Future Healthcare Logistics

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Future healthcare logistics: a survey of the public opinion on drones in Denmark

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Abstract

Drones are expected to become widespread in society, making public readiness an important prerequisite for successfully unleashing them. This article investigates Danish citizens' opinions on drones across varying fields of application and, specifically, six potential cases of healthcare logistics. Survey data representative of age, gender, and geography were collected and included information about respondents' background, knowledge level of drones, and opinions on different drone use cases. Data were analysed with frequency tables and bivariate cross-tabulation. A thousand and four Danish adults completed the survey. Although other fields of application received higher levels of support, a majority of the respondents were positive towards using drones for healthcare logistics. Transportation of medicine and blood samples between hospitals were the most accepted healthcare use cases. Support varies across age with the highest support found in the eldest age group. Also, the more citizens report to know about drones, the more they tend to support using them. The results suggest that policymakers and firms must be attentive towards the public opinion on drones and seek insights into what citizens regard as noble purposes of using drones. Moreover, citizens must become more acquainted with drones, as this will likely boost public support.

Key words: drones, unmanned aerial vehicles, surveys and questionnaires, public opinion, health policy, delivery of healthcare

Introduction

The healthcare system in many countries is under continuous and ongoing transformation, and the adoption of new technologies is considered both an important driver and a cause of these changes (Balas and Chapman 2018). New technologies are introduced into the healthcare system with increased pace and in great variety, based on the hospitals increasingly making decisions concerning early development of and investment in innovative medical technologies (Safi et al. 2018; Barzekar et al. 2019; Fasterholdt et al. 2019). Beyond the direct implementation of new technologies for office automation or for reducing medical errors (Bernstein et al. 2007), others focus on different technologies for improved processes among healthcare professionals and on decentralising healthcare to, for instance, enable care for the patients in their own home (Shah et al. 2018). What can be seen from these observations is a dual process of transforming the healthcare system; both for increased specialisation of treatments and processes within the hospital, and for increased attention to care—away from the hospital—at the patients' home. New technologies are the key enablers for these transformation processes and for enabling new logistics solutions (Gutiérrez and Vidal 2013). A derivative of these processes is an increasing visibility of patient care in the public, as healthcare moves from hospitals into society across multiple locations and geographies. The new logistics solutions and systems to accommodate these changes, therefore, influence all stakeholders in society and not only patients and their families.

Public opinion matters to the implementation of new logistics solutions

This article focuses on the potential adoption of unmanned aerial vehicles (drones) into the healthcare system, such as for cargo logistics and transportation of healthcare professionals. In most countries, including Denmark, the potential of using drones is still unknown but expectedly high, yet far from being realized. Many barriers are identifiable, but restrictive legislation that prohibits, for instance, flight beyond the drone pilot's visual line of sight or flight close to hospitals' helipads is important (EASA 2021*a*). Besides technical issues (such as the development of sense-and-avoid capabilities, fail-safe solutions, and emergency landing systems), further attention is given to the widespread adoption and integration of drones in airspace, which can give rise to resistance from the population due to, for example, noise discomfort or other general nuisances (Cawthorne and Robbins-van Wynsberghe

2020). In fact, Komasová (2021) finds that *the dependence on the acceptance of drones' use among the public* is the most often mentioned reason for concern. Policymakers, therefore, seek compelling evidence that the technology can unleash the promised potential at low risk, while they remain sensitive towards any changes in the public opinion on technologies in general and drones specifically (Smith et al. 2022).

As the use of drones in society is still relatively rare, only few studies investigate the public opinion on these unmanned aerial vehicles (see, for instance, Clothier et al. 2015; Rice et al. 2018; Walther et al. 2019). Based on a 2019 review of academic literature, Komasová (2021) supports the importance associated with public acceptance of using drones; however, none of the studies reviewed by Komasová researched the opinions on using drones for healthcare logistics. Thus, to fully understand and unleash the potential of drones in healthcare, further insight into the public opinion is required. The aim of this article is, therefore, to improve our understanding of the potential of using drones in the Danish healthcare system by investigating the public opinion on using drones more generally and specifically for healthcare logistics. We ask the following questions:

- *What are the opinions of Danish citizens on drones across varying fields of application?*
- *Which personal contextual factors influence the public opinion on using drones in Danish healthcare?*

Recent studies on the public opinion on the use of drones

In most countries, drones for logistics purposes, such as transportation of blood samples between hospital units, as well as ordinary goods, such as groceries, are just figments of the imagination. Nonetheless, in recent years, findings on public opinions towards drones used for various transportation purposes have been investigated. The results of studies across different countries and contexts, and communicated primarily through industry reports, reveal both perceived benefits and challenges of using drones for logistics purposes.

