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Public acceptance of the use of drones for logistics: the state of play and moving towards more informed debate

Abstract

Policy makers are keen to understand public and stakeholder concerns in relation to the greater deployment of drones within transport systems and studies have sought to quantify public acceptance of drones with common themes including worries relating to privacy and safety and a lack of engagement with the technology amongst some demographic groups. This paper critically examines the research on public acceptance of drones finding the conflation of a diverse range of drone applications has led to ambiguity in the prevailing concerns and that the absence of clear parameters for drone use in local transport environments limits scope to develop informed opinion. We find that studies which build familiarity and understanding of practical drone use demonstrate the potential for more positive and informed outcomes than do more generic surveys on attitudes. The paper raises questions about the role of public acceptance research and its use in policy and calls for studies that build understanding of drones within transport environments so that stakeholders can engage in more informed debates to shape future transport provision.

Keywords: drone; uncrewed aerial vehicles (UAVs); public acceptance; knowledge; attitudes; perceptions

1. Introduction

Research has highlighted governance and regulatory challenges associated with the introduction of uncrewed aerial vehicles (UAVs, hereafter referred to as drones) (Kirkhope, 2019) and it is vital that national strategies are agreed to realise any potential economic and environmental benefits. Our interest lies in integrated last-mile logistics fleets incorporating drones. Challenges include integrating drones and crewed aircraft in shared airspace and how drones could be integrated with ground logistics to achieve more sustainable distribution of goods. The form that regulation will take is still to be determined and therefore there is little clarity on the volume of drone traffic likely to be generated, operating parameters and locations. This makes it difficult to explore public and stakeholder concerns yet public acceptance of drones is highlighted by policy makers as essential to pave the way for greater integration of drone technology in various settings and, in particular, within transport systems. For example, the International Transport Forum (2021) identifies the need to address public concerns to achieve greater acceptance. This is also a key element of the Roadmap for the Integration of Civil Remotely-Piloted Aircraft Systems into the European Aviation System (ERSG, 2013) and the UK's Department for Transport (Department for Transport) includes "Understanding public perceptions" (Department for Transport, 2019a, p9) as a work stream for supporting the development of the future urban transport strategy. However, in the absence of a defined system of provision it is not clear what policy makers are asking the public to accept with the danger that engagement represents a 'rubber stamping' exercise (Hopkins and Schwanen, 2018) as opposed to meaningful discussion on the role of drones within future transport.

Recent studies have explored public views of both a range of drone applications and specific use cases, and indicate greater acceptance of drones where they are used for social good, such as use in emergency aid scenarios, but lower acceptance for certain applications including retail logistics (see

for example, EASA, 2021a; Aydin, 2019; Department for Transport, 2019b; PWC, 2019; Klauser and Pedrozo, 2017). Concerns tend to focus on privacy and safety, and studies have observed differences in levels of acceptance by demographics and between different stakeholder groups (see for example, EASA, 2021; Aydin, 2019; Department for Transport, 2019b; West et al., 2019; Zwickle et al., 2019).

This paper begins with a critical examination of themes identified within the literature as representing core issues regarding the public's acceptance of drone use. It identifies how methodological approaches adopted within the studies provide for an inconclusive position on the reality of the public's concerns about key issues such as safety and privacy, particularly with respect to future logistics uses. It finds that the often-assumed public preference for drone deployment for the public good is open to alternative interpretation. Closer scrutiny of the findings within the literature indicates that the public is largely disengaged with the subject area and the final section of the literature review therefore identifies studies which have at least in part overcome this through more hands-on, qualitative approaches. Section 3 provides additional analysis of secondary data from the Department for Transport's Transport and Technology: Public Attitudes Tracker (2021) to extend understanding of the interaction between public knowledge, experience and engagement with drones and the concerns and support for various use cases. The paper's contribution lies in establishing the current position on the public's receptiveness to the use of drones for logistics and exploring how non-experts might better contribute to debates about the future integration of drones into transport systems. This will support work developing the potential for drones to assist in the shift to low-carbon logistics.

2. Literature review of public acceptance and perception of drones

The academic literature was investigated using a search engine that accesses all institution databases in a single search. Within this, the main hits were from Academic Search Ultimate and Complementary Index. The search was conducted using a range of terms in common use that refer to drones (drone, unmanned aerial vehicle, unmanned aerial system, UAV and UAS) from 2000 to 2021. This yielded 102,528 items. This was reduced to 109 items with the addition of search terms related to public or stakeholder acceptance (acceptance, attitude, engagement, perception). Titles and abstracts from these were reviewed for relevance along with further items of interest found in the grey literature. Items focused specifically on military drones, for example, 'drone strikes', and police drones were excluded. The following review of the literature discusses four key themes that emerge which raise methodological implications for understanding public acceptance of drones ((knowledge of drones, support for drone applications for the public good, identification of public concerns and variations in levels of support between demographic groups,). Following analysis of these themes, a final section explores studies that have sought to involve non-experts in more informed debates about drones.

2.1. Drone Knowledge

Degree of knowledge and familiarity with drone technology is identified as a determinant of attitudes and acceptance. Eißfeldt et al. (2020) show how those who consider themselves to be better informed about drones are more likely to hold a more positive attitude towards the technology. Those with links to the drone industry or more direct experience of drones have fewer concerns and are generally more supportive of drone use (Aydin, 2019) although, Nelson et al. (2019) demonstrate that this level of support is more nuanced when more detailed aspects of drone use are considered, finding that recreational use of drones presented slightly more privacy concerns for those who work with drones than those with no direct experience of drone use. Lidynia et al. (2017) found that the opinions of non-drone users were significantly different to drone users. The studies show that mainstream media is the main source of knowledge of drones for the general public in the UK (Boucher, 2016; Department for Transport, 2016) and the USA (Aydin, 2019; Nelson et al., 2019; Reddy and Delaurentis, 2016) with

those with closer personal or professional experience of drone use drawing knowledge from more technical or specialist sources (Aydin, 2019).

