

Marianne Harbo Frederiksen, Ian Stampe & Mette Præst Knudsen

Status and Expectations of the Danish Drone Industry: An ecosystem perspective

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Colophon

This memo presents the results of a nationwide survey distributed to a wide variety of drone-oriented stakeholders in Denmark in 2019 with the aim of gaining insights into the status and expectations of the Danish drone industry in 2019.

The authors thank Innovation Fund Denmark for the financial support for some of the research behind the memo, which was conducted as part of the “FreeD” project. Moreover, the authors thank UAS Denmark, the Danish drone cluster organization, for a close and fruitful collaboration on collecting and analyzing the data.



Authors

Marianne Harbo Frederiksen: Associate Professor at SDU Innovation and Design Engineering, Department of Technology and Innovation, University of Southern Denmark.

Contact: mha@iti.sdu.dk or search at website: <https://portal.findresearcher.sdu.dk>

Marianne Harbo Frederiksen focuses her research on activities related to new product design, development, and innovation, ranging from managing ideas at the front end of the innovation process towards achieving successful commercialization based on the adoption by users and customers of new technologies, such as drones.

Ian Stampe: Teaching Associate Professor at the Center for Integrative Innovation Management, Department of Marketing & Management, University of Southern Denmark.

Contact: ian@sam.sdu.dk or search at website: <https://portal.findresearcher.sdu.dk/en/persons/ian>

Ian Stampe teaches within the subjects market research and statistics. He contributed to this project in the data collection process and in the analysis of the collected data.

Mette Præst Knudsen: Professor and Head of the Center for Integrative Innovation Management, Department of Marketing & Management, University of Southern Denmark.

Contact: mpk@sam.sdu.dk or search at website: <https://portal.findresearcher.sdu.dk>

The research of Mette Præst Knudsen seeks to integrate market, management, and technological perspectives on innovation processes. The focus on commercialization is particularly useful in relation to the development of new technologies with unknown market potential as for instance with innovative drone technologies and green technologies.

Contents

1	General introduction.....	3
2	Main take-aways and issues to consider	4
3	Overview of the survey respondents.....	7
4	Is the Danish drone industry gaining momentum?	9
4.1	Number of employees focusing on drone activities	10
4.2	Drone-related turnover	11
4.3	Main markets and fields of application	12
4.4	Technology development or commercialization	13
5	Barriers to unleashing the potential	14
6	Expectations and needs	17
6.1	Expectations for number of employees and need for adding competences	17
6.2	Impact of supporting technologies	18
6.3	Largest fields of application in the next decade	19
7	Research approach.....	20

1 General introduction

This is the third memo in a series of publications that focus on the opportunities and challenges in using unmanned aerial vehicles, also known as drones, for civil and commercial applications in Denmark. The publications aim to inform existing and potential new businesses, inventors, investors, and policy makers about the opportunities for drones to develop into a new growth industry.

The series of publications are concerned with the following fields of application:

1. Drones for offshore and maritime missions: Opportunities and barriers
https://www.sdu.dk/en/om_sdu/institutter_centre/i_marketing/marketing_nyheder/free+the+drones
(the research for the memo was sponsored by Innovation Fund Denmark)
2. Drones for inspection of infrastructure: Barriers, opportunities and successful uses
https://uasdenmark.dk/wp-content/uploads/2019/06/Final_Infrastructure-Memo_30.05.2019.pdf
(the research for the memo was sponsored by The Danish Industry Foundation)
3. Status and expectations of the Danish drone industry: An ecosystem perspective (this memo).

This memo no. 3 is sponsored by Innovation Fund Denmark as part of the “FreeD”¹ project. The memo presents the results of a nationwide questionnaire survey conducted in the first half of 2019 with a total of 190 respondents representing various stakeholders of the Danish drone industry ecosystem. The aim of the study was to take stock of the current situation, the perceived challenges and the expected opportunities facing the Danish drone industry.

Reading guide:

- For those wishing to gain a quick overview of the main take-aways of the study, pages 4-6 provide an outline hereof, including considerations for the future.
- For those interested in the detailed analyses, pages 7 onwards provide the main results and describe the research approach of the study.

¹ Info on the FreeD project: https://www.sdu.dk/en/om_sdu/institutter_centre/sduuascenter/researchprojects/freed

2 Main take-aways and issues to consider

190 respondents representing various stakeholders of the Danish drone industry ecosystem answered the questionnaire survey². These include drone technology and service providers, (potential) customers of drone solutions, public organizations focusing on e.g. researching and/or promoting the industry and other types of drone-oriented organizations, such as consultancies, financial organizations, investors etc.



Drone flying in the sky. Photo: Jason Blackeye on Unsplash.

Geographical location. The organizations are located all around Denmark; although, mainly in and around the largest cities. This concentration around, especially, Copenhagen, Odense, Aarhus and Aalborg, follows and co-locates with the bulk of drone-oriented university research and industry promotion. As an example, a range of initiatives are taken by UAS Denmark³, the Danish drone cluster organization, to advice drone start-ups in the robotics hub in Odense⁴ and facilitate cluster networking activities in the largest cities.

Firm characteristics On average, the organizations have focused on drone-related activities since 2015. The providers (operators, technology developers etc.) have on average 3.8 employees focusing on drone activities, whereas the average number among the (potential) customers is 10.5. If we remove

² Even though the number within some of the respondent types is limited, we have taken the liberty of generally treating the data as valid for concluding on the status and expectations of the Danish drone industry in 2019.

³ Webpage of UAS Denmark: <https://uasdenmark.dk/>

⁴ Webpage of Odense Robotics Startup hub: <https://www.odenserobotics.dk/build-your-startup/>

the outliers, the average among the (potential) customers is 3.3. This indicates that the generally small providers target their offerings at organizations, which are characterized by having the same or more volume in drone-related activities in-house as themselves. The providers expect to almost double the number of employees within a year, and thereby look at the near future as promising for further development and growth. Nevertheless, the differential in size – as most customers, irrespective of their drone-related employees, are larger than the providers – could incentivize the providers to team up to gain the necessary ‘muscles’ for developing their offerings towards the market. This would lead to an industry consolidation and e.g. increased export by giving leeway for the organizations to become more globally oriented than they are today, where the providers report that they are mainly oriented towards the domestic market.

Future fields of application. An industry consolidation may also pave the way for the operators to start focusing on fields of application other than photo and/or video recordings or outdoor inspection, as is currently the case for the majority of them. The fields of application that the respondents expect to have the largest potential within the next 10 years include building work, search and rescue and infrastructure, but also the energy sector, mapping and monitoring and surveillance and safety missions.

Increase of turnover. Since last year-end account in 2017 (this survey was conducted early 2018), 14.5% of the operators and around 6% of the technology providers expect that their drone-related turnover has decreased to some degree, whereas around 37% of the operators and around 39% of the technology providers expect that their turnover has increased to some or a large extent. Thus, although an even larger share of the same respondent types expects that turnover has not changed, quite a lot of these providers state that they have sold more in 2018 than in 2017.