The European Union Aviation Safety Agency (2021*b*) has investigated societal acceptance of drones among citizens of Barcelona, Budapest, Hamburg, Milan, Paris, and the cross-border region Öresund (Copenhagen and Malmö). Based on expectations of drones being faster, cleaner, and extending connectivity, 83% of EU citizens express positive sentiments towards and interest in drones, and 71% regard themselves as potential users of drone delivery services and air taxis. However, the study also shows that EU citizens are concerned about risks related to safety, noise, security, and impact on wildlife. The Sky Limits project (Kellermann and Dannenberger 2020) finds that a majority of German citizens are opposed to delivery drones (55%) and transportation by air taxis (62%), mainly based on fear of drones crashing (75%) and causing human injuries (81%). Women and citizens older than 60 years are the least positive. Eißfeldt et al. (2020), who also studied the opinion of German citizens, find a slightly larger percentage of the population to be positive (49%) than negative (43%) towards drones for civil purposes. Moreover, they find less support for the use of drones for purposes such as parcel delivery compared to the use of drones for rescue operations and healthcare purposes. In fact, the highest level (on a scale from 1 = max to 4 = min) of support is for uses such as catastrophe response (1.43), rescue and police operations (1.56) as well as transportation of medicine (1.83). Hence, the German population appears divided in their opinions and with a preference for what can be regarded as meaningful uses. The results vary across demographic factors, such as gender and age but also income and place of residence. A study made by IMECHE (2019) shows that only 23% of citizens across Great Britain support drones for delivery of online orders. Again, there are demographic differences, both across gender with men being more supportive than women (37% versus 25%) and across age groups with respondents aged 18–24 being more positive than those aged 65–74 (45% versus 18%). Overall, although the study by the European Union Aviation Safety Agency (2021*b*) shows that the prevailing opinion on the use of drones is positive among EU citizens, the studies made in Germany (Eißfeldt et al. 2020; Kellermann and Dannenberger 2020) and Great Britain (IMECHE 2019) signal that a considerable share of citizens are less positive.

The European Union Aviation Safety Agency (EASA 2021*b*) found that the perceived usefulness of drones is highest in cases of emergency and healthcare, especially for transporting injured persons and medical supplies to hospitals (41% each) and for transporting emergency medical personnel (36%). The support for such use cases is similarly high in the Sky Limits study (Kellermann and Dannenberger 2020) of the public opinion in Germany, where the use of drones for purposes such as delivery of AED (automated external defibrillator) to wherever the person suffering a heart attack is located, is supported by almost two-thirds of the respondents. This is in line with the study by IMECHE (2019) showing that 75% of citizens across Great Britain support drones for emergency purposes. The Sky Limits project further shows that elderly respondents tend to be those most in favour of air taxis for emergency purposes. In a study among Singaporean citizens, as much as 92% of the public support the use of drones for search and rescue operations (Tan et al. 2021). These results, compared to those concerning drones for transportation in general, emphasize the importance of drone flights serving a perceived meaningful purpose to gain the support from the majority of citizens. This is supported by an academic literature review by Smith et al. (2022).

The literature review by Komasova (2021) finds that respondents with self-declared knowledge of drones are more supportive of all kinds of drone uses. Eißfeldt et al. (2020) find similar results for Germans' opinions on drones: the higher the (self-reported) knowledge of drones, the more positive respondents are towards them, which aligns with an earlier study (presumably also conducted in Germany) by Lidynia et al. (2017). Most studies on public opinions concerning drones encompass respondents with no actual experience with drones (e.g., Clothier et al. 2015; IMECHE 2019; Kellermann and Dannenberger 2020), except one study in Virginia, USA, where the majority of the survey population has first-hand experience with drone delivery services

(Virginia Tech. 2020). Overall, 89% of the respondents have used or are likely to use drone delivery services themselves. Eighty seven percent of the respondents are to some degree positive towards using drones for delivery of packages whereas 7% express negative sentiments towards delivery drones. Concerns include noise, privacy, service limitations (such as weather restrictions), potential job loss, impersonality, delivery errors, and safety. Speed and convenience (e.g., for people with impairments), environmental benefits, reduced traffic, and contact-free delivery in the light of the COVID-19 pandemic are seen as positive aspects of drone delivery. Prior experience with drones positively affects opinions hereof. The importance of pre-knowledge of drones is also apparent in the study among Singaporean citizens, where drone operators—i.e., those who are used to operating drones—are primarily concerned with accidents whereas laypersons perceive violation of privacy as their biggest concern (Tan et al. 2021).

