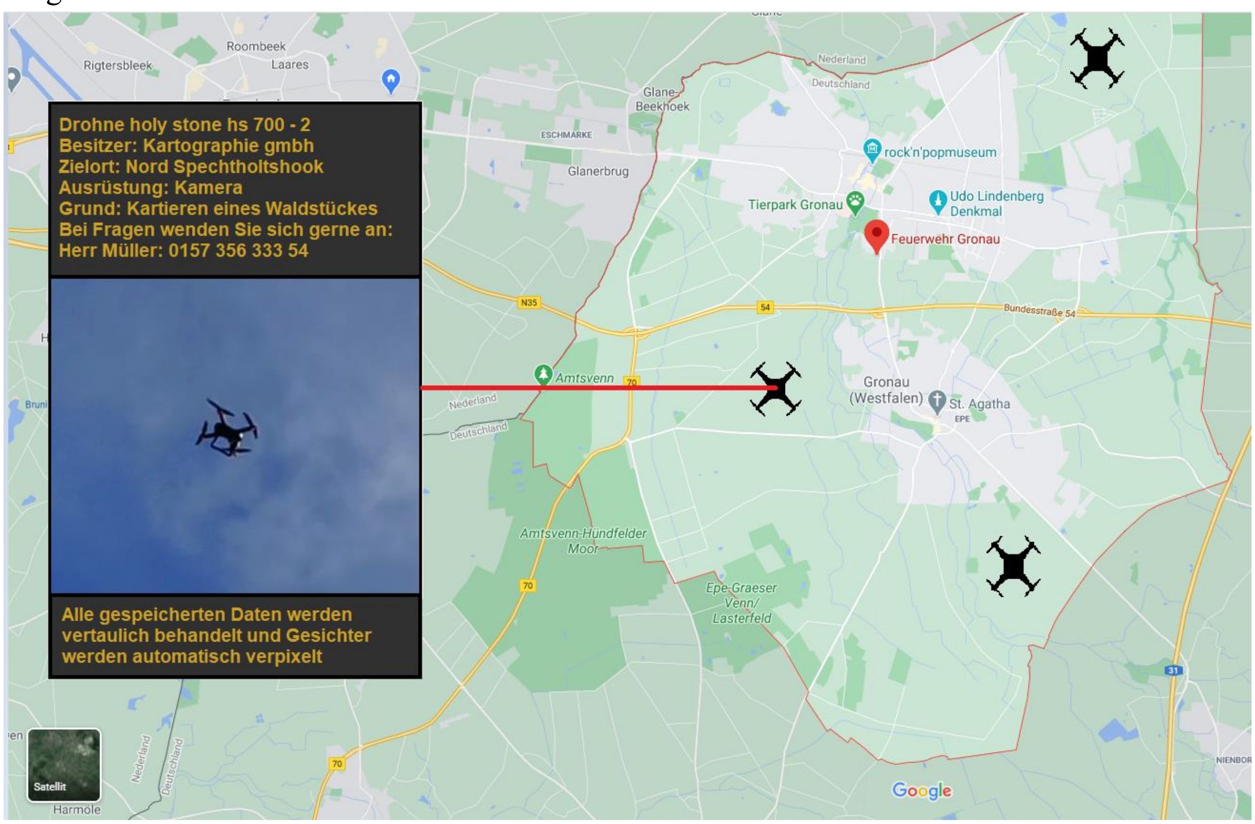
Transparenzgruppe: (Eine schwarze Drohne fliegt über einen privaten Garten + es werden Informationen über den Grund des Einsatzes transparent dargelegt)

(Kontrollfrage für alle Gruppen)