Stage and challenges. The majority of the respondents stating that their (private or public) organization does or has developed drone-related technologies or products respond that their technology/product is still under development. This could entail that many new drone-related offerings will enter the market in the coming years. However, gaining a foothold on the market may be impeded by, especially, the drone legislation, which the respondents rank as the biggest challenge to unleashing their commercial potential. The legislation is also seen as the biggest challenge affecting turnover at present, although gaining access to the market is perceived as an important barrier as well. The challenge perceived to least affect turnover is attracting relevant and qualified labor. Thus, either the respondents have experienced – or expect – that there are qualified applicants for job vacancies. Alternatively, their organizations are not yet at a stage, where they need to hire new employees, which again can be seen in the light of technologies/products being at a pre-market stage.

Competences needed. 42% of the respondents (the (potential) customers were not asked) state a need for adding, especially, technology competences⁵ to their organization, but between 19-35% of them also see a need for strengthening the focus on e.g. market issues and business development. The focus on adding e.g. tech-savvy resources is to be expected, having in mind the development stage at

⁵ There is one dedicated university education in drone technology development in Denmark. It has been offered by the University of Southern Denmark (SDU) since 2015. Within the last year, 15 students have graduated as MSc in Engineering in Drone Technology (autumn semester 2018 + spring semester 2019).

which many of the organizations are. Only around 5% of the respondents see the need for strengthening their manufacturing competences and knowledge, which may be a potential gap to consider – especially for start-ups on the verge to commercializing their technologies. These indicators of competence focus and development stage can, in combination, be a sign of the organizations not really expecting to soon commercialize and scale up their offerings.

Supporting technologies will be a benefit. Across the industry, the respondents find that the further development of a range of supporting technologies and technological systems providing capabilities essential to implementing and continuously refining drones will benefit the development of their organizations. These are solutions and technologies for autonomous flight, including sensors and battery life, solutions for flights beyond visual line of sight and a system for unmanned traffic management.

Putting the results into perspective. Largely, the results of our nationwide study paint a picture of an industry that continues to be at a nascent stage. A similar study from June 2017 found that 49% of the operators used drones for photo and video recordings (e.g. for media production) and almost half of the various providers were one-man businesses or had maximum nine employees⁶. Our study shows that, two years later, the same field of application is still the largest – followed by outdoor inspection tasks – and the number of employees on the provider-side does not seem to have risen. Although the respondents in our study, on average, began focusing on drone-activities some four years ago, around 59% of those developing technology are still at, exactly, the development stage and not commercializing yet. Moreover, as the providers are mainly focused on the small, domestic market, scaling their businesses may not happen for the foreseeable future. On the positive side, the providers expect both an increase in turnover and to hire more people soon, and some (potential) customers have already a focus on drones as a strategic area of interest. Moreover, our study confirms the presence of a variety of other actor types in the ecosystem focusing on drone-related activities. The public organizations, such as universities, research and technology organizations and cluster initiatives, on average, have the highest number of drone-oriented employees. These employees focus on technology research and development and facilitation of industry collaboration and, thereby, contribute to growing the industry. Further results of our data show that around 57% of the technology providers already collaborate with universities and 26% collaborate with research and technology organizations⁷. Nonetheless, for the technology providers, there may be a further potential in utilizing the ecosystem characteristics. Significantly more is invested in drone-related resources within the public organizations, and some of the (potential) customers have more drone-oriented employees than the provider-side. In this way, the providers can benefit from collaborating, to a larger extent, with both the public organizations and the expected customers – and not least each other. Such (continued) collaboration among the actors in the ecosystem on developing relevant and fail-safe drone-related solutions is a prerequisite for obtaining a relaxation of the perceived impeding drone legislation and for leveraging the Danish drone industry.

⁶ Teknologisk Institut (2017). Dronebranchen in Danmark: Opdateret. Rapport 4.

⁷ Public-private projects already help bridge collaboration between the provider- and the buyer-side and, thereby, enable the providers to develop relevant solutions and get closer to their expected customers. Examples of bridge-building public-private projects are the ongoing "HealthDrone": <https://sundhedsdroner.dk/> and "Innovation on Wings": <https://uasdenmark.dk/innovation-paa-vinger/> projects.

3 Overview of the survey respondents

The 190 respondents provided the postal code of their respective organizations. Figure 1 illustrates that it is a nationwide study (including organizations at the island, Bornholm, to the far right in the figure). It also shows a clustering of organizations in and around the larger cities of Denmark (especially Copenhagen, Odense and Aarhus with more than ten respondents per city; and to some extent Aalborg and Kolding with more than five respondents per city).