Mainstream media offers a limited source of balanced information about drones which is also recognised within the Department for Transport study (2016) and even respondents with more personal familiarity with drones do not necessarily have the technical knowledge to offer an opinion on the threats and benefits of their greater deployment (Nelson et al., 2019). Clothier et al. (2015, p1170) found relatively neutral responses to drones, acknowledging that "for drones there are limited sources of information available to the public". They suggest that neutral responses to questions should be taken as an indication of lack of information. Their analysis indicates concerns related to knowledge of drone technology, capabilities and uses is a prominent theme.

Evaluating the extent of the public's knowledge of drones is shown to be problematic. Department for Transport (2018) report high awareness of drones but recognised depth of knowledge was likely to be limited with the majority stating that they knew "a little" or "hardly anything" about the technology (Department for Transport 2018, p4). Studies which adopted the Knowledge, Attitude, Practice (KAP) model in the development of their survey tool (Tan et al., 2021; Aydin, 2019; Reddy and Delaurentis, 2016) sought to relate levels of knowledge held within the survey sample to the stated attitudes and extent of acceptance. The knowledge tests employed within these studies provided for a largely superficial assessment of aspects of drone use rather than their understanding of the technical capabilities which would determine the extent to which prevailing concerns represented actual risks. Nelson et al. (2019, p95) undertook a more detailed assessment of participants understanding of the operational capabilities of drones regarding flying and recording of photos and videos, finding that familiarity with drones does not necessarily equate to familiarity with their technical capabilities and that in the absence of this familiarity it is difficult to hold an "informed opinion on the threats and benefits of UAV use".

2.2. Greater support for drone applications for the public good

Studies find higher levels of support for the use of drones when the application is for the public good compared to commercial and amateur/hobbyist uses. For example, there is higher support for public safety and scientific uses (Aydin, 2019) and emergency use cases (Department for Transport, 2019b; Sedig et al., 2020) and lower support for package delivery (see for example, Department for Transport, 2019b; Klauser and Pedrozo, 2017; PWC, 2019). Reddy and Delaurentis (2016) found levels of support were conditional to the circumstances, with support for drone use in regulated environments. Similarly, using analysis of free-text responses, Aydin (2019, p9) highlights underlying concerns which are likely drivers of the lower level of support for commercial and hobbyist drone use: "potential noise pollution, inexperienced operators, airspace congestion, and drones getting lost due to signal failures". Perception of the drone user plays a role with hobbyists less trusted compared to professional users who are considered to have greater expertise, training and regulation (Bajde, 2017; Boucher, 2016; Department for Transport, 2016).

Indicative levels of support for different applications may, therefore, reflect the public's caution associated with the impacts of more widespread deployment of drones in society and the safety and security concerns related to unregulated use. Therefore, the underlying concerns which drive the reduced support for commercial use scenarios, such as logistics, may relate more to the potential external consequences such as the risk of accidents, crowded skies and noise, rather than a desire for future deployment to be altruistic. As the implications resulting from a wider proliferation of drones are not yet fully understood, participants' responses are based upon their existing knowledge alongside any further information and experiences gained during studies, noting that even the most hands-on experiences did not provide any parameters relating to frequency and locations of potential future use. The problem of 'function creep' is raised by Boucher (2016), where initial drone

introduction for social good is felt to lead to a proliferation of other applications linked to a 'full skies' vision which is also evident in Department for Transport (2016). This concern is not unfounded, for example, EASA (2021b, p32) identifies an approach "starting with use cases that bring the highest societal benefit (e.g., medical)" as a potential mitigation measure for the barrier of public acceptance.

Many of the drone use scenarios presented in studies are unlikely to encroach on everyday lives, for example, drones used to check remote infrastructure. Typically, scenarios likely to infringe on daily lives receive least support, for example, "Retail use such as package delivery, stock checking", "Professional photography, filming and journalism", "Leisure use such as flying drones for fun, taking pictures & video" (Department for Transport, 2019b, p20). Similarly, Tan et al. (2021) found that use in residential areas had lower acceptance levels and raised more concerns compared to industrial, commercial and recreational contexts. Klauser and Pedrozo (2017) also report higher rejection of both hobby and commercial drones in urban settings.

Conversely, where the technology has some value to respondents, responses are more positive. For example, EASA (2021a) considers 'usefulness' of drones for general deliveries and reported a higher level of comfort for deliveries made by drone to gardens or private areas compared to more public spaces such as a nearby park. This reflects the level of convenience in relation to delivery receipt rather than a preference for use contexts, and is reinforced by 64% of respondents being "rather likely" or "very likely" to use delivery drones should they become available in their city. Relevance of the technology is a fundamental consideration with perceived use value likely to influence responses. It is also questionable to ask the general public whether they support or oppose a technology they will not directly experience or use. A further consideration is the potential for more everyday exposure to the use of drones. Determining the extent of this potential exposure and its implications is fundamental to understanding relative acceptability.

2.3. Areas of Concern

A comparison was made of concerns identified within the three largest studies (EASA, 2021a, Department for Transport, 2018 and United States Postal Service, 2016), each of which provide full details of the survey format used (Table 1). It is evident that privacy, safety and security represent the three most frequently cited or selected areas of concern raised by participants. Noise and potential job losses also represent some of the additional concerns identified within both EASA and Department for Transport. Noise is highlighted as being a key potential barrier to public acceptance of urban air mobility (Theodore 2018) but despite this, its prominence as a concern is low when compared with privacy, safety and security. The EASA (2021a) and United States Postal Service (2016) studies required respondents to select from a list of potential concerns, some of which are unique to these particular studies. The findings suggested that 28% (11% ranked this first, 9% second, 8% third) of respondents to the EASA survey selected concerns regarding "local environment, such as air pollution, negative impact on bird life and insects, or decreasing biodiversity in general" (EASA 2021a p71) as their first, second or third most concerning issue with respect to drone deliveries.