Methods

The opinions of Danish citizens were investigated by means of a voluntary population web-survey conducted with people aged 18 or above. Fielded from January to February 2021, the survey collected the following information: background information (gender, age, highest level of education, postal code, number of children (<18 years old) living at home, annual household income before taxes, and type of occupation), knowledge level of drones (five levels ranging from no to a high degree of knowledge), opinions on drone use in different areas, and the opinion specifically regarding potential healthcare use cases encompassing drone transportation of blood samples, medicine, and clinicians. To report the results, the Checklist for Reporting Results of Internet E-Surveys is used (Eysenbach 2004).

Sample and data collection

Respondents were recruited by Epinion, a professional recruiting company, from pre-recruited panels of individuals. The panel members have agreed to complete research projects for small incentives such as drawing lots for gift vouchers. The panel aims to be representative with respect to age, gender, education, and geography at the regional level. While Epinion distributed the survey, it was developed by a Danish research project consortium (HealthDrone), and the survey focused on the potential implementation of drones in the health sector. The first page of the survey stated the purpose of the research project along with the purpose of the survey study, length, handling of data, and informed consent. The survey contained 15 items (one item per page). All answers had to be submitted, and some items had nonresponse options such as “don’t know”/“undecided”. All respondents had beforehand agreed to receive participation offers regarding market research conducted by Epinion. The survey was only accessible through a personalized link emailed to participants in the online panel. It was not possible to use the same link more than once, and respondents could not change their statements upon completing the survey.

Data were subsequently weighed to correct for minor deviations to improve the representativeness of the sample. The survey weights ensure that the weight given to respondents in the sample reflects the distribution in the general population when it comes to age, gender, education, and region. The weights were calculated using the Raking method (Battaglia et al. 2009). All results throughout the report are calculated using the survey weights. The sample distribution is very close to that of the Danish population with respect to age, gender, and region, while the respondents have a higher education than the Danish population in general.

Data were anonymized by Epinion before they were handed to the project team, and only completed surveys were analysed. It has not been possible to retrieve information regarding view, participation, and completion rates due to Epinion’s data protection (Epinion deletes raw data 3 months after termination of the study). The full survey with the questions asked can be seen in online supplementary Table S1 (in Danish). The online supplementary Table S2 contains the distribution of respondents regarding demographic variables (age, gender, education, region) and knowledge level of drones.

Statistical analysis

All analyses were performed using Excel. Questions that used the Likert scale offered either five or seven possible responses when capturing the degree of agreement with a given question or statement. However, when presenting results, some answers were aggregated for clarity. “Very positive” and “positive” were grouped, and “very negative” and “negative” formed into another group. Data were analysed with frequency tables and bivariate cross-tabulation, and proportions were calculated. Furthermore, comparisons were done using appropriate statistical tests, i.e., one-way analysis of variance for categorical and quantitative data and χ^2 test for categorical data alone. Statistical significance was set at $p < 0.05$.