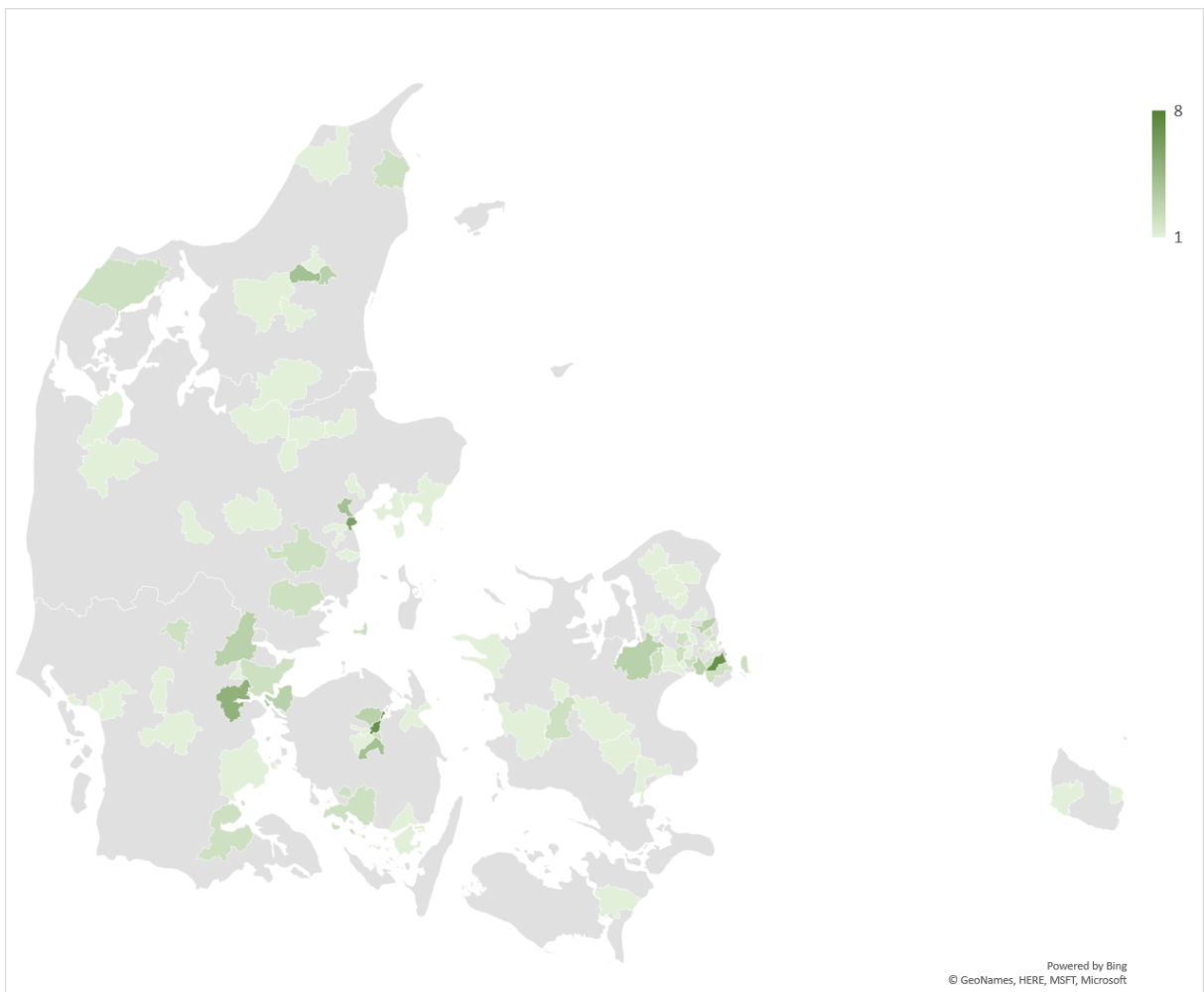


Figure 1: Geographical location of the respondents' organizations throughout Denmark; n = 190.

Table 1 lists the type of organization that the respondents represent (below: respondent type) and the frequency of each respondent type in the dataset.

	Frequency
Operators (private and public drone service providers)	83
Course providers (drone flight education + certificate)	7
Technology providers (private developers of software and/or hardware)	23
Vendors (of drone technology)	6
Public organizations (drone education/research, research and technology organizations + cluster initiatives)	27
(Potential) customers (of drone solutions)	17
Other (media/PR, consultancy + financial actors such as investors)	27
Total	190

Table 1: Types and frequency of organizations (represented by the respondents); n = 190.

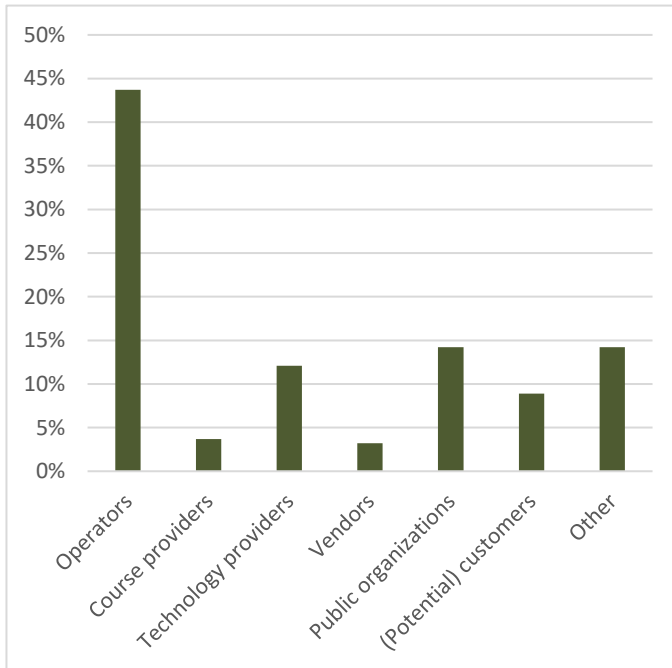


Figure 2 shows the distribution of the respondent types.

The largest respondent type in the dataset is the operators (43,7%). Next are the public organizations, the technology providers and the 'other' category (around 12-14% each). The smallest categories are the course providers and the vendors (around 3% each), whereas the (potential) customers constitute around 9% of the respondents.

Figure 2: Percentage distribution of the respondent types; n = 190.

Some of the questions were only given to selected respondent types (e.g. only to those focusing on developing and/or offering drone services or technology). Each question was answered by, if not all, then a high percentage of the potential respondents.

4 Is the Danish drone industry gaining momentum?

UAS Denmark – the Danish drone cluster initiative – was established already in 2013, as the City of Odense (in the southern region of Denmark) realized a need for an organized effort to develop and promote the Danish drone industry. Shortly after, some of the Danish universities and research and technology organizations started focusing several research and educational activities on drone technology and industry development. And in 2016, the Danish Government launched a strategy⁸ for the use of civil and commercial drones in Denmark. Based on this national strategy, public funding for public-private collaboration on drone technology and industry development was made available.

Figure 3 shows that most of the organizations in our dataset **started focusing on drone-related activities** around 2015-2016. Further results reveal a tendency towards the first entrants in the industry being the operators, i.e. organizations offering drone services, and then a range of support functions emerge, such as software developers and consultants. However, the average year of starting to focus on drones across respondent types is 2015.

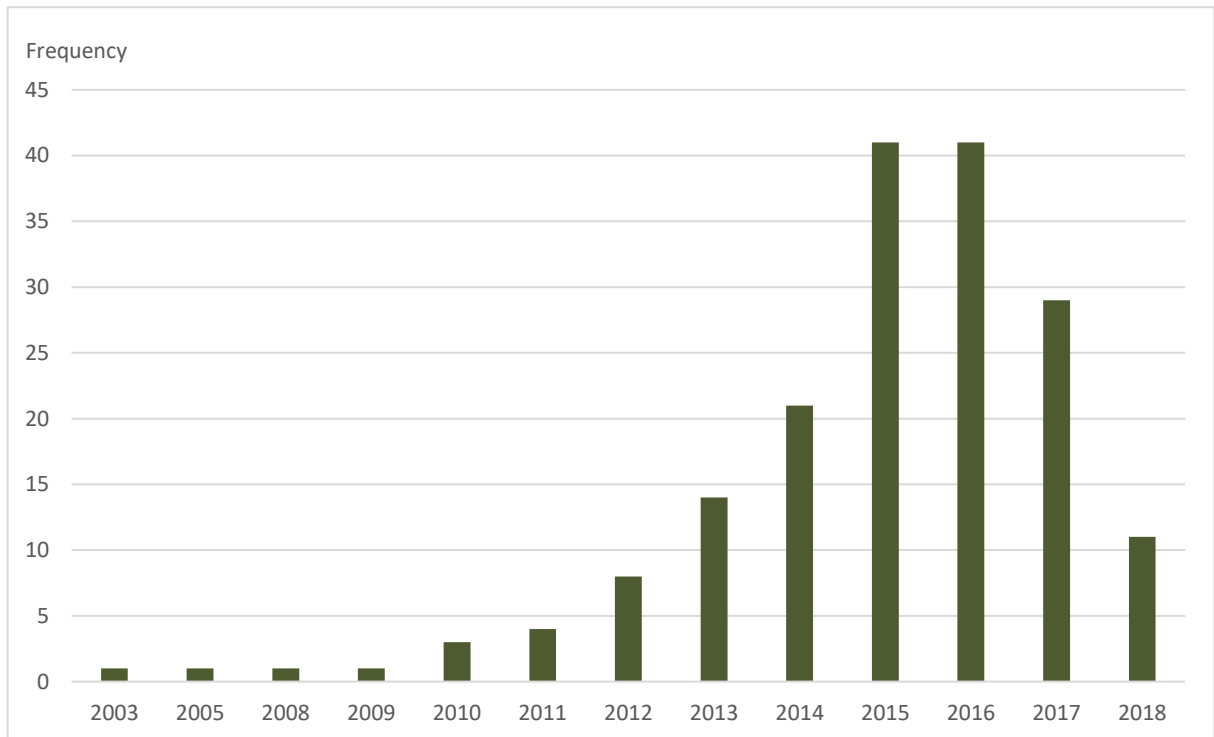


Figure 3: The years the organizations started focusing on drones; n = 176 of 190.