Concerns were also raised by participants in the Department for Transport study where the majority of the sample were aware of the existence of drone technology but held a limited depth of knowledge. Prompting respondents on concerns can have the effect of triggering responses. For example, Nelson et al. (2019) and Eißfeldt et al.'s (2020) found more familiarity with drones was associated with lower concern, while Komasová et al. (2020) found those with more experience of drones were more aware of risks. Nelson et al. and Eißfeldt et al. prompted respondents by listing concerns triggering responses to these concerns in the less informed, while Komasová et al. was unprompted providing the less informed with no cues.

Table 1. A comparative summary of questions posed on concerns relating to drone use within the three largest studies (EASA, 2021a, Department for Transport, 2018 and United States Postal Service, 2016)

Study, location and sample size	Department for Transport (2018) England Sample size: 7,037 (Combined 2017 (3,499) and 2018 (3,538))	EASA (2021) Europe (Spain, Hungary, Germany, Italy, Paris, Denmark and Sweden) Sample size: 3690	Office of Inspector General United States Postal Services (2016) USA Sample size: 1207
Question strategy	Open question with no prompts or choices	Closed question with choice of answer options	Closed question with choice of answer options
Privacy and intrusion	Privacy/ intrusion – 59%	Privacy concerns, for instance, a drone flying close to my window or over my property – 30%	Might not be used in a way that respects my privacy – 31%
Intentional Misuse of Drones	Misuse of drones (e.g. hacking, terrorism, criminals) – 28%	Security threats, for instance, criminal organizations (for ransom), hacktivists, or terrorists hacking into the control system and hijacking or misdirecting drones – 39%	Might be used to transport illicit goods – 34% Might be intentionally used to injure people or property – 26%
Safety Concerns	Concerns about use of airspace/ aircraft collisions – 25% Whether owners use them safely/ safety of device – 19% Drones malfunctioning – 15%	Safety concerns (such as drones crashing) – 44%	Might malfunction and damage property – 54% Might malfunction and injure someone – 50%
Noise	Noise – 8%	Noise pollution, such as loud and/or annoying sounds – 28%	N/A
Job Losses	Impact on jobs e.g. taking over human job roles – 7%	Job losses, for instance within local delivery companies – 30%	N/A
Visual Pollution	Not explicitly reported but may be integrated into 'intrusion'	Visual pollution, such as annoying air traffic - 19%	Might make the sky less pleasant to look at – 22%
Environmental	None explicitly mentioned in the report	Concerns regarding local environment, such as air pollution, negative impact on bird life and insects, or decreasing biodiversity in general – 28% Global environmental concerns, such as negative	

		impact on climate change – 14%	
Concerns related to delivery services	N/A	Affordability, i.e. the service being affordable only for rich or privileged people – 21%	Might malfunction and damage the package it's carrying – 61% and/or the package it's carrying might be stolen – 52% Might deliver my package to a different address – 50% [Package] might be damaged by others – 44% Would have no place to land at my residence – 23%
Other concerns	Difficulty of tracing drone owners/ operators – 9% The use of drones in the military (if as a weapon) – 5% Commercial sensitivity (e.g. spying on businesses) – 5%	Other – 1%	Other – 4%
No concerns	No concerns – 5%	None of these – 4%	I am not concerned about any of these – 11%
Don't know	Don't know – 15%		

2.3.1. Privacy Concerns

Qualitative studies reveal the complexity that privacy represents for future drone use with findings pointing to the potential for infringements on visual information privacy and physical/sensory invasions of privacy (Bajde et al., 2017; Boucher, 2016; Department for Transport, 2016). The former allows for a more discrete definition with the potential for drones to record and share visual information without consent, with implications relating to greater state surveillance and opportunities for misuse for "peeking and stalking" (Wang et al., 2016, p178). Parallels are drawn with the widespread proliferation of CCTV but, unlike CCTV where the operator is more readily identifiable, the operator of a drone may be unknown or difficult to establish representing a lack of control over the situation. In addition, CCTV is typically static and unlikely to encroach into personal space. Bajde et al. (2017) found that participant's privacy concerns were associated with the limited knowledge of who or why a drone is being used with a desire for easy access to this information. The Department for Transport (2016) identified 'anonymity and traceability' as the highest priority to be addressed with study participants calling for ready access to information on the purpose and operator of the drone. PytlikZilling et al. (2018, p89) reinforce this, highlighting the importance to the public of "how, why and by whom the UAVs will be used".

Privacy has further implications for the contexts where drone use is acceptable. Wang at al. (2016) presented five different use contexts focusing on the videography/photography application of drones, finding that private space extended beyond the boundaries of home and is further determined by levels of consent and notification. Bajde et al. (2017, p9) found participants expressed a sense of ownership of airspace above their homes with concerns relating to the potential for drones to hover within it. They noted that drones merely flying by represented less of a concern, summarising that "the faster the movement, the lower the privacy concern". However, participants were found to be unaccustomed to "thinking of privacy 'vertically', and find it hard to explain what a reasonable privacy zone would be in terms of altitude" (Bajde et al., 2017, p11).

Ideas relating to infringement of private space and time overlap with the more physical concerns about invasion of privacy. For example, Boucher 2016 (p 1401) suggested that "participants were more concerned about the feeling of having their personal space intruded than they were about excessive surveillance or privacy". This sentiment was also found by Bajde et al. (2017), with drones representing an unwanted physical presence or noise. These concerns relate to the broader concern about the proliferation of drones with implications of sensory intrusion beyond spaces which are typically considered as private. Floridi (2016, cited in Nelson et al., 2019, p83) refers to the conceptualization of physical privacy, defining private space as "areas that are free from sensory interference or intrusion—an area where individuals can separate themselves from unwarranted and unwanted interruption such as sound, touch, and sight".