Ethics approval and consent

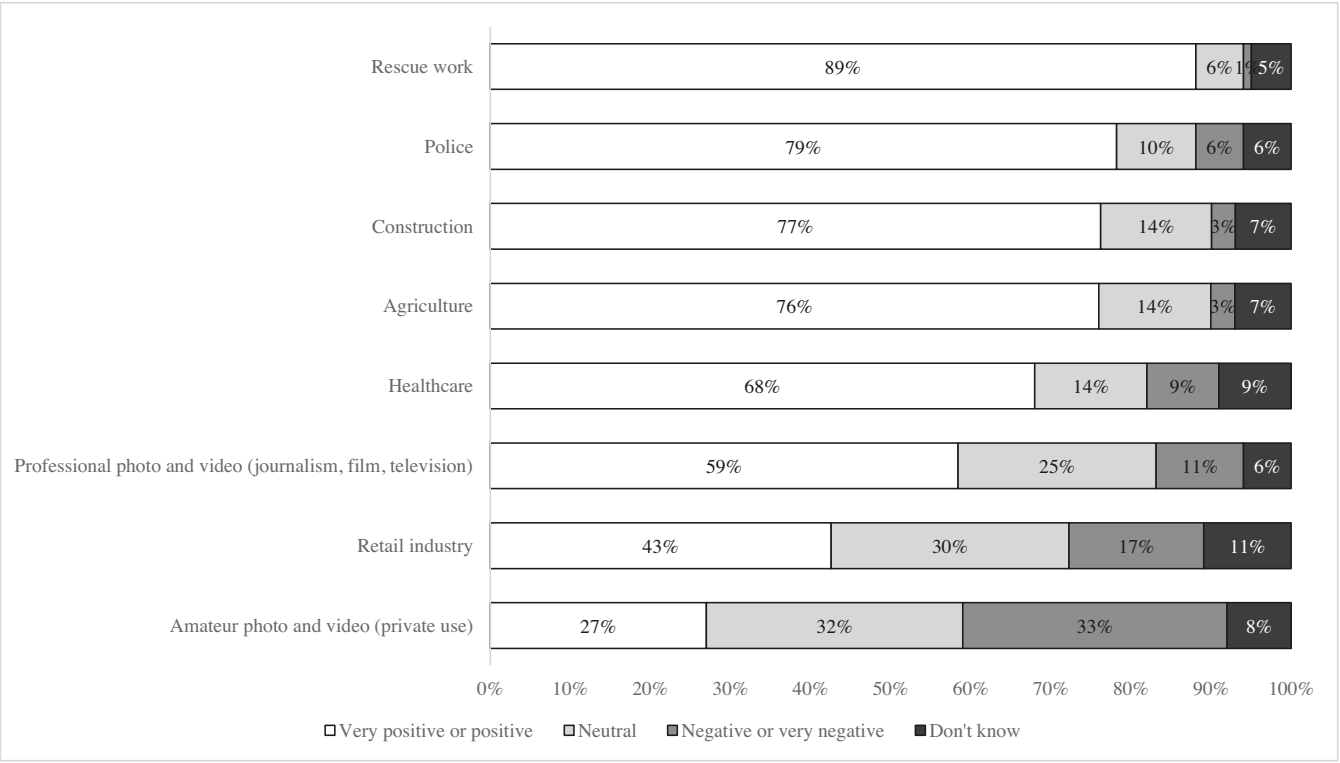
The study was not approved by any Research Ethics Committee, as this is not relevant in Denmark for this kind of study. Respondents were provided with an online information sheet outlining the details and ethical issues associated with the survey, and only those who consented to these conditions progressed with the survey.

Results

Opinions on the use of drones in different fields of application

The most positive opinions towards the use of drones across different application areas were found for rescue and police operations, where around 80%–90% of the 1004 respondents indicated a positive opinion, followed by the construction industry, agriculture, and the health sector (see Fig. 1). The private use of drones received far less support, as less than one-third of the respondents indicated a positive opinion.

Fig. 1. Opinions on the use of drones in different fields of application ($N = 1004$).



Note: Respondents were presented with different fields of application and examples of use cases in that area. For instance, regarding the police, the complete text presented was "Police, e.g., monitoring fan groupings in connection with football matches, traffic monitoring, and surveillance and management of accident sites". See also online supplementary Table S1.

Supplementary analysis reveals statistically significant differences in opinions regarding age for all fields of application. The *p*-value is lower than 0.05 for all eight domains (see online supplementary Table S3). On average, mean age is lower across all eight domains, as the support goes from positive to negative, indicating that younger people express more negative opinions towards drone use. However, this pattern is reversed regarding two applications. Regarding private drone use, the mean age is 53.5 in the category "very negative" or "negative" answers, while the mean age is 42.5 in the "very positive" or "positive" category (the numbers are, respectively, 51.5 and 46.5 for professional photo and video). Additional supplementary analyses show no statistically significant difference between gender and support for the various domains (*p*-value >0.05 for all eight domains).

Degree of support for specific healthcare use cases

The results concerning use of drones for different healthcare cases show that transportation of medicine and blood samples between hospitals are the most accepted areas, with one-third of the respondents indicating a high level of support, as seen in Table 1.