⁸ The Danish drone strategy: <https://ufm.dk/en/publications/2016/danish-drone-strategy>

4.1 Number of employees focusing on drone activities

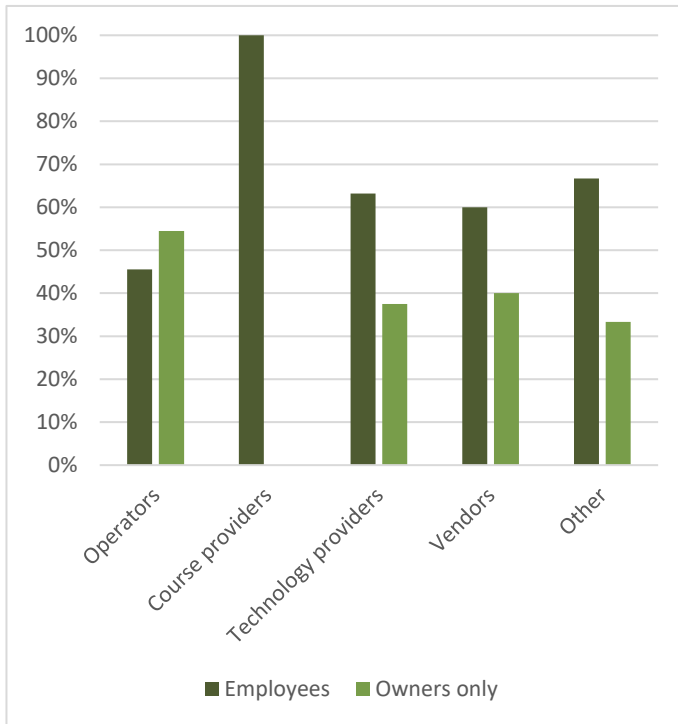
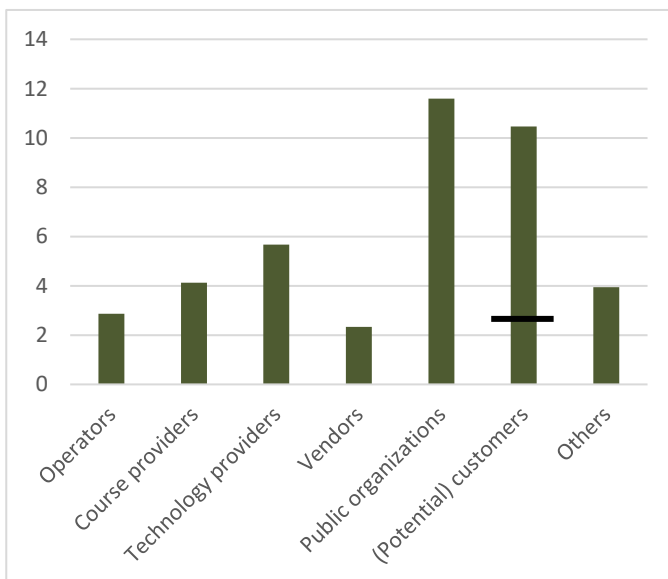


Figure 4 illustrates the distribution of responding **organizations having employees versus owners only**. This question was only for the respondent types preoccupied with selling drone technology or services, i.e. the operators, course providers, technology providers, vendors and others. More than half of the operators have no employees, whereas this is only so for one third of the technology providers.

Figure 4: Employees versus owners only within selected respondent types; n = 123 of 146.

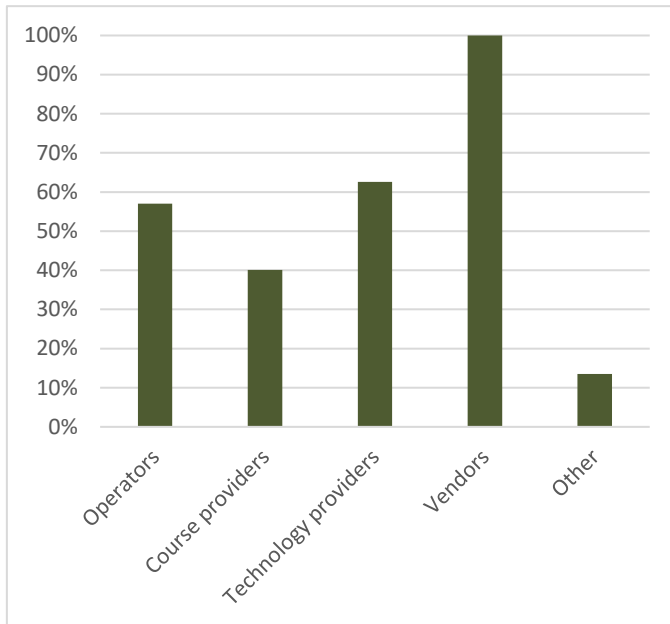
Figure 5 shows the average number of **employees who fully or to some extent focus on drone activities** in each of the organization types. The public organizations, which include universities' drone research units, generally have the highest number of drone-oriented employees (11.6). The operators, course providers, technology developers and vendors have on average 3.8 employees focusing on drone-related activities, whereas it is 10.5 among the (potential) customers. Thus, the provider-side has fewer drone-related resources than the buyer-side.



However, a detailed look at our data reveals that among the (potential) customers there are a couple of outliers with 50 drone-oriented employees, whereas the rest have maximum 10. If the outliers are left out, the average number of drone-oriented employees among the (potential) customers is 3.3 (black line in Figure 5). Nonetheless, some of the (potential) customers apparently have many resources for drone-oriented activities.

Figure 5: Average number of drone-oriented employees per type of organization in 2019; n = 136 of 190.

4.2 Drone-related turnover



Those focusing on drone technology development or services were asked to state the **drone-related share of their organization's total turnover in 2017**. In total, these respondents constitute around 62% of the operators, course providers, technology providers, vendors and others. Figure 6 shows the distribution for each type. Detailed calculations show that, on average, around 55% of turnover within these organizations derive from drone-related activities.

Figure 6: Drone-related share of total turnover in 2017; n = 91 of 146.

We asked the selected respondent types to estimate **the development of their organization's drone-related turnover since 2017** (until the time of answering the survey). Figure 7 shows that none of the vendors expect a change in their drone-related turnover, whereas (when adding columns 4 and 5) between 36-50% within the other respondent types expect some or a large increase. 14.5% of the operators and 6% of the technology developers expect a decrease to some degree.