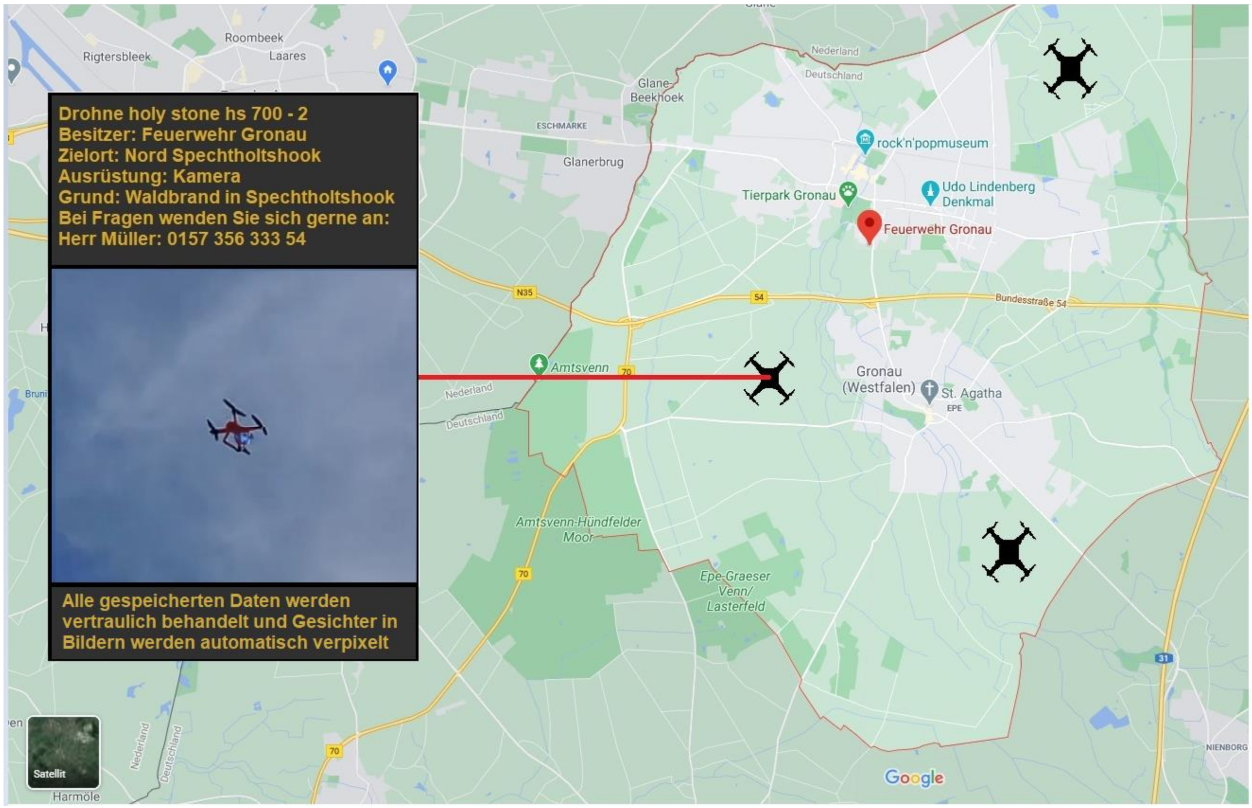
Von wem denken Sie wurde diese Drohne betrieben?

____

Auf einer neu entwickelten Website, von der Sie kürzlich gehört haben können Sie einige zusätzliche Informationen über Drohnen einsehen. Wenn Sie die Website aufrufen, sehen Sie Folgendes:



Transparenzgruppe: (Eine schwarze Drohne fliegt über einen privaten Garten + es werden Informationen über den Grund des Einsatzes transparent dargelegt)



Umgestaltungs- + Transparenzgruppe: (Eine Drohne in Feuerwehrfarben + Sirene und Blaulicht flieht über einen privaten Garten + es werden Informationen über den Grund des Einsatzes transparent dargelegt)

Fragebogen Vertrauen:

Vertrauensskala für Drohnen von Ahrendt (2020) ins Deutsche übersetzt.

Bitte geben Sie im Folgenden an inwieweit Sie den Aussagen zustimmen.

Stimme voll und ganz zu	Stimme zu	Stimme eher zu	Stimme weder zu noch lehne ich ab	Stimme eher nicht zu	Stimme nicht zu	Stimme überhaupt nicht zu
○	○	○	○	○	○	○

Generelles Vertrauen (7-stufige Likert-Skalen):

16. Ich bin bereit, den Drohnenbetreiber Entscheidungen für Leute wie mich treffen zu lassen.
17. Ich denke, dass es wichtig ist, den Drohnenbetreiber genau zu beobachten, damit er Leute wie mich nicht ausnutzt.
18. Ich vertraue darauf, dass der Drohnenbetreiber sich um Leute wie mich kümmert.
19. Ich vertraue dem Drohnenbetreiber genug, um ihn Entscheidungen treffen zu lassen für Leute wie mich.
20. Ich vertraue darauf, dass der Drohnenbetreiber keine persönlichen Informationen über mich preisgibt.

Wohlwollen (7-stufige Likert-Skalen):

21. Ich glaube, dass der Drohnenbetreiber am Wohlergehen von Menschen wie mir interessiert ist, nicht nur von sich selbst.
22. Ich glaube, der Drohnenbetreiber berücksichtigt Meinungen wie meine, wenn er Entscheidungen trifft.
23. Wann immer der Drohnenbetreiber Entscheidungen trifft, weiß ich, dass er sich um Menschen wie mich kümmert.

Integrität (7-stufige Likert-Skalen):

24. Der Drohnenbetreiber behandelt Leute wie mich fair und gerecht.
25. Der Drohnenbetreiber ist jemand, der seine Versprechen hält.
26. Solide Prinzipien unterliegen dem Handeln des Drohnenbetreibers.
27. Der Drohnenbetreibe führt Leute wie mich nicht in die Irre.

Kompetenz (7-stufige Likert-Skalen):

28. Ich bin zuversichtlich, was die Fähigkeiten des Drohnenbetreibers angeht.
29. Der Drohnenbetreiber hat die Fähigkeit das zu erreichen, was er verspricht.
30. Es ist bekannt, dass der Drohnenbetreiber bei den Dingen, die er tut, erfolgreich ist.

Von Oltvoort, A. (2018).

