



# Nordic Drone Initiative

Driving the development of sustainable drone-based transport services in the Nordic region



# Contents

|                                                                                                                  |    |
|------------------------------------------------------------------------------------------------------------------|----|
| <b>Preface</b>                                                                                                   | 3  |
| <b>Summary</b>                                                                                                   | 4  |
| <b>1. Identifying highest value use cases</b>                                                                    | 5  |
| 1.1. Method                                                                                                      | 5  |
| 1.2. Results                                                                                                     | 11 |
| 1.2.1. Framework for categorising use cases                                                                      | 11 |
| 1.2.2. Metrics and methods to evaluate and prioritise use cases                                                  | 12 |
| 1.2.3. Detailed analysis and customer insights of the highest value use cas-es                                   | 13 |
| 1.2.4. Understanding of benefits and challenges of introducing drone-based transportation systems in the Nordics | 23 |
| <b>2. Mapping tech- and ecosystems</b>                                                                           | 24 |
| 2.1.1 Method                                                                                                     | 24 |
| 2.1.2 Results                                                                                                    | 25 |
| <b>3. Nordic requirements</b>                                                                                    | 29 |
| <b>4. Regulatory recommendations</b>                                                                             | 30 |
| 4.1 Method                                                                                                       | 30 |
| 4.2 Results                                                                                                      | 31 |
| 4.2.1 Background of the cross-border operations                                                                  | 31 |
| 4.2.2. Differences between EU countries                                                                          | 33 |
| 4.2.3 Recommendations                                                                                            | 34 |
| <b>5. Main results and conclusions</b>                                                                           | 35 |



# Preface

This report describes the work done in, and results from, the project Nordic Drone Initiative, NDI. NDI was formed to drive the development of sustainable drone-based transport services in the Nordic region. The Nordic countries have the ambition to be a leader in the development of sustainable business models in the digital age. Forecasts for drones with passengers and parcel deliveries indicate that that market is heading for a dramatic increase in the next ten years.

## NDI had several objectives:

- To identify and evaluate how drones can be used in the transport sector to provide the greatest benefit to society, business and the environment.
- Map the Nordic ecosystem for drones and the opportunities that this technology provides.
- Contribute to the development of drone technology for Nordic weather conditions.
- Propose the development of rule changes that enable drone transport and large-scale operations with vertical take-off and landing.
- Create a platform for continued research and innovation and developed international cooperation.

BELL ROCK



BUSINESS  
TAMPERE



DRONENORD



NORDIC  
EDGE



# Summary

The Nordic Drone Initiative, NDI, was formed as a response to the need identified by the funder Nordic Innovation. The project ran for almost two years and was led by RISE Research Institutes of Sweden. The consortium consisted of 16 partners from four Nordic countries including: RISE, Katla Aero, Kista Science City, Mainbase, LFV, and Östergötland Region from Sweden; VTT, Bell Rock Advisors, Robots Expert, Business Tampere from Finland; NORCE, Nordic Edge, Drone Nord, and UAS Norway from Norway; and Gate21 from Denmark. The project also had Avinor from Norway and ANS from Finland in the reference group.

NDI focused on key areas for drone-based mobility solutions, identifying the most relevant use cases in the Nordic context that maximize

the benefits of sustainability and business potential, mapped the application needs, technology maturity, business potential, and complementary competences bring together the relevant stakeholders for collaborative innovation on technologies, policies and standards that enables cross-border goods delivery and passenger transport with drones and create a knowledge base and digital platform that integrate the Nordic competences for accelerating the introduction of drone-based mobility services.

**The work was divided into four main work packages: Identifying highest value use cases; Mapping tech- and ecosystems; Nordic requirements; and Regulatory recommendations.**





# 1. Identifying highest value use cases

The intention of this work package was to identify and evaluate the highest value drone use cases in the Nordics. This task was divided into four more specific areas:

- Framework for categorising use cases
- Metrics and methods to evaluate and prioritise use cases
- Detailed analysis and customer insights of the highest value use cases
- Understanding of benefits and challenges of introducing drone-based transportation systems in the Nordics

Three cross-cutting insights underline the adoption of drones in Nordic transportation:

## **Drones have a unique value proposition:**

It's unlikely that drone-based transportation can compete against rubber tires on price in the near future, but rather the economic potential is built on differentiated value propositions.