A supplementary analysis was done regarding age and support, and the results show statistically significant differences in the degree of support regarding age. The *p*-value was <0.05 for all six healthcare use cases (see online supplementary Table S4). On average across the six use cases, mean age is lower as the support goes from positive to negative, indicating that younger people tend to be more negative towards healthcare drone use than elderly people (apart from a very small increase in mean age from negative to the very negative category). The biggest age differences are seen on use cases 1, 2, and 3 (see online supplementary Table S4).

Support for drone use based on knowledge level of drones

More than half of the respondents have some knowledge of drones—of whom 15% state that they have a high degree of knowledge. Table 2 indicates differences in support for healthcare use cases based on the respondents' knowledge level of drones (ranging from a very high level to no knowledge at all). Sixty eight percent are, to some degree, positive towards healthcare use cases, irrespective of their knowledge level of drones (the right column), while 9% of all respondents are negative, to some degree, towards the use of drones for healthcare logistics. Most importantly, the more citizens know about drones, the more they support their use, where the level of support varies from 90% down to 39%, but especially those with some knowledge are more positive.

Moreover, there are differences in public opinion on drones when analysing the respondents' occupation. Across all

Table 1. Degree of support for six specific healthcare use cases ($N = 1004$).

	Very high	High	Some	Low	None	Don't know
(1) Transportation of medicine between hospitals	33%	24%	19%	8%	5%	12%
(2) Transportation of blood samples between hospitals	33%	24%	18%	8%	5%	11%
(3) Transportation of medicine to patients' home	28%	23%	22%	10%	6%	11%
(4) Transportation of healthcare professionals between hospitals	22%	16%	22%	10%	9%	22%
(5) Transportation of healthcare professionals to scenes of accidents	23%	19%	19%	9%	8%	21%
(6) Transportation of patients from scenes of accidents to hospitals	22%	15%	18%	12%	12%	22%

Table 2. Level of support for healthcare use cases in relation to knowledge level of drones ($N = 1004$).

	Knowledge level of drones					
Level of support	Very high	High	Some	Low	None	Total
Very positive/positive	90%	73%	72%	63%	39%	68%
Neutral	3%	15%	12%	18%	14%	14%
Negative/very negative	7%	8%	9%	11%	7%	9%
Don't know	0%	3%	7%	8%	40%	9%
Total	100%	100%	100%	100%	100%	100%

Note: Question asked: "What is your immediate opinion on the use of drones in the following fields of application?—Healthcare, e.g., for delivery of blood samples, defibrillators, and/or delivery of medicine to islands". This question is grouped by knowledge level of drones.

occupational groups, 68% of the respondents are positive to some degree, with retired people being the most positive group (78%) and people under some form of education and those in the "other" category are the least positive groups (<50% positive) (Table 3).

Discussion

By means of a survey with 1004 respondents, we set out to gauge Danish citizens' opinions towards the implementation of drones as a widespread, general logistics solution for transportation of cargo and humans in Denmark and, specifically, in the Danish healthcare system. We initially investigated the public opinion on drones across varying fields of application and, secondly, which personal contextual factors might influence the public opinion on using drones in healthcare. Our findings show differences across age and knowledge level of drones as well as differences of the most favoured fields of applications.

The results of existing, mainly EU-based studies of the public opinion on drones for transportation of cargo (and, in some studies, also humans) show variation across countries, fields of application and, in some cases, demographic factors such as age and gender. Our study of Danish citizens' opinion on the use of drones for various purposes, including healthcare logistics, also points to some differences.

The results of this study show that for healthcare logistics, elderly and retired citizens are, in all six cases, more in favour of using drones than young citizens and students. These results align with the findings of the Sky Limit's project in Germany regarding air taxis for emergency purposes (Kellermann and Dannenberger 2020) and also for cargo transportation of medicine and blood samples. These findings for the health sector are surprising, because although young people generally perceive themselves as being at significantly less at risk of experiencing accidents and health problems than elderly people do (Kim et al. 2018), and therefore probably do not have healthcare logistics top of mind, younger people normally tend to be more positively prone towards new technology (Tsourela and Roumeliotis 2015). Overall, our findings concerning age suggest that widespread use of drones in healthcare for both cargo and person transportation might encounter public resistance in the long run, as a little more than half of the young citizens do not readily embrace drones today. This makes it crucial that these unmanned aerial vehicles show their worth.