Privacy and intrusion have been explored in quantitative studies in different ways including direct questions and unprompted open questions. The Department for Transport (2019b, p11) ask about concerns as an unprompted open question with 59% of respondents raising an issue of concern related to either privacy or intrusion. The Department for Transport group these responses together and it is not possible to draw clear conclusions as to the extent to which concerns relate to either of these issues. Concerns regarding intrusion may have their roots in a 'full-skies' vision discussed above.

The prevalence of concerns relating to privacy and spatial intrusion highlight the importance of understanding the more direct implications of future drone use scenarios on people's everyday lives with the need to establish the parameters that will determine whether these concerns will actually be manifest. The privacy implications stemming from the greater use of drones for logistics will vary significantly depending on the extent to which these uses are adopted and the form that the

regulatory environment eventually takes. This development would ideally reflect on the level of sensory and spatial intrusion that is acceptable.

2.3.2. Safety and Security

Studies indicate that concerns relating to safety and security prevail although the approach to investigating this potential issue varies in terms of the level of explicit priming on possible risks provided to respondents. Without specific prompts, the Department for Transport (2019b) found "Misuse of drones (e.g. hacking, terrorism, criminals)" and "Concerns about use of airspace/ aircraft collisions" were the most significant areas of concern raised after those relating to "privacy/intrusion" with 28% and 25% of respondents identifying these concerns respectively. This indicates these concerns were readily associated with drone use by at least a quarter of the sample population. Conversely, Aydin's (2019, p10) survey questions actively frame potential risks and concerns. Most of the resulting average scores assigned to listed risk options indicated a tendency to hold some level of concern with the potential for drones to be "misused by criminals or terrorists", which was highlighted the most. Other studies provide limited detail regarding the survey design but drew similar conclusions. Klauser and Pedrozo (2017, p236) reported that 64% of respondents fear that hobby drones could be involved in terrorist strikes. Reddy and Delaurentis (2016, p85) found that the risks associated with operating drones strongly affected the level of public support with key examples including "mid-air collisions with other aircraft, crash landings and invasion of privacy" thereby grouping safety issues with privacy.

Clothier et al. (2015) sought to present drones using carefully selected images to avoid reference to their purpose and use context avoiding a presumption that the respondents would associate the technology with specific safety risks. In contrast to other studies, results indicate that "Respondents did not consider the technology to be overly unsafe or risky, beneficial, or threatening" (Clothier et al., 2015, p1174), and that the technology was safe. Despite this, free text comments at the end of the survey continued to raise issues associated with safety and security.

Qualitative studies provide more in depth understanding of how participants' perceptions have formed and how this may influence support for drone applications whilst helping to identify appropriate solutions. For participants in the Department for Transport (2016) study, safety was the second most important priority after anonymity and traceability. Safety concerns fell within three categories: (1) 'drone users', with the potential for accidents and injuries increasing with greater use by an untrained and unregulated public and a particular tendency amongst younger people for more reckless behaviour exacerbated by the low cost of drones and absence of traceability; (2) 'equipment and materials' with safety concerns relating to lower quality, cheaper and older drones and reliability of battery power; and (3) 'mis-use and terrorism', with drones having the capacity to carry explosives or chemicals or access high security areas. Boucher (2016) also identified concerns relating to terrorism, with the greater proliferation of drones increasing this risk, and an association between the status of the drone operator and safety (and therefore acceptability of use). Within the Department for Transport (2016) study, participants had the opportunity to view a selection of drones and interact with their operators during which they were able to learn about safety features resulting in some level of reassurance, although the safety concerns listed above prevailed throughout the study.

2.4. Variation in levels of support between demographic groups

Gender differences exist in terms of awareness of and attitudes to drones with the general conclusion that women are less aware of the potential applications and more cautious in stating their support (see for example, Aydin, 2019; Eißfeldt et al., 2020; Reddy and Delaurentis, 2016; West et al., 2019). Zwickle et al. (2019) found that women demonstrated higher levels of support for drone regulation. EASA (2021a) found women to be more reluctant to use delivery drones and air taxis with lower levels of awareness potentially reflecting women's more limited involvement with drones both

professionally and recreationally. Klauser and Pedrozo (2017) found only 1.8% of female participants had experience of piloting drones compared to 18% of the male participants, similarly 96% of the drone users within the Lidynia et al (2017) sample were male. Kuzma and Dobson (2019) sampled companies specialising in drone services and found women to be under-represented, on average comprising of just 13% of the workforce and with female employees more likely to hold non-technical roles in human resources or business support. The Department for Transport (2019b) found that men were more likely to claim knowledge about drones and were more likely to have used a drone than women, with support for all uses of drones significantly more likely among men.

The Department for Transport (2019b) also report differences between age groups with older adults (aged 65+) reporting lower awareness of drones, less support for the use scenarios proposed and greater concerns. Studies also suggest evidence of greater perceived risks (Klauser and Pedrozo, 2017) and more reluctance to use drone services (EASA, 2021; Reddy and Delaurentis, 2016) among older people. Reddy and Delaurentis (2016) suggest that this is a result of less familiarity and comfort with new technology in general, although drones are not new technology as such, personal exposure to uses beyond hobbyist drone activity is limited with less direct experience with drones reported by older age groups (Klauser and Pedrozo, 2017).

2.5. Facilitating informed public views

Several studies have engaged non-experts in more informed debates about drones. These studies employed qualitative or mixed methods approaches to provide a more nuanced understanding of the differences in acceptance levels and the concerns raised while helping participants to build knowledge, develop their viewpoint and contribute to co-developed solutions. However, there are limitations in terms of the level of detail presented.

Boucher (2016) used a semi-structured focus group methodology to understand first impressions of a range of civil drones, associated uses and their acceptability. The study was careful to allow participants to draw out their own visions and narratives. Information was provided on a range of potential applications in the form of images, text and videos. The materials and moderation avoided judgements though Boucher (2016) recognises that materials can influence participants and there are representational problems. The study provides some robust insight into how the public envision the increased deployment of drones, their preferences as to how this is achieved (i.e. for social benefit) and their prevailing concerns relating to privacy, nuisance and inappropriate/illegal use.