## **Industrial sectors are first to benefit:**

Indoor and onsite use cases create more economic value compared to use cases in the open airspace during the next 10 years.

## **Consumer services are emerging:**

Regulation and technology are constantly developing, and increasing number of success stories will enable drones to improve our everyday quality of life.

Below is a condensed version of the study. Please contact NDI for full documentation of this work package.

## **1.1. Method**

The work package sets to identify highest value use cases by coupling the potential drone use cases with the industries which make up the Nordic economies. NDI network and external sources were used to discover the likely use cases which could take place in the next ten years, and Standard industrial classification was used to evaluate the impact of each use to each industry.

The research method was divided into three phases:

**1. Foundation:** Creating a knowledge base on how drones create value in transportation within the next 10 years.

**1. Screening:** Identifying and grouping use cases of transportation drones in different industries.

**2. Evaluation:** Evaluating the economic potential of use cases with desktop research and validating the findings with Nordic-wide drone survey.

**1. Foundation:** Based on the interviews with NDI network and external research drones have a unique value proposition compared to rubber tires but it's unlikely that they can compete in efficiency in the near future. Drones offer flexibility in comparison to rubber-tires as they:

- **Can be operated in different types of environments** from indoor spaces to open terrain and built environment. This is enabled

by the scalable sizing of drones and their low dependency from existing infrastructure.

- **Can be used for multiple tasks;** to collect data, to carry goods or people, and even for some processing work.

- **Scalable costs** due to differences in hardware requirements – small drones used for imaging in private space are the most affordable.

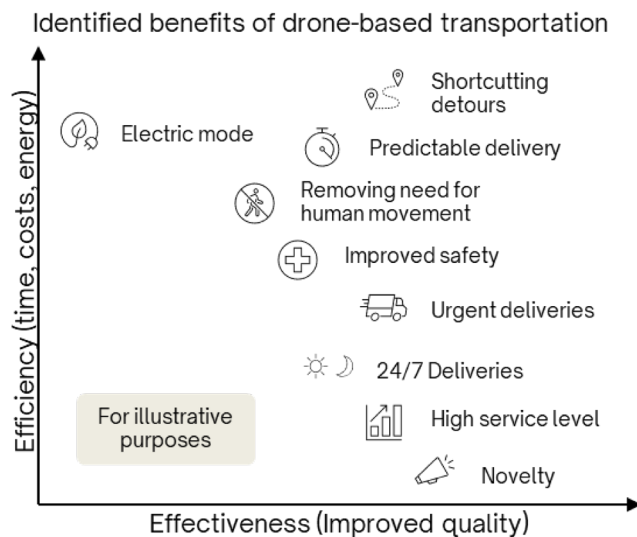


Figure 1 Examples of how drone-based transportation can create value



## 2. Screening

To identify practical transportation drone use cases the prior knowledge of how drones create value in was reflected against the industries which make up the Nordic economies. To do so, we analyzed 18 Industry Divisions which from Standard industrial classification. Standard industrial classification consists of divisions which allow to grasp sets of industries which make up the Nordic economies by being relatively.

- **Mutually exclusive** – Each division is unique even though they encapsulate multiple industries.
- **Collectively exhaustively** – The classification encapsulates close to entirety of the economies.

Each division can be opened into a **value chain** as the industries share common characteristics. Note: National defense and household activities were not included in the scope.

Each industry division was deconstructed to a high-level value chain, and potential use cases for drones were identified based on activities in each step of the chain. The discovered use cases were grouped into categories based on their type. The analysis yielded 28 unique use cases for drones across different industries.