In line with Eißfeldt et al.'s (2020) study in Germany, we find that citizens' knowledge level of drones impacts their opinion. The higher the level of knowledge of drones, the more positive Danish citizens are towards their use for healthcare purposes. This finding indicates that letting citizens become acquainted with drones for healthcare purposes is likely to support their acceptance of airborne logistics solutions.

In their study of the German context, Eißfeldt et al. (2020) find that drones for rescue and police operations receive more support than transportation of medicine whereas the latter receives more support than the use of drones in agriculture. In our study, drones for rescue and police operations similarly receive a higher level of support than drones for healthcare logistics. Surprisingly, the respondents are also more positive towards the use of drones in construction and agriculture. This finding begs the question: What is a noble purpose of using drones? According to Walther et al. (2019) and Smith et al. (2022), drones used for social good would

Table 3. Level of public opinion on drones in healthcare grouped in relation to occupation ($N = 1004$).

	Employed in private sector	Employed in public sector	Self-employed	Enrolled in education	Unemployed	Retired	Other	Total
Very positive/positive	71%	68%	56%	49%	60%	78%	48%	68%
Neutral	13%	13%	34%	17%	21%	11%	14%	14%
Negative/very negative	10%	8%	5%	14%	9%	6%	19%	9%
Don't know	7%	10%	5%	20%	9%	6%	20%	9%
Total	100%	100%	100%	100%	100%	100%	100%	100%

receive greater acceptance than, say, drones for retail logistics. Expectedly, the use of drones in healthcare would be considered a meaningful purpose, as the drones can potentially preserve human welfare. Examples hereof are the case in Rwanda where the US company Zipline uses drones for transporting blood bags to remote and hard-to-reach areas or in Switzerland, where another US company, Matternet, uses drones for transporting blood samples from hospital to laboratory (Cawthorne and Robbins-van Wynsberghe 2020). Thus, our finding—together with that of Eißfeldt et al. (2020)—indicates that what counts as the most noble purposes of using drones will have to be researched further. Our study, therefore, questions this general signal of the nexus between the meaningfulness of drone use cases and the public opinion.

Recommendations

Policymakers concerned with deciding on the type and extent of either restrictive or supportive legislative frameworks require detailed insights into the readiness and possible concerns among diverse groups of citizens for a widespread use of drones. Most young citizens appear to be less supportive of using drones for healthcare logistics, which points to a need for monitoring the public opinion—not only now and in the near future, but also in the longer term. Opinions on drones might change over time as citizens get used to or have either good or bad experiences with drones in public spaces. Previous research (Virginia Tech. 2020) has shown that actual insight into drones positively affects the public opinion. This may be seen as a steppingstone for policymakers—at this early stage of identifying and experimenting with use cases—to find ways to let drones be integrated on a trial basis in public spaces under restricted conditions. In this way, we may speculate that in the pursuit of securing safe flights with minimum risk of drone accidents, the policymakers may in fact distance the public from experiencing drones if they do not allow drones to be more visible in everyday life. We, therefore, recommend that demonstrations of use cases involve the public to make them acquainted with drone use to stimulate understanding and a more detailed view on drones in public spaces. In this way, policymakers and drone-based firms may seek to demystify the technology. Besides the experimentation approach, an alternative is to utilize the understanding of what the public imagines and design a targeted effort for successfully implementing drones in specific areas, e.g., within the healthcare system.

As these recommendations illustrate, implementing drones requires cross-disciplinary collaboration and coordination between policymakers, firms, healthcare professionals and management, and the public. We especially stress the importance of involving policymakers who are concerned with traffic- and health-related domains, respectively. The different policymaker perspectives are required, as logistics in healthcare requires both politicians and administrators working with health and traffic. As the domain concerns traffic, the recommendations would naturally be targeted at policymakers dealing with traffic laws, but often these have limited insight into the health domain. We, therefore, argue for the importance of involving policymakers from both the traffic/logistic domain and the health policy domain in any discussions and implementation efforts relating to health drone solutions to expediently unleash drones in society. A balance is required to combine actual drone flights with high levels of safety as well as consideration for the public opinion.