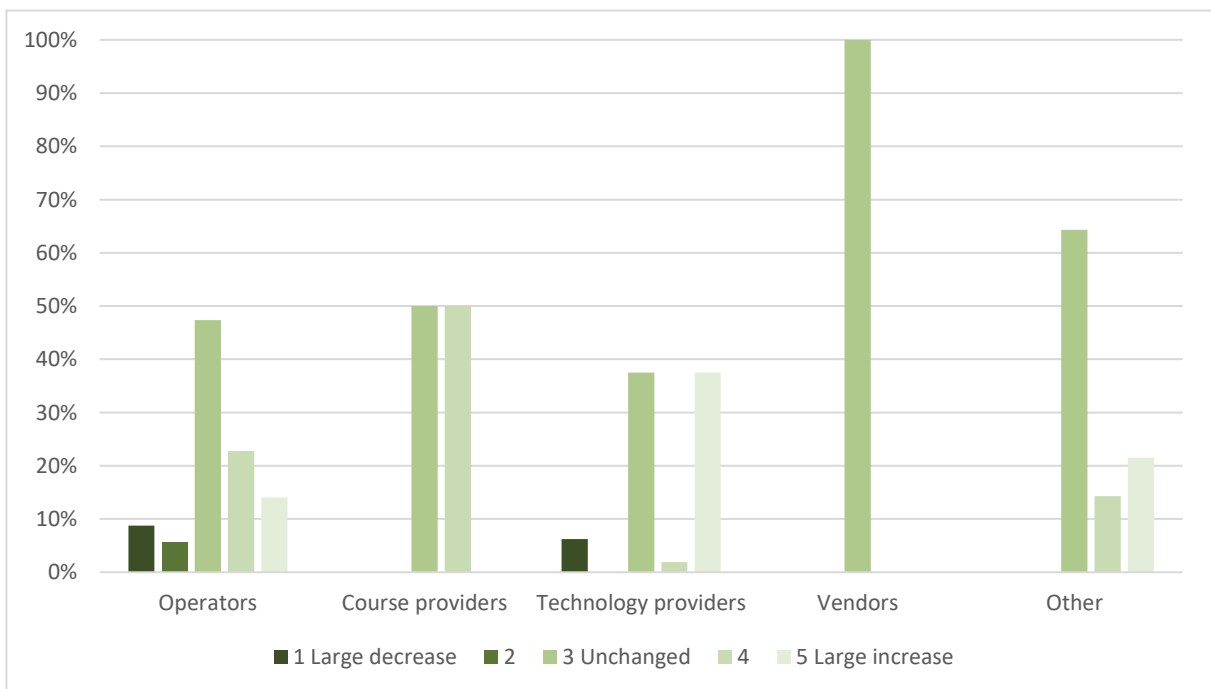


Figure 7: Selected respondent types' expectations of the development in their respective organizations' drone-related turnover since 2017; n = 139 of 146.

4.3 Main markets and fields of application

To understand the potential for market development, we asked for **expectations of which markets would have created the largest drone-related turnover(s) in 2018**. This time we did not ask the course providers, as these expectedly focus on the domestic market. However, the operators, technology providers, vendors and others could tick some or more of the options.

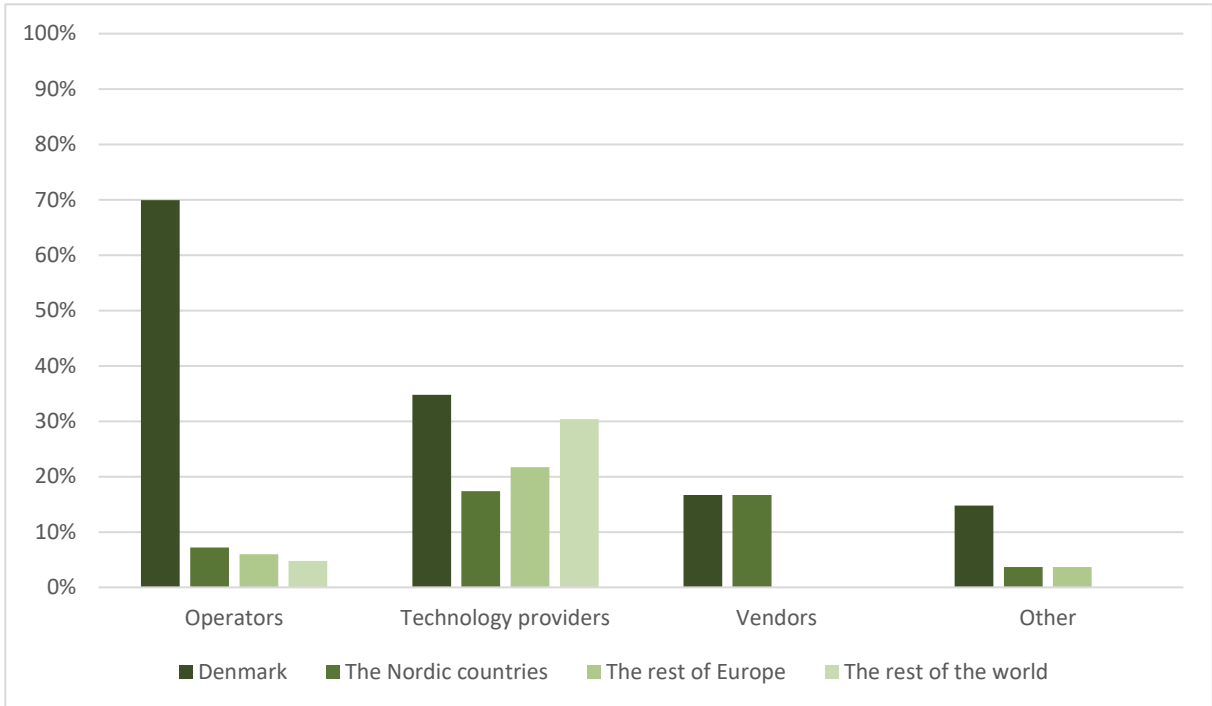


Figure 8: Percentage distribution within respondent types of expected largest market(s) in 2018; n = 139 of 139.

Figure 8 shows the distribution within respondent types of expectations for what would constitute the largest market(s) in 2018. The two types with the apparently largest opportunities for exporting their offerings, i.e. the operators and the technology providers, focus their efforts differently. The operators are clearly oriented towards the domestic market, whereas the technology providers focus only around one third of their efforts on the domestic market and are therefore quite internationally oriented.

The operators were asked to tick **for what fields of application they find a use for drones today**.

The options were:

- Photo and video recordings and/or demo-flights
- Outdoor inspection (of e.g. rooftops, fields or power lines)
- Indoor inspection (of e.g. boilers at power stations or buildings)
- Inspection with special equipment
- Transportation (of e.g. equipment or goods)
- Using highly specialized equipment (for e.g. research purposes)
- Other