The Department for Transport (2016) has undertaken one of the most detailed engagement activities identified in the literature, though the study took a generic overview of multiple drones and uses. This involved an initial workshop with key stakeholders that informed materials for use in three waves of public workshops in multiple locations. The public workshops provided a forum for stakeholders to engage and interact with participants and provided opportunities for non-experts to build a wider understanding of drones. Wave 1 focused on listening to participants and answering initial questions while in wave 2, expert stakeholders provided more technical expertise and brought in drones to explain their features and how they work. In wave 3 the dialogue constructively challenged participants' views and sought to tease out a more nuanced understanding. Participants initially had low awareness and knowledge of drones but were able to progressively build their knowledge and engagement. A final stakeholder summit reflected on the findings with the resulting effect that participants were more positive about drones and held a more "balanced view of the benefits and risks" (p6).

Given the generic nature of the above studies, there was little context on specific uses and how these might play out in real-life settings, however, several subsequent studies have focused on more specific drone use scenarios. Ogilvie et al. (2019) report a participatory design process that sought to integrate

community social acceptability perspectives into the proposed use of drones in urban areas for biological security work. The focus was on developing a methodology for wider use and the participatory work involved scientists from other parts of the programme and New Zealand citizens. Participation involved sorting flash cards describing 13 categories of current drone use on a continuum from "very unlikely to gain public acceptance" through to "very likely to gain public acceptance" and open questions about the thought process. The qualitative findings were then fed back to the technology designers and operators to consider participants' concerns in shaping operating protocols. The analysis identified positive and negative themes similar to other studies and similar levels of acceptability in relation to how drones are deployed. Lack of familiarity with the subject area emerged as a theme and Ogilvie et al. (2019) note that asking questions alone is limited as many participants lack the knowledge to make a meaningful contribution.

In another specific drone use scenario, Truog et al. (2020) reported successful public engagement in a study of drones for medical delivery in Africa (Malawi, Mozambique, Democratic Republic of the Congo and the Dominican Republic). This draws attention to culturally relevant content for engagement strategies and the need to adapt to different settings. Focus groups and interviews were undertaken in a three-phased approach to: I) assess community perceptions; ii) implement outreach activities prior to drone flights; and iii) explore community reactions post flights. The participants varied in each context but included national and district level stakeholders, health workers, community leaders and the general public living near take-off and landing sites of planned drone test flights. Truog et al.'s (2020) analysis suggests two-way communication should be established in areas where drones are operated and notes that developing people's understanding of contextual benefits, addressing misconceptions and mitigating risks are critical to the success of operations. This became apparent when there was an accident and the community remained supportive for flights to continue as they had understood the benefits they could bring. The three-phased approach enabled the operator team to understand key issues and then develop targeted messages for the outreach activities.

3. Methodology and data

In order to reflect on the nature and importance of the themes raised by the literature, data from the Department for Transport (2021) Transport and Technology: Public Attitudes Tracker was subject to further analysis. The Public Attitudes Tracker is based on a questionnaire survey administered twice a year from December 2017 to August 2020. All waves of the questionnaire included a question on respondents' knowledge of drones, however, waves 1, 2 and 4 were used in this analysis as they all included additional questions on respondents' use of drones, types of drones heard about, support/opposition for use of drones in various scenarios and concerns about drone use.

Approximately 3,500 respondents completed each wave of the survey and the total sample from waves 1, 2 and 4 was 10,615. The sample was conducted using random location sampling and then applying quota sampling. The data is considered representative of the population aged 16+ in England (Department for Transport, 2019b). The data was downloaded from the Department for Transport (2021) and transferred to SPSS for further analysis. The Department for Transport (2018 and 2019b) has reported some descriptive analysis of this data, including percentage responses and some comparisons by gender, age groups, changes in levels of concern between survey waves and by rural versus urban dwellers. Further analysis was therefore conducted on relationships between respondents' self-reported knowledge of drones; experience of drone use; types of drones heard about; support/opposition to use scenarios; and concerns about drone use.

4. Results

4.1. Knowledge and experience of drones

Knowledge of drones is captured by a question asking 'How much, if anything, would you say you know about drones?' with answer options: 'Hadn't heard about them before now; Hardly anything but I've heard of them; A little; A fair amount; A lot; and Don't know'. This is self-reported and subjective knowledge that is not tested by a definitive measure of drone knowledge. When knowledge of drones was compared with experience of drone use, those who have used drones are associated with more knowledge ($\chi 2$ (3) = 768.393, p <.001) as might be expected. Both knowledge and experience of drone use were also associated with having heard about drone uses across all categories (all $\chi 2$ significant at the p< .001). The latter were presented as a list that will have prompted recall.

4.1.1. Knowledge of drones and support for drone uses

The questionnaire explored support/opposition for the following drone types/scenarios with overall support fairly high (Department for Transport 2018 and 2019b):

- Police use such as monitoring borders, surveillance
- Emergency response such as search and rescue
- Infrastructure management such as building or bridge inspection, monitoring crops
- Retail use such as package delivery, stock checking
- Professional photography, filming and journalism
- Leisure use such as flying drones for fun, taking pictures & video

Police, emergency response and infrastructure use scenarios garnered most support and were much less controversial than retail use, professional photography and leisure use (see Table 2). Respondents stating that they had knowledge of drones and those who have used drones are associated with more support for all the drone uses (all χ^2 significant at the p< .001). This reflects recent findings in Germany (Eißfeldt et al. 2020). Those stating that they had less knowledge were more likely to choose 'neither support nor oppose' or 'don't know', i.e. these respondents feel less able to give a view.