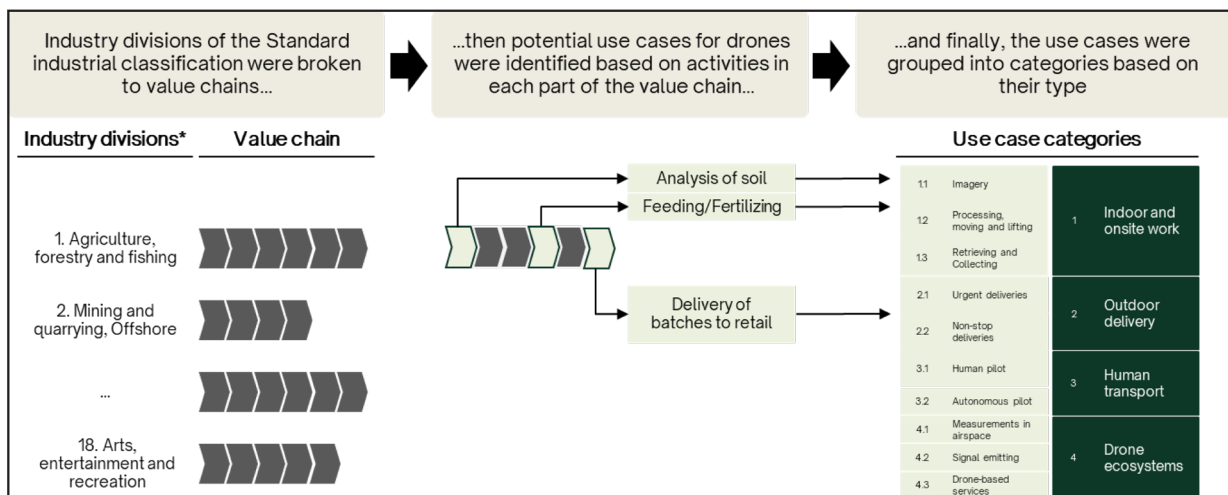


Figure 2 Screening process

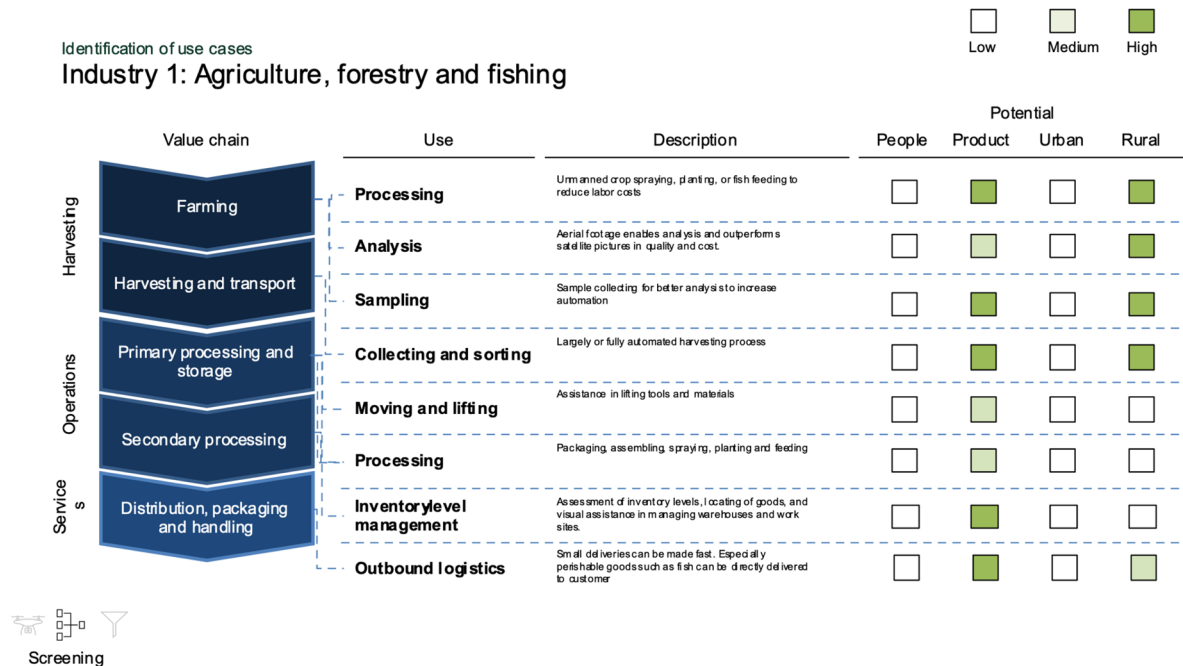


Figure 3 Example of Industry analysis

Economic potential was estimated for use cases that met the minimum requirements for successful adoption of drone-based transports within the next 10 years. All identified use cases were evaluated along four key dimensions required for successful adoption on the set time-horizon:

- **Public acceptance:** The perceived benefits must outweigh the risks for sufficient proportion of population
- **Performing technology:** The performance must be on a high-enough level to enable applications
- **Sufficient infrastructure:** Critical infrastructure must have sufficient coverage and quality to serve the drone operations

- **Enabling legislation:** Regulation must enable deliveries to customers and competition among companies

Use cases that met the minimum requirements were analyzed further to understand their economic potential, meaning that the use case must solve a real problem for the user and have business potential on the supply side. High-level economic potential for selected use cases estimated based on qualitative assessment of their impact in each given industry.

## Evaluation dimensions:

- **Productivity:** Extent to which the use of UAVs can improve the productivity of the process/use case e.g. shortcutting detours, reduce need for human involvement
- **Customer experience:** Improves or enhances customer perceived value of quality of the service or product e.g. duration, punctuality, quality, service level, 24/7 service, predictable delivery, urgent deliveries, novelty
- **Safety:** Has a positive impact on the safety e.g. reducing need for human involvement/movement, preventative safety
- **Sustainability:** Reduces the environmental impact e.g. no local emissions, noise reduction, reduces need to use fossil fuels, improves soil quality.

|                                                                                                                            |                                                                                                                                                                                                               |                                                                                                                                                                                                           |                                                                                                                                                                                                                                  |                                                                                                                                                                                                            |
|----------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>ECONOMIC POTENTIAL</b><br><br>Needs to solve a real problem for the user and have business potential on the supply side | <br><b>PRODUCTIVITY</b><br><br>Extent to which the use of UAVs can improve the productivity of the process/use case          | <br><b>CUSTOMER EXPERIENCE</b><br><br>Improves or enhances customer perceived value of quality of the service or product | <br><b>SAFETY</b><br><br>Has a positive impact on the safety                                                                                  | <br><b>SUSTAINABILITY</b><br><br>Reduces the environmental impact                                                       |
|                                                                                                                            | <br><b>PUBLIC ACCEPTANCE</b><br><br>The perceived benefits must outweigh the risks for sufficient proportion of population | <br><b>PERFORMING TECHNOLOGY</b><br><br>The performance must be on a high-enough level to enable applications          | <br><b>SUFFICIENT INFRASTRUCTURE</b><br><br>Critical infrastructure must have sufficient coverage and quality to serve the drone operations | <br><b>ENABLING LEGISLATION</b><br><br>Regulation must enable deliveries to customers and competition among companies |

Figure 7 Evaluation criteria

## 3. Evaluation

The economic potential of drone use cases was analyzed by evaluating the impact of discovered use cases across the industries making the Nordic economies. Our methodology exhaustively covers all industries with Standard industrial classification and combines it with all identified UAV use cases. Then the economic potential is evaluated based on four proxies to score each industry/ use case combination.