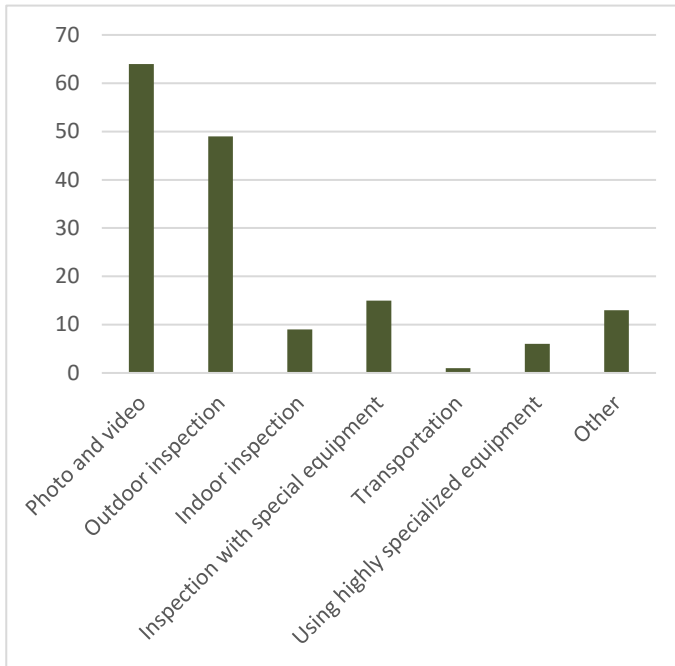
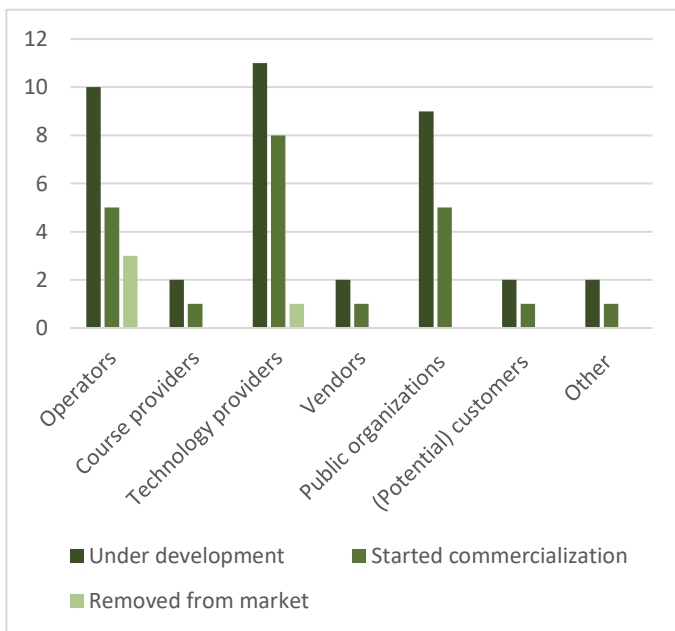


Figure 9 presents the responses and shows that they mainly do photo and/or video recordings or outdoor inspections. In the other-category, respondents mention consultancy, surveying, emergency management, teaching and spraying (of e.g. crops). More detailed data in our dataset further establish that the operators are typically specialized within one field of application.

Figure 9: Frequency of applications for drones, according to the operators; n = 80 of 83.

4.4 Technology development or commercialization?

All respondent types were asked – in case their organization (had) develop(ed) a drone-related **product/technology – what stage it is at**: Under development, commercialization has started or was introduced to the market but removed again. If they had more projects/products, they were asked to focus on what they would consider the most important one.



64 respondents stated that their respective organizations develop products/technology. Figure 10 shows, across respondent types, that the majority (equivalent to around 59%) of these organizations are still developing their products/technology. This indicates that many new drone-related offerings are on the way to the market. The graph furthermore shows that a few of the (potential) customers and quite many of the public organizations are also developing and offering products/technologies. Thus, also the buyer-side and not only private organizations develop and offer drone-related products/technologies.

Figure 10: Frequencies of the stage of products/technology; n = 64.

5 Barriers to unleashing the potential



A multirotor drone. Photo: David Henrichs on Unsplash.

All respondent types were asked **what they regard as the biggest challenges to unleashing their organization's development and growth potential based on drones**. They could tick as many of the nine listed challenges as they wanted.

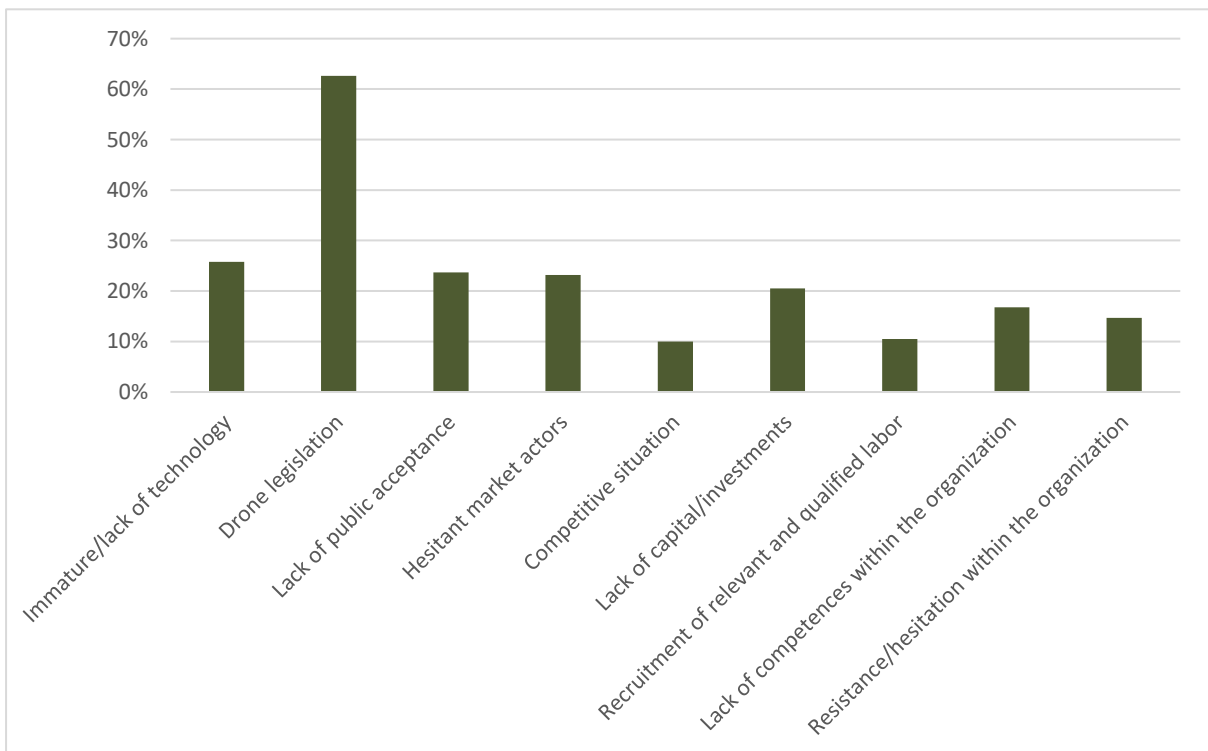


Figure 11: Percentage distribution of perceived biggest challenges to unleashing the organizations' development and growth potential based on drones; n = 175 of 190.

Figure 11 shows that drone legislation is regarded as the biggest challenge to unleashing the potential. The survey was conducted right around the time when the first EU-legislation became effective (June 2019). Up until then, a national Danish drone legislation was valid, but the content of the EU-legislation was published months before. It is therefore assumed that the respondents were, when answering the questionnaire, aware of the rules in force – including the upcoming EU-legislation. Detailed within-type calculations of our dataset show that more than half ticked legislation as a challenge, whereas the rest of the listed challenges were ticked by less than 26%, no matter respondent type.

All, except (potential) customers, answered **to what degree five of the issues from Figure 11 affect their organizations’ turnover**. They could tick as many of the five issues as they wanted.