Retail use is of specific interest since this includes parcel delivery, although this is conflated with stock checking ("Retail use (e.g. package delivery, stock checking") (Department for Transport 2019b, p20) despite these uses being very different in terms of potential visibility and impact on the public with stock checking taking place in an enclosed and private setting. The latter should not concern the public aside from perhaps impact on employment. Across all levels of knowledge, views were more polarised on retail use compared to other use categories. A closer look at opposition to retail use indicates that those who have not heard of drones oppose retail use less than those who claim to know more (χ^2 (25) = 2100.578, p <.001). This contrasts with other drone uses where patterns of opposition are relatively similar across knowledge categories. This is in part due to those with no knowledge choosing 'neither support nor oppose' or 'don't know' which reduces the level of both opposition and support (see bold text in Table 3).

Cross tabulations and chi-square tests were carried out for corresponding categories of drone uses respondents had heard about and levels of support for that drone use (i.e. heard about police use and support for police use) (Table 2). For all, there was a significant association with having heard about the drone use and support for the use (all χ^2 significant at the p< .001). Those who had not heard of the drone use were more likely to choose 'neither support nor oppose' or 'don't know'. This is apparent for retail use which is of particular interest to logistics as this includes package delivery.

The respondents who had not heard of any drone uses show lower support for all drone uses compared to those who have heard of at least one drone use, however, this is not necessarily lower support, rather people opting for 'neither support nor oppose' or the 'don't know' option (see bold

figures in Table 2). Actual levels of opposition amongst those with no knowledge are the same or lower, and notably lower for final three scenarios. The data shows that between 36% and 44% were willing to adopt a position on use scenarios despite not having heard of them and this raises a further methodological problem where respondents are asked questions about a topic where they have declared no knowledge.

Table 2. Support for drone uses comparing group who had not heard of any drone uses (n=996) with those who reported knowledge of at least one drone use (n=9619)

		Strongly support	Tend to support	Neither support nor oppose	Tend to oppose	Strongly oppose	Don't know
Police use such as monitoring borders, surveillance	Heard of drones %	46	35	**12**	4	3	**1**
	Not heard of drones %	15	21	**35**	4	4	**22**
Emergency response such as search and rescue	Heard of drones %	61	27	**8**	2	2	**0.4**
	Not heard of drones %	19	20	**33**	2	3	**22**
Infrastructure management such as building or bridge inspection, monitoring crops	Heard of drones %	37	41	**15**	4	2	**1**
	Not heard of drones %	11	20	**38**	5	4	**23**
Retail use such as package delivery, stock checking	Heard of drones %	11	26	**29**	20	14	**1**
	Not heard of drones %	3	13	**42**	12	8	**23**
Professional photography, filming and journalism	Heard of drones %	23	38	**22**	11	6	**1**
	Not heard of drones %	6	17	**41**	8	6	**23**
Leisure use such as flying drones for fun, taking pictures & video	Heard of drones %	12	30	**26**	19	13	**1**
	Not heard of drones %	3	12	**41**	11	11	**22**

Table 3. Crosstabulation of drone knowledge and support for retail use

	How much, if anything, would you say you know about drones?					
Support for retail use	Hadn't heard about them before now	Hardly anything but I've heard of them	A little	A fair amount	A lot	Don't know
Strongly support	41 5.6%	139 5.8%	464 9.6%	283 14.4%	118 20.1%	0 0.0%
Tend to support	84 11.4%	534 22.3%	1265 26.0%	543 27.7%	151 25.7%	5 6.5%
Neither support nor oppose	323 **43.9%**	787 **32.8%**	1462 **30.1%**	503 **25.7%**	133 **22.7%**	20 **26.0%**
Tend to oppose	75	493	960	380	87	3

	10.2%	20.6%	19.8%	19.4%	14.8%	3.9%
Strongly oppose	73	369	671	245	91	1
	9.9%	15.4%	13.8%	12.5%	15.5%	1.3%
Don't know	140	75	35	7	7	48
	19.0%	**3.1%**	**0.7%**	**0.4%**	**1.2%**	**62.3%**
Total	736	2397	4857	1961	587	77
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

4.1.2 Knowledge of drones and concern about their use

Respondents were asked 'What concerns, if any, do you have about the use of drones?' which was presented as an unprompted question without response options. Those stating some knowledge identified more concerns (χ^2 (5) = 87.781, p <.001) which reflects their awareness of potential concerns. On the other hand, there are no statistically significant differences between drone users and non-drone users and their levels of unprompted concern with any item, with the exception of safety, where drone users are a little more concerned (23%) than non-drone users (20% concerned). Therefore, direct experience of drone use leads to support for drone uses, but concerns are relatively consistent with other respondents.

Respondents who had not heard of any drone uses were associated with having no concerns (χ^2 (1) = 114.871, p< .001) which reflects their lack of drone knowledge. However, these respondents do express some concerns, in particular concerns were expressed about privacy (24% mentioned as a concern). As the concern question was an unprompted response question, this suggests that some concerns about drones are widely circulating in the population.

4.2 Gender

There are gender differences related to experience of drone use with only 6% of the women having experience compared to 14% of the men (χ^2 (1) = 193.238, p <.001). Commercial/work-related use of drones was small for both males and females (1.1% and 0.3% respectively). There was less overall support from women across all of the six use contexts presented in the survey compared to men (all χ2 significant at the p< .001, see Table 4). For the first three use contexts, this difference was accounted for by the proportion of non-committal answers ('neither support nor oppose' or 'don't know'), levels of opposition being very similar across genders. Women showed greater opposition than men to the final three use contexts all of which could be considered to have increased potential to infringe on everyday lives. Despite this, levels of concern for the various potential impacts of drone use (privacy/intrusion, noise, safe use, malfunctioning) were similar for both genders. The consistency of concern was also evident across drone users/non-users and to some extent those who had not heard of any drone uses (section 4.2 and 4.3) and suggests a pervasive social representation (Bauer & Gaskell, 1999) of drones that positions them as an object of concern.