| Scale                                                                                                      | Productivity                                                                                                           | Customer experience                                                                                                              | Safety                                                                                                         | Sustainability                                                                                                         |
|------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|
| <br>High<br>(Score = 5)   | <ul style="list-style-type: none"> <li>Significant improvement and/or enables completely new way of working</li> </ul> | <ul style="list-style-type: none"> <li>Significant improvement or enables a completely new service or product</li> </ul>         | <ul style="list-style-type: none"> <li>Significant improvement in end user or bystander safety</li> </ul>      | <ul style="list-style-type: none"> <li>Significant improvement in environmental or social impact</li> </ul>            |
| <br>Medium<br>(Score = 2) | <ul style="list-style-type: none"> <li>Noticeable improvement in productivity</li> </ul>                               | <ul style="list-style-type: none"> <li>Noticeable improvement in customer experience</li> </ul>                                  | <ul style="list-style-type: none"> <li>Noticeable improvement in safety</li> </ul>                             | <ul style="list-style-type: none"> <li>Noticeable improvement in sustainability</li> </ul>                             |
| <br>Low<br>(Score = 0)    | <ul style="list-style-type: none"> <li>Does not noticeably improve or even decreases productivity</li> </ul>           | <ul style="list-style-type: none"> <li>Does not noticeably improve or even decreases customer perceived value/quality</li> </ul> | <ul style="list-style-type: none"> <li>Does not noticeably improve or even decreases overall safety</li> </ul> | <ul style="list-style-type: none"> <li>Does not noticeably improve or even decreases overall sustainability</li> </ul> |

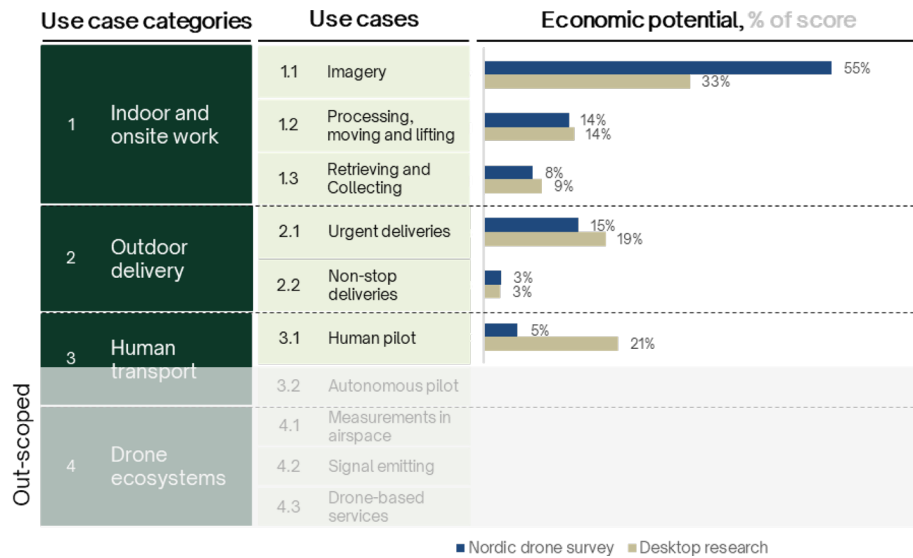
Figure 4 Proxies to evaluate the economic potential of use cases

| CASE EXAMPLE               |                                          |                                                                                                                 |              |                     |        |                |       |
|----------------------------|------------------------------------------|-----------------------------------------------------------------------------------------------------------------|--------------|---------------------|--------|----------------|-------|
| Wholesale and retail trade |                                          |                                                                                                                 |              |                     |        |                |       |
| Use case                   | Specific use                             | Description                                                                                                     | Productivity | Customer experience | Safety | Sustainability | Score |
| 1.1                        | Imagery                                  | Commoditization of high-quality imagery allows to improve the output quality of multiple industries.            | Low          | Low                 | Low    | Low            | 0     |
| 1.1                        | Inventory-level management               | Assessment of inventory levels, locating of goods, and visual assistance in managing warehouses and work sites. | High         | High                | Medium | Low            | 12    |
| 1.2                        | Safety work                              | Aiding in work site safety by e.g. Delivering first aid, Extinguishing fires                                    | Low          | High                | High   | Low            | 10    |
| 1.3                        | Collecting and sorting                   | Largely or fully automated collecting and sorting e.g. Warehousing, Harvesting, Logistics center work           | High         | High                | Medium | Low            | 12    |
| 2.2                        | Single route logistics                   | Continuous delivery of units and small batches of light and perishable goods between two points                 | Low          | Low                 | Low    | Low            | 0     |
| 2.1                        | Circulating delivery and courier service | Delivery of goods from single point to multiple recipients                                                      | High         | High                | Medium | Low            | 12    |
| 2.1                        | Last mile delivery                       | Delivery of goods from single point to drop-off points near consumers                                           | High         | High                | Medium | Low            | 12    |
| 2.1                        | Sending parcels from home or office      | Delivery of goods directly from home/office                                                                     | High         | High                | Low    | Low            | 10    |
| 2.1                        | Delivery to distribution center          | Delivery of goods to local distribution centers                                                                 | Low          | Low                 | Low    | Low            | 0     |