		Labor n = 133	Financing n = 130	TRL n = 130	Legislation n = 132	Market access n = 129
A challenge, but not affecting turnover	Operators	9	15	26	29	10
	Course providers	1	2	3	3	2
	Technology providers	8	5	2	3	1
	Vendors	3	1	2	1	1
	Public organizations	1	0	0	1	0
	Other	1	5	4	6	1
	Total Percent of those ticking something	23 17.3	28 21.5	37 28.5	43 32.6	15 11.6
A challenge affecting turnover	Operators	5	9	11	35	35
	Course providers	0	2	2	3	2
	Technology providers	6	9	7	9	9
	Vendors	0	2	1	2	1
	Public organizations	0	0	0	0	0
	Other	0	2	0	6	3
	Total Percent of those ticking something	11 8.3	24 18.5	21 16.2	55 41.7	50 38.8
Total Percent of those ticking something	34 25.6	52 40.0	58 44.6	99 75.0	65 50.4	

Table 2: Frequency of five issues perceived to be a challenge either not affecting or affecting turnover; N = 129-133 (of 173), including those ticking ‘not a challenge’ (which are not shown).

The issues (and their labelling in Table 2) were:

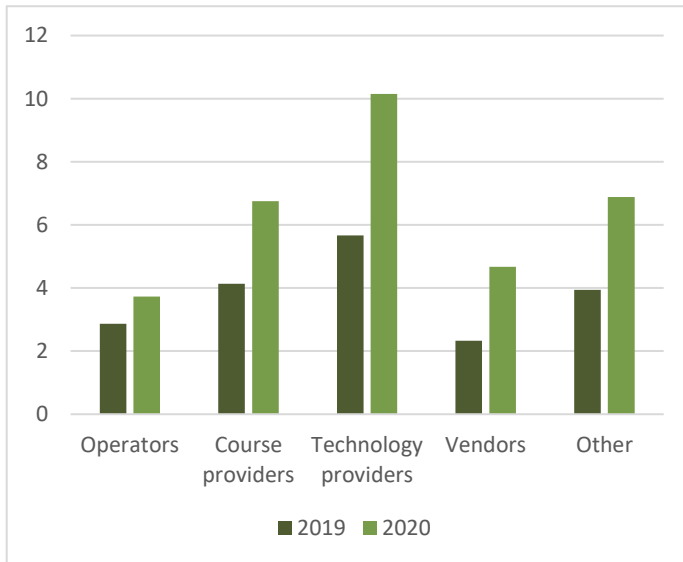
- Attracting relevant and qualified labor (labor)
- Gaining access to risk capital and investments (financing)
- Drone technology readiness level (TRL)
- Drone legislation (legislation)
- Acquiring customers/gaining access to market(s) (market access)

The five issues were rated as either not a challenge, a challenge not affecting turnover or a challenge affecting turnover. Table 2 lists the frequencies and percentages of ticks on the five issues – either not affecting or affecting turnover. Across respondent types, the biggest challenge perceived to affect turnover is legislation (41,7%), closely followed by the challenge of gaining access to markets (38,8%). The challenge perceived to least affect turnover is attracting relevant and qualified labor⁹ (8,3%). The within-type frequencies show that the operators perceive legislation and market access to equally challenge their turnover, whereas the technology providers, by and large, see all five issues as challenging their turnover (however, mainly financing, legislation and market access).

⁹ There is only one dedicated university education in drone technology development in Denmark. It has been offered by the University of Southern Denmark (SDU) since 2015 and, within the last year, 15 students have graduated as MSc in Engineering in Drone Technology (autumn semester 2018 + spring semester 2019).

6 Expectations and needs

6.1 Expectations for number of employees and need for adding competences



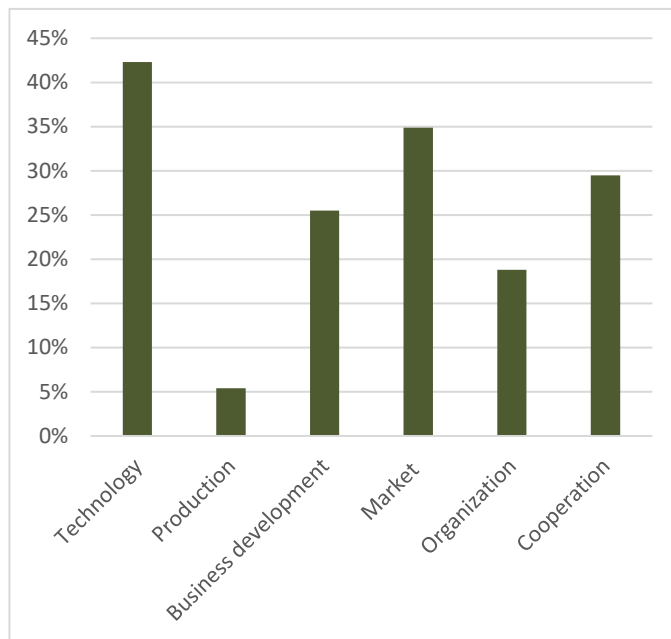
Selected respondent types were asked about their expectations for number of employees in a year's time; i.e. in 2020. Figure 12 shows the average answers within-respondent types; for both 2019 and 2020. Generally, the respondents expect to almost double the number of employees within a year. Thus, they look at the near future as promising for development and growth of their respective organizations.

Figure 12: Selected respondent types' expectations for number of employees in 2020 compared to 2019; n = 77 of 146.

All respondents, except the (potential) customers, were asked **what competences and knowledge their respective organizations need to add to be able to fulfill its ambition for development and growth based on drones**. They could tick as many categories on a predefined list as they wanted:

- Technology (concerning IT, programming, sensors, camera solutions etc.)
- Production (planning hereof, purchasing etc.)
- Business development (e.g. financing of further development)
- Market (development of sales channels, sales experience, insights into market needs etc.)
- Organization (structure hereof etc.)
- External cooperation (cooperative relationships externally)

Figure 13 shows that the category ticked by most of the respondents is 'Technology' (around 42%), but also that competences within 'Market', 'External cooperation', 'Business development' and 'Organization' is ticked by around 19-35% of the respondents. The last category, 'Production' is only ticked by around 5% of the respondents.



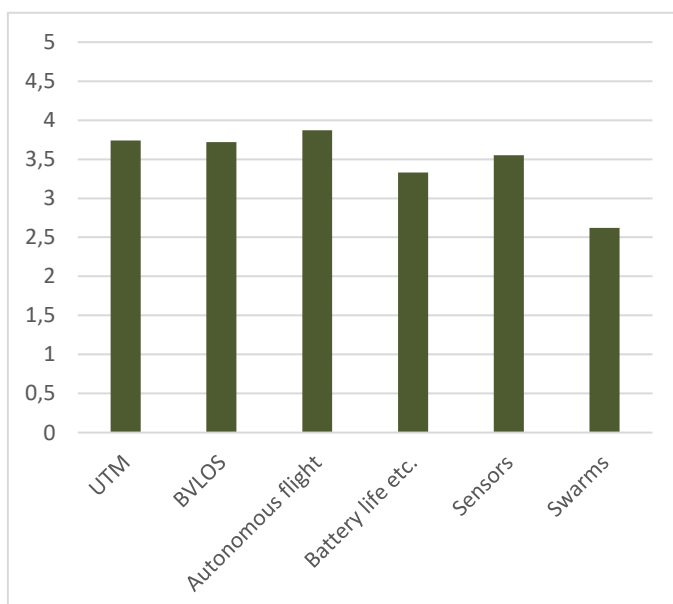
These answers should be assessed having in mind the development stage, which the organizations are at. However, the percentages indicate a tendency for the firms to be focused mainly on technology development and partly on business development and commercialization (market), but very little on how to manufacture their offerings once finishing the development of them.