Table 4. Support for drone use contexts by gender

		Strongly support	Tend to support	Neither support nor oppose	Tend to oppose	Strongly oppose	Don't know
Police use such as monitoring borders, surveillance	Male %	47	32	12	4	3	2
	Female %	40	35	15	4	3	3
Emergency response such as search and rescue	Male %	62	24	9	2	2	2
	Female %	53	28	12	2	2	3

Infrastructure management such as building or bridge inspection, monitoring crops	Male %	41	37	15	4	2	2
	Female %	28	41	20	5	3	4
Retail use such as package delivery, stock checking	Male %	12	26	29	18	13	2
	Female %	7	22	32	20	14	4
Professional photography, filming and journalism	Male %	27	37	21	8	5	2
	Female %	16	35	27	13	6	3
Leisure use such as flying drones for fun, taking pictures & video	Male %	15	32	25	16	11	2
	Female %	8	24	29	20	15	3

5. Discussion

5.1. Knowledge of drones

The general public's knowledge of drones is understandably diverse and will depend to a large extent on exposure to and interest in drones. Aside from hobbyist drones, most people have limited exposure to drones in their day-to-day lives and, though this exposure is increasing, knowledge of drones is sparse. Analysis of the Public Attitudes Tracker data indicates a high degree of non-committal responses, particularly from respondents declaring least knowledge. This was also seen in an early public acceptance study with MacSween-George (2003) speculating that this would change with more information, though this change has yet to materialise. The general public are in part a disengaged audience since drones do not generally pervade everyday life at this point in time. Qualitative studies suggest the public is labile and greater knowledge and understanding would put people in a better position to give an informed view. People generally become more open to drone uses if they find out more about them or have higher self-declared drone knowledge or experience. The public's views are adaptable and "the public is currently in the process of forming their understanding of the implications of drone technology and is still developing their individual specific positions on its acceptability" (Zhu et al., 2020, p9).

Studies show that information provided and knowledge of respondents can both influence answers, though studies demonstrate mixed effects of knowledge. Komasová et al. (2020) viewed this through the lens of the 'familiarity hypothesis' which implies lower risk expectation and higher approval in more knowledgeable groups and drone users, though they found this does not always follow. They conclude that learning about drones is a non-linear process. They suggest that some knowledge may make people aware of risks, but as people gain more experience and understand the technology better, these perceived risks may dissipate. However, this may not hold for all issues as Eißfeldt et al. (2020) found that noise concerns increase when people have experienced the sound of a drone.

The analysis raises questions about the validity of measuring support and concerns when knowledge is not taken into account. Where views are uninformed, there is scope to misrepresent issues and this could harm decision making particularly where there is greater neutrality in responses and where the public might have little grasp of issues. Acceptance of drone scenarios might be later regretted. Studies like the Department for Transport (2018 and 2019b) are based on self-reported knowledge that is subjective and those reporting high levels of knowledge may know little. Some drone users reported

low levels of knowledge perhaps recognising there are areas where they lack understanding. Several studies highlight the need to improve public engagement with and knowledge of drone uses (Boucher, 2016, Ogilvie et al., 2019), with Nelson et al. (2019) raising concerns about the impact of uninformed public views of drones on policy and decisions. Qualitative studies show that helping participants to build levels of familiarity via information provision and engagement can help people contribute more constructively to decisions about drones, but challenges remain regarding understanding the practical deployment of drones in realistic situations (see below).

5.2. The methodology matters

Support for drone use for public good along with concerns related to privacy/intrusion and safety are prominent in the literature and evident in the Department for Transport data. The issues for each need to be teased out more clearly in studies, for example, concerns about drones are conflated with one another and there are a myriad ways people can interpret privacy, intrusion and safety. The public's concerns in these areas are not fully understood and need to be explored in depth. Different drone uses are also often put together. Here, context is critical as discrete use contexts will have different implications for people's lives. People are also asked to give a view on drone uses to which they have had no tangible exposure and little inkling of how they might work. In the meantime, their exposure to drones is likely dominated by hobby drones where use practices often entail hovering and capturing images with obvious scope to invade privacy. Markowitz et al. (2017) flag a concern that opposition to other drone uses may impact on the continued use of drones for conservation work.

In addition, most drone use scenarios are somewhat tangential to people's everyday lives. For example, infrastructure management roles are unlikely to directly infringe on people's experiences and only indirectly provide benefits. There is also a socially desirable response to drone use for public good often in contrast to how other drone uses are positioned, for instance as 'commercial' or 'private industry'. It is highly likely that drones for public good will be operated by a commercial organisation that would have the skills and infrastructure required, but currently unclear whether this would make the drone or drone use less acceptable. With respect to understanding attitudes towards drone use in logistics, most use scenarios are not transport related. It is therefore not possible to draw conclusions about perceptions/acceptance for this area of interest.

Studies of drone perception, attitudes and acceptance approach the research in different ways and therefore find different things. This includes focusing on different aspects, as would be expected in an emerging field, including individual or multiple use scenarios and focusing on specific issues such as drone related risks (for example, Komasová et al., 2020) or end-user trustworthiness (for example, PytlikZillig et al., 2018). Study designs which prompt respondents, for example, by listing concerns or drone uses, position this front of mind for respondents and this can shift the prominence of issues for different groups. Context also plays a role as Macsween-George (2003) found when comparing two questionnaires, one with minimal information and one with information about higher safety and lower cost of drones with this positive framing leading to more positive responses to cargo drones. In contrast, Del-Real et al. (2021) found a high negative response to beach rescue drones, but here, no context was provided for a drone use ostensibly for the public good.

The term 'rescue drones' is vague and open to multiple interpretations and associations, including absence of human rescuers, which may not be positive. Therefore, the presence or absence of information and the framing of this information can influence responses. Studies therefore need to pay close attention to the approach to questions asked; the framing of questions as prompts; the context provided regarding drones and their use operations; the value of real case studies; and studies of particular use scenarios. Furthermore, where theory has been applied in studies the theories tend to draw on approaches such as theory of reasoned action or the technology acceptance model that privilege individual attitudes and ignore social contexts of use (Paddeu et al., 2020). Zhu et al. (2020,

p1) also questions these approaches which are based on “atomized and isolated beliefs” and argue that risks related to drone deliveries are related to one another in clusters.