Figure 5 Example of Industry-specific use cases

## 1.2. Results

'Indoor and onsite work' and 'Outdoor deliveries' using drones present significant economic potential and meet the criteria to be widely adopted in the next ten years.



Below is a breakdown of results for each area of the study

### 1.2.1. Framework for categorizing use cases

The screening process discovered 28 unique drone use cases which were categorized into four high level use categories which are divided into practical use cases:

| Use case categories      |                                    | # of identified use cases    |
|--------------------------|------------------------------------|------------------------------|
| 1 Indoor and onsite work | 1.1 Imagery                        | 12 unique cases<br>71 usages |
|                          | 1.2 Processing, moving and lifting |                              |
|                          | 1.3 Retrieving and Collecting      |                              |
| 2 Outdoor delivery       | 2.1 Urgent deliveries              | 7 unique cases<br>29 usages  |
|                          | 2.2 Non-stop deliveries            |                              |
| 3 Human transport        | 3.1 Human pilot                    | 6 unique cases<br>22 usages  |
|                          | 3.2 Autonomous pilot               |                              |
| 4 Drone ecosystems       | 4.1 Measurements in airspace       | 3 unique cases<br>5 usages   |
|                          | 4.2 Signal emitting                |                              |
|                          | 4.3 Drone-based services           |                              |

Figure 6 Identified drone use case categories

**Indoor and onsite work:** Wide variety of support activities occurring in restricted areas largely in industrial processes and create value by providing higher quality outputs, removing need for human movement and by improving safety.

**Outdoor delivery:** Delivery of products in airspace for corporate and consumer customers which add value by saving time, improving predictability, improving cost avoidance and by providing opportunities to streamline supplychains.

**Human transport:** Short to medium range transportation of people has niche use cases which add value by saving time, providing access to certain hard-to-reach places and by novelty.

**Drone ecosystems:** Wide variety of businesses and services based on well- established use of drones in transportation such as businesses built on specific data, flight paths or residual payload capacities. This category was later excluded from the scope of the study as it failed to meet the minimum requirements.

### 1.2.2. Metrics and methods to evaluate and prioritize use cases

The identified use cases were subjected to two-phased evaluation: The first evaluated their plausibility to be successfully adopted on 10-year time horizon. The second phase focused on evaluating the economic potential of use cases.

Based on the evaluation two areas were excluded: Autonomously piloted transportation of humans was found to not meet the legislative requirements in 10 years. The adoption and technical mature to utilize 'Drone ecosystems' were evaluated to not be realistic in ten years.