Limitations

Our study has some limitations. First, the sample distribution with regards to level of education does not entirely mirror the Danish population. We did not find any significant results when checking for level of education, but with a fully representative sample, some might have occurred. Thus, it remains to be verified whether level of education has an impact on the Danish public's opinion on the use of drones. Second, our study is forward-looking, as it investigates uses of drones which are not yet taking place—at least not the six healthcare use cases. Our survey can, therefore, be seen as taking the temperature of the public's expectations of using drones, while not being able to investigate the role of the respondent's actual knowledge of drones in the public space—as this is premature in the Danish context. To allow respondents to make sense of what this could entail, we had to outline some general potential risks and benefits associated with the implementation of drones as well as detail what drones are or could be used for in the various fields of application. We might, therefore, have given the respondents information that they would not have thought about themselves. However, we had to make sure that they understood what characterizes the use of drones within the various fields of applications. When drones are more widespread, studies might be needed that are in line with the one conducted in Virginia, USA (Virginia Tech. 2020), where respondents have experienced the use of (delivery) drones in everyday life. Such

studies appear to be of high value for the potential unleashing of drones in Danish skies.

Conclusion

The healthcare system is under constant pressure to seek ways to improve healthcare and efficiency in operating processes. Therefore, a dual process of transforming the healthcare system can be observed for increased specialisation of treatments and processes within the hospital, and for increased attention to care—away from the hospital—at the patients' home. New technologies are the key enablers for these transformation processes, and this article focused specifically on the potential logistics solutions using drones and how the increased visibility of patient care in the public eye would be received. The findings show a generally positive public perception towards the use of drones for logistic solutions, such as transport of blood samples. Most noticeable, the results show a more positive perception of the elderly and retired citizens as compared to younger generations. These results highlight the importance of raising a public debate on the future implementation of civil drones for commercial use with attention to diversity in stakeholder involvement with respect to, for instance, age, occupation and knowledge of drones. In line with this conclusion, we propose for future research to investigate the interrelationships between perceived purpose of the use case, the public opinion, and the potential mediating role of knowledge about drones to further substantiate these early results. Moreover, the potentially widespread notion that successfully implementing drones in healthcare can help open the market for drones, also for commercial use, is now challenged and warrants further research.

With fully integrated drone traffic in Danish skies, the public will meet the drones and the healthcare professionals will interact with them—two factors that are crucial for the future success of using drones in healthcare. However, such fully integrated drone use is still in the future, and the realisation of these scenarios demand continued support from stakeholders, from policymakers to healthcare professionals and the public.

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Survey data are available from the corresponding author on reasonable request.

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Project administration: IF, MPK, MHF
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Supervision: IF, MHF
Validation: IF, MHF
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Competing interests

The authors declare there are no competing interests.

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Supplementary material

Supplementary data are available with the article at https://doi.org/10.1139/dsa-2022-0050.

References

Balas, E.A., and Chapman, W.W. 2018. Road map for diffusion of innovation in health care. Health Aff. **37**: 198–204. doi:10.1377/hlthaff.2017.1155. PMID: 29401030.

Barzekar, H., Ebrahimzadeh, F., Luo, J., Karami, M., Robati, Z., and Goodarzi, P. 2019. Adoption of hospital information system among nurses: a technology acceptance model approach. Acta Inform. Med. **27**: 305–310. PMID: 32210497.

Battaglia, M.P., Hoaglin, D.C., and Frankel, M.R. 2009. Practical considerations in raking survey data. Clin. Endocrinol. Surv. Curr. Pract. **2**: 1–12.

Bernstein, M.L., Mccreless, T., and Côté, M.J. 2007. Five constants of information technology adoption in healthcare. Hosp. Top. **85**: 17–25. doi:10.3200/HTPS.85.1.17-26. PMID: 17405421.

Cawthorne, D., and Robbins-Van Wynsberghe, A. 2020. An ethical framework for the design, development, implementation, and assessment of drones used in public healthcare. Sci. Eng. Ethics, **26**: 2867–2891. doi:10.1007/s11948-020-00233-1. PMID: 32578062.

Clothier, R.A., Greer, D.A., Greer, D.G., and Mehta, A.M. 2015. Risk perception and the public acceptance of drones. Risk Anal. **35**: 1167–1183.

EASA. 2021a. Easy Access Rules for Unmanned Aircraft Systems. European Union Aviation Safety Agency (EASA), Cologne, Germany.