Fragebogen Transparenz (7-stufige Likert-Skalen):

31. Der Drohnenbetreiber möchte verstehen, wie seine/ihre Entscheidungen Leute wie mich betreffen
32. Der Drohnenbetreiber stellt nützliche Informationen dar, die Leute wie ich nutzen können, um informierte Entscheidungen treffen zu können
33. Der Drohnenbetreiber will Leuten wie mir gegenüber Verantwortung für sein Handeln übernehmen
34. Der Drohnenbetreiber will, dass Leute wie ich wissen was sie tun und warum sie es tun

Fragebogen wahrgenommene Kontrolle (7-stufige Likert-Skalen):

35. Ich hatte Kontrolle über die Situation
36. Ich konnte die Situation vorhersehen
37. Ich hatte eine Wahl/ Ich konnte aussuchen, ob ich mit der Drohne in Kontakt kam
38. Ich bin verantwortlich für die Situation, die vom Drohnenbetreiber verursacht wurde
39. Ich war in der Lage die Situation zu beeinflussen/ Ich hatte ein Mitspracherecht bei dem Drohnenbetreiber

Meiner Meinung nach war die Drohne (7-stufige Likert-Skalen):

Nutzlos	…	Nützlich
Unangenehm	…	Angenehm
Schlecht	…	Gut
Nervig	…	Angenehm
Überflüssig	…	Effektiv
Irritierend	…	Vernünftig
Unnütz	…	Hilfreich
Unerwünscht	…	Erwünscht
Einschläfernd	…	führt zu erhöhter Alarmbereitschaft

Inwieweit empfinden Sie die Drohneneinsätze der folgenden Institutionen angemessen? (7-stufige Likert-Skalen):

Für mich wäre ein Drohneneinsatz <u>der Feuerwehr/ des Rettungsdienstes</u> (auch über privatem Gelände) angemessen

Für mich wäre ein Drohneneinsatz <u>der Polizei</u> (auch über privatem Gelände) angemessen

Für mich wäre ein Drohneneinsatz <u>eines Paketlieferenten</u> (auch über privatem Gelände) angemessen

Für mich wäre ein Drohneneinsatz <u>eines Essenslieferanten</u> (auch über privatem Gelände) angemessen

Für mich wäre ein Drohneneinsatz <u>eines privaten Unternehmens</u> (auch über privatem Gelände) angemessen

Für mich wäre ein Drohneneinsatz <u>einer Privatperson</u> (auch über privatem Gelände) angemessen

Stimme voll und ganz zu	Stimme zu	Stimme eher zu	Stimme weder zu noch lehne ich ab	Stimme eher nicht zu	Stimme nicht zu	Stimme überhaupt nicht zu

Usmanova, D (2019)

1. Es logisch, dass die Feuerwehr/ Kartographie Gmbh die Drohne in der Situation genutzt hat
2. Ich kann verstehen, warum die Feuerwehr/ Kartographie Gmbh die Drohne in der Situation genutzt hat

In der Situation, was könnten die Gründe sein, damit die Drohne über deinem privaten Garten geflogen ist? Bitte listen sie mögliche Gründe auf

____

____

____

____

____

Demografische Fragen

Sie sind fast am Ende angekommen. Zuletzt würde Ich gerne noch einige demografische Daten erheben.

Wie alt sind Sie?

____

Sind sie______?

männlich, weiblich, divers, anderes

Was ist Ihr höchster Bildungsabschluss?

Grundschule, Hauptschule, Realschule, Gymnasium, Berufsfachschule, Fachhochschule, Bachelorabschluss, Masterabschluss, Doktorabschluss, Anderes

Wohnen Sie in Gronau?
Ja, Nein

Wie oft haben Sie schon eine Drohne in Gronau fliegen sehen?
Noch nie, 1-mal, 2-5 mal, 6 – 20 mal, öfter

Abschluss

Vielen Dank, dass Sie sich die Zeit genommen haben! Das Ziel dieser Studie war es herauszufinden, wie die Feuerwehr Gronau, am besten Drohnen für Einsätze nutzen kann und dabei die Wünsche und Sorgen der Bevölkerung eingehen können.
Es gab vier verschiedene Gruppen, der Sie zufällig zugelost wurden:

Kontrollgruppe: (Eine schwarze Drohne fliegt über einen privaten Garten)
Umgestaltungsgruppe: (Eine Drohne in Feuerwehrfarben + Sirene und Blaulicht fliegt über einen privaten Garten)
Transparenzgruppe: (Eine schwarze Drohne fliegt über einen privaten Garten + es werden Informationen über den Grund des Einsatzes transparent dargelegt)
Umgestaltungs- + Transparenzgruppe: (Eine Drohne in Feuerwehrfarben + Sirene und Blaulicht fliegt über einen privaten Garten + es werden Informationen über den Grund des Einsatzes transparent dargelegt)

Es wurde vermutet, dass die umgestalteten Drohnen sowie erhöhte Transparenz zu mehr Vertrauen in die Drohne führen.

Sollten Sie weitere Fragen haben, Ihre Teilnahme zurückziehen wollen oder sind an den Ergebnissen der Masterarbeit interessiert wenden Sie sich gerne an mich:
l.meilander@student.utwente.nl