Our research indicates that different analysis- and maintenance-related use cases offer the most near-future economic potential for UAV implementation. Note that the analysis studied the industries and the use cases as a whole and does not claim that individual use cases inside any of the industries would not have potential for UAVs.

| Use case categories |                          |                                    | Social acceptance* | Technology performance* | Infrastructure* | Legislation* |
|---------------------|--------------------------|------------------------------------|--------------------|-------------------------|-----------------|--------------|
| Out-scoped          | 1 Indoor and onsite work | 1.1 Imagery                        | ✓                  | ✓                       | ✓               | ✓            |
|                     |                          | 1.2 Processing, moving and lifting | ✓                  | ✓                       | ✓               | ✓            |
|                     |                          | 1.3 Retrieving and Collecting      | ✓                  | ✓                       | ✓               | ✓            |
|                     | 2 Outdoor delivery       | 2.1 Urgent deliveries              | ✓                  | ✓                       | ✓               | ✓            |
|                     |                          | 2.2 Non-stop deliveries            | ✓                  | ✓                       | ✓               | ✓            |
|                     | 3 Human transport        | 3.1 Human pilot                    | ✓                  | ✓                       | ✓               | ✓            |
|                     |                          | 3.2 Autonomous pilot               | ✓                  | ✓                       | ✓               | ✗            |
|                     | 4 Drone ecosystems       | 4.1 Measurements in airspace       | ✓                  | ✓                       | ✓               | ✓            |
|                     |                          | 4.2 Signal emitting                | ✓                  | ✗                       | ✗               | ✓            |
|                     |                          | 4.3 Drone-based services           | ✓                  | ✗                       | ✗               | ✓            |

Figure 8 Summary of minimum requirements analysis



## Industry division

## Score

|                                                          |    |
|----------------------------------------------------------|----|
| Mining and quarrying, (+Offshore drilling)               | 79 |
| Electricity, gas, steam and air conditioning supply      | 74 |
| Wholesale and retail trade                               | 68 |
| Construction                                             | 68 |
| Water supply; sewerage, waste management and remediation | 56 |
| Transportation and storage                               | 54 |
| Human health and social work activities                  | 53 |
| Manufacturing                                            | 46 |
| Real estate activities                                   | 38 |
| Information and communication                            | 38 |
| Accommodation and food service activities                | 29 |
| Agriculture, forestry and fishing                        | 26 |
| Arts, entertainment and recreation                       | 15 |
| Professional, scientific and technical activities        | 14 |
| Administrative and support service activities            | 14 |
| Education                                                | 12 |
| Financial and insurance activities                       | 10 |

Table 2 Economic potential score by industry division

### 1.2.3. Detailed analysis and customer insights of the highest value use cases

Our research indicates that different analysis- and maintenance-related use cases offer the most near-future economic potential for UAV implementation. Industries with the highest analysis scores are also the most attractive ones in terms of total industry turnover/expenditure in the Nordics.

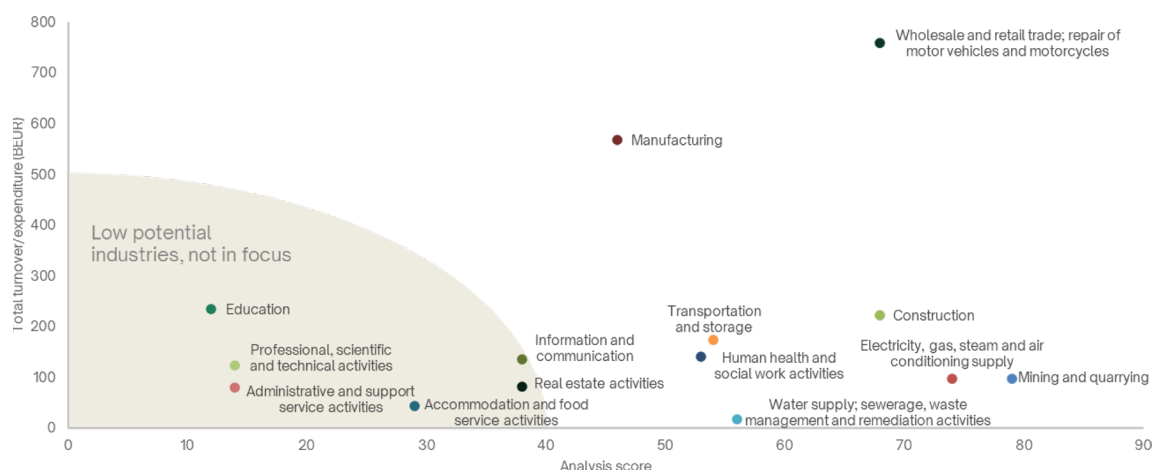


Figure 9 Use cases compared to total industry turnover/expenditure in the Nordics