Figure 13: Competences, which six of the seven respondent types state that they need to add; n = 149 of 173.

6.2 Impact of supporting technologies

All respondent types, except the (potential) customers, were asked to **rate the impact that six drone-related technology developments will expectedly have** on their respective organizations. The options were (and their labelling in Figure 14):

- Unmanned traffic management system (UTM)
- Technology for safe and stable flight beyond visual line of sight (BVLOS)
- Technology for safe and stable autonomous flight (autonomous flight)
- Battery and/or other, CO₂ neutral energy supplies (Battery life etc.)
- Sensors (sensors)
- Technology that enables flying a swarm of drones (swarms)



With ratings on average between 2.6 and 3.8, all six options were expected – across respondent types – to have some degree of impact on the organizations. This can be interpreted as expectations of further possibilities for growth.

Figure 14: Rating from 1 (no impact) to 5 (huge impact) of six drone-related technology developments; n = 112-123.

6.3 Largest fields of application in the next decade

All respondent types were asked to rate **which fields of application they find have the largest potential within the next 10 years**. The respondents could tick three of 14 options.

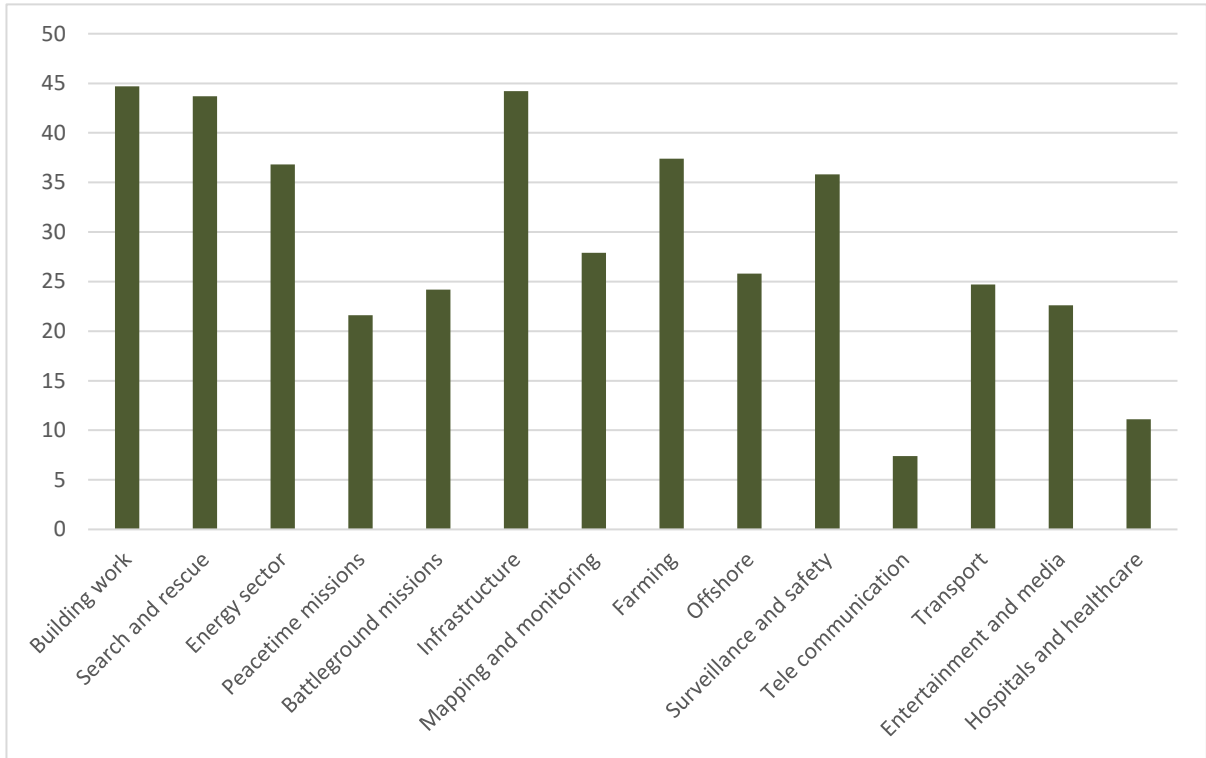


Figure 15: Frequency of votes for field of application holding importance within the next 10 years; n = 190.

Figure 15 shows that building work, search and rescue and infrastructure received most votes, closely followed by energy sector, mapping and monitoring and surveillance and safety. Some respondents were specific by stating for example ‘surveillance of emission’.

7 Research approach

The ambition of this study was to collect data from various stakeholders in the Danish drone industry ecosystem, including both private and public organizations that to some extent focus on drones.

There is no official classification code for the drone industry in Denmark that we could use for identifying potential respondents. Danish Technological Institute (DTI) had, for a survey they conducted early 2018¹⁰, acquired access to Experian's BusinessInsight¹¹ data bank of 484 companies in Denmark working with drones and drone technology. DTI got 105 responses (n = 21,7%) of which 85% stated that they were flying drones, i.e. drone operators constituted the majority of the respondents. The others (between 2-7% of the respondents) were working with software or hardware development, software or hardware sales, organizing of courses, research and development etc.

Differently from this approach, we used an ecosystem perspective to enable having a broader range of actor types within the drone industry participate in our study, including developers of software and/or hardware, vendors, course providers, operators, (potential) customers of drone solutions, universities, research and technology organizations, cluster initiatives, consultancies, investors etc. Since we and our partner in this project, UAS Denmark, together have an extensive network within the Danish drone industry ecosystem, we were able to compile a list of 609 potential respondents with all the above-mentioned actor types represented.

In February 2019, the questionnaire survey was sent by e-mail to the sampled organizations. We send out a reminder and performed a round of phone calls to encourage more respondents. In June 2019, 190 (n = 31,2%) had filled in the questionnaire, which suffice to draw statistical conclusions. All types of organizations are represented in the dataset, but the number within each group is insufficient to draw generalizable conclusions. However, as the number of potential respondents in the industry for some types of stakeholders (e.g. technology providers) is limited, combined with the fact that we have in our sample a total of 119 respondents focusing on developing and/or offering drone services and technology (adding the operators, course providers, technology providers and vendors), we have treated the data as valid for concluding on the status and expectations of the Danish drone industry in 2019.

¹⁰ Sørensen and Holsbo (2018). Flere dronevirksomheder i Danmark: Status, potentialer, lovgivning og marked. Report (in Danish) by Teknologisk Institut (Danish Technological Institute).

¹¹ Experian's Business Insight gives its customers access to its industry data bank, including market data, credit rating and sales functions: <https://www.experian.dk/produkter/businessinsight/index>

www.sdu.dk/freed