5.3. Determining systems of provision

The general public and non-expert stakeholder groups lack a vision and common understanding of potential logistics drone operations. For example, Zhu et al. (2020) point out the limitation of service concept descriptions which describe a single drone delivering a parcel, yet many drones would be required to meet service needs, and this may alter people’s concerns. However, with respect to concerns about a full-skies scenario, in reality drones will not fly everywhere but until a provisional model is established it is hard for stakeholders to make objective comments. Essentially people are commenting on a nebulous idea given they have little or no insight into what many use applications might actually look like as this is largely undetermined. Even experts are still grappling with the complexities of drone regulation and governance. For instance, Kunze and Frommer (2021) describe how the future form that urban transport will take is uncertain drawing upon popular culture to envisage a spectrum of levels of urban mobility with multi-layer air corridor systems depicted in the ‘The Fifth Element’ presenting a ‘full-skies’ outcome at one extreme. Reporting of developments within drone logistics incorporate pictures of drones carrying things and images of drones landing on balconies, driveways or lawns, for example, Amazon Prime Air (Amazon 2021) and the Financial Times (2021) which pictured multiple drones carrying parcels when reporting on trials. These visions in the public domain are unlikely to be a reality in the near future.

Underpinning concerns and levels of support for drone uses are underlying considerations of who is the drone operator, are they trained, how is it regulated, how frequently will drones be present, where will they fly and what can they see? These questions remain unanswered but are critical to making an informed judgement. Safety risks will vary widely between drone applications, use contexts and operators.

It is something of a ‘chicken and egg’ situation given it is unlikely that we will achieve a common understanding of drone logistic provision prior to regulatory and governance decisions (see also Stilgoe and Cohen 2021 with respect to self-driving vehicles). This presents dilemmas with Sah et al. (2020) noting that regulations will help mould public perceptions. Regulations may enable flights, which might not prove to be acceptable, or, alternatively, misplaced public concern may lead to an overly regulated environment that fails to realise the benefits of drones. There is also a need to understand the bigger picture in logistics where drones will be integrated with other modes and how this might improve delivery times and reduce carbon emissions which Zhu et al. (2020) argue may change public perceptions, though perceived benefits may or may not be realised (see Paddeu et al., 2020 re autonomous vehicles).

5.4. Acceptance

Stilgoe and Cohen (2021) describe how the public are framed as a problem within transport innovation with a focus on achieving acceptance of the inevitable adoption of new technologies such as self-driving vehicles, calling for a shift instead towards engagement which provides for understanding of what determines acceptability. Indeed, ‘how to make drones more acceptable’ underpins a number of the studies discussed above. Maclas et al. (2019) further highlight the need for inclusiveness and approaches that empower people to get involved in decision making and, as experts build understanding of systems of provision, there will be communication opportunities. While it is relatively easy to show people drones and their capabilities, it is less easy to show them how provision might look in terms of volume of drones, where they might fly, how high/low, how far away, how they might sound. This may need to be communicated to people in familiar local contexts and, as PytlikZillig et al. (2018) suggest, in locally acceptable ways. There is scope for innovative approaches using animation and gaming tools to explore scenarios and understand better where people feel drones

would be viable (see for example from work on climate change, Flood et al., 2018; Wadey et al., 2015). Work is emerging to quantify risks (see for example Zhang et al. 2018), but this needs to be translated to and explored with the public. This more nuanced understanding then needs to feed into regulatory and governance decisions. It is vital to recognise and communicate that some questions cannot be answered at this stage.

6. Conclusion and recommendations

This paper set out to establish the current position on the public's receptiveness to the use of drones for logistics and to explore how non-experts might better contribute to debates about the future integration of drones into transport systems. Our analysis shows that it is not possible to conclude a position based on the research to date due to methodological challenges and problems of contextualising realistic future use scenarios and finding ways to relate these to people's lives.
The parameters for greater deployment of drones in logistics are yet to be determined with the need to define regulatory requirements and understand where the clear benefits are to be gained, such as improved delivery times and reduced carbon emissions. Concerns such as privacy, intrusion and safety are in part dependent on technological capabilities of the drones to be deployed but will also be conditional on the form that regulation takes in determining the frequency of logistic drone movements, localities for use and permitted operators.

Levels of public acceptance are important for the development of frameworks governing the future use of drones, but caution needs to be taken in responding to concerns that have been identified without clear reference points. The analysis presented in this paper demonstrates the challenge of gauging public opinion given the low salience of future drone uses, with some groups being less engaged than others and drone uses being abstract concepts for many. There are future opportunities for researchers to explore detailed use cases and operating parameters with stakeholder groups to help develop regulatory frameworks for the future.

We call for future logistics to move beyond a model of public acceptance of drones to one which identifies a desirable use of drones within transport. In the first instance, this requires an evidence-based vision for future operations that necessitates the progression of expert knowledge to establish how systems of provision may look and be regulated. There is also a need for a detailed understanding of, and response to, prevailing areas of public concern to enable the informed co-development of an acceptable future for transport logistics integrating drones.

From a policy perspective, logistics is currently stuck in a 'predict and provide' scenario. Demand for products is always shifting thanks to wider developments and social change and continued level of consumption at a high rate is unsustainable. Policy aspirations need to shift to a "vision and validate" perspective (Marsden et al., 2018) to guide the integration of drones into logistics. These early stages are the time to really reflect on what society wants to achieve in the longer term. We would echo Ogilvie et al. (2019) and a point originally made by Boucher (2016, p1393) that "we should not focus on making citizens accept civil drones, but on making civil drones acceptable to citizens". This not only requires understandings of general public expectations but also a process that enables the public to truly engage in drone use scenarios to inform decisions on provision.

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