The results from the desktop analyses were validated by comparing the results to a survey which was conducted by NDI in 6/2021 and sent to private sector professionals across the Nordics. The survey had 426 responses from professionals who were primarily not experts in drones. The results support the initial findings:

"On a scale from 1-5 where 1 is very poor and 5 is excellent economic value how much economic value do you think drones could create for your company when it comes to:"

Figure 12 Economic value of use cases, Norway

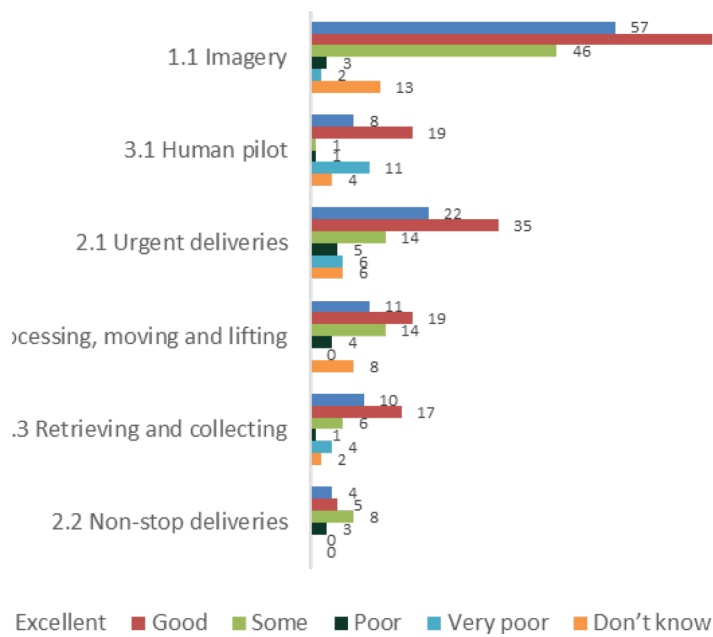
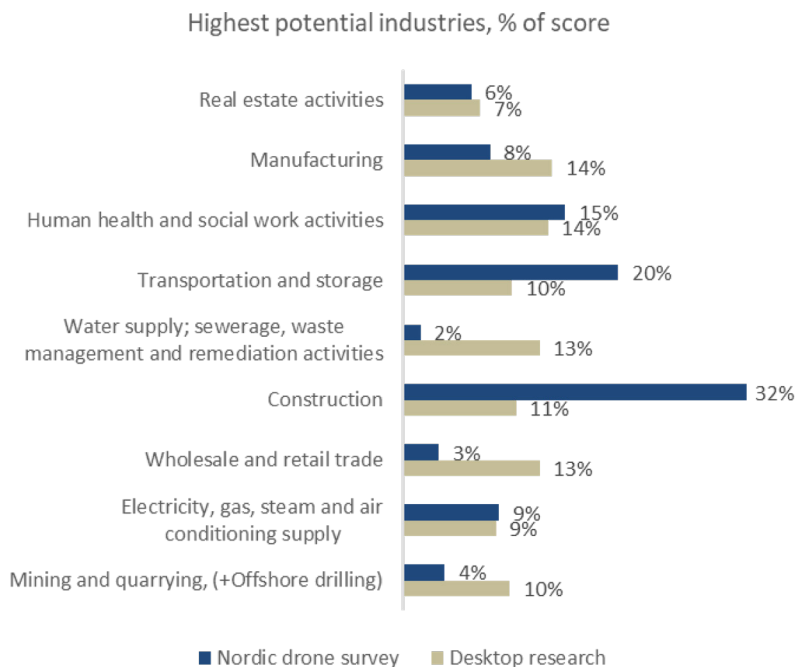