EASA. 2021b. Study on the Societal Acceptance of Urban Air Mobility in Europe. European Union Aviation Safety Agency (EASA), Cologne, Germany.

Eißfeldt, H., Vogelpohl, V., Stolz, M., Papenfuß, A., Biella, M., Belz, J., and Kügler, D. 2020. The acceptance of civil drones in Germany. CEAS Aeronaut. J. **11**: 665–676. doi:10.1007/s13272-020-00447-w.

Eysenbach, G. 2004. Improving the quality of web surveys: the checklist for reporting results of internet E-surveys (CHERRIES). J. Med. Internet. Res. **6**: e34. doi:10.2196/jmir.6.3.e34. PMID: 15471760.

Fasterholdt, I., Kidholm, K., Yderstræde, K.B., and Pedersen, K.M. 2019. Early realistic assessment of the development of innovative medical technologies in hospitals (EARTH): a conceptual model. Int. J. Hosp. Based Health Technol. Assess. **1**: 4–19.

Gutiérrez, E.V., and Vidal, C.J. 2013. Home Health Care Logistics Management: Framework and research perspectives. Int. J. Indus. Eng. Manag. **4**: 173–182.

IMECHE. 2019. Public Perceptions Drones: Survey Results 2019. Institution of Mechanical Engineers, London, UK.

Kellermann, R., and Dannenberger, N. 2020. Traffic solution or technical hype? Representative population survey on delivery drones and air taxis in Germany. Wissenschaft im Dialog and Technische Universität Berlin, Berlin.

Kim, Y., Park, I., and Kang, S. 2018. Age and gender differences in health risk perception. Cent. Eur. J. Public Health, **26**: 54–59. PMID: 29684299.

Komasová, S. 2021. Possible inspiration: drone-related literature and its potential for public perception research. J. Intell. Robot. Syst. 103.

Lidynia, C., Philipsen, R., and Ziefle, M. 2017. Droning on about drones—acceptance of and perceived barriers to drones in civil usage contexts. *In* Advances in human factors in robots and unmanned systems. *Edited by* P. Savage-Knepshield and J. Chen Springer International Publishing, Cham. pp. 317–329.

Rice, S., Tamilselvan, G., Winter, S.R., Milner, M.N., Anania, E.C., Sperlak, L., and Marte, D.A. 2018. Public perception of UAS privacy concerns: a gender comparison. J. Unmanned Veh. Syst. **6**: 83–99. doi:10.1139/juvs-2017-0011.

Safi, S., Thiessen, T., and Schmailzl, K.J. 2018. Acceptance and resistance of new digital technologies in medicine: Qualitative study. JMIR Res. Protoc. **7**: e11072. doi:10.2196/11072. PMID: 30514693.

Shah, T.K., Tariq, T., Phillips, R., Davison, S., Hoare, A., Hasan, S.S., and Babar, Z-U-D. 2018. Health care for all: effective, community supported, healthcare with innovative use of telemedicine technology. J. Pharm. Policy Pract. **11**: 3. doi:10.1186/s40545-018-0130-5. PMID: 29435335.

Smith, A., Dickinson, J.E., Marsden, G., Cherrett, T., Oakey, A., and Grote, M. 2022. Public acceptance of the use of drones for logistics: the state of play and moving towards more informed debate. Technol. Soc. **68**: 101883. doi:10.1016/j.techsoc.2022.101883.

Tan, L.K., Lim, B.C., Park, G., Low, K.H., and Seng Yeo, V.C. 2021. Public acceptance of drone applications in a highly urbanized environment. Technol. Soc. **64**: 101462. doi:10.1016/j.techsoc.2020.101462.

Tsourela, M., and Roumeliotis, M. 2015. The moderating role of technology readiness, gender, and sex in consumer acceptance and actual use of technology-based services. J. High Technol. Manag. Res. **26**: 124–136. doi:10.1016/j.hitech.2015.09.003.

Virginia Tech. 2020. Perspectives on drone delivery. From the first community in the U.S. to experience residential package delivery by drone.

Walther, J., Pytlikzillig, L., Detweiler, C., and Houston, A. 2019. How people make sense of drones used for atmospheric science (and other purposes): hopes, concerns, and recommendations. J. Unmanned Veh. Syst. **7**: 219–234. doi:10.1139/juvs-2019-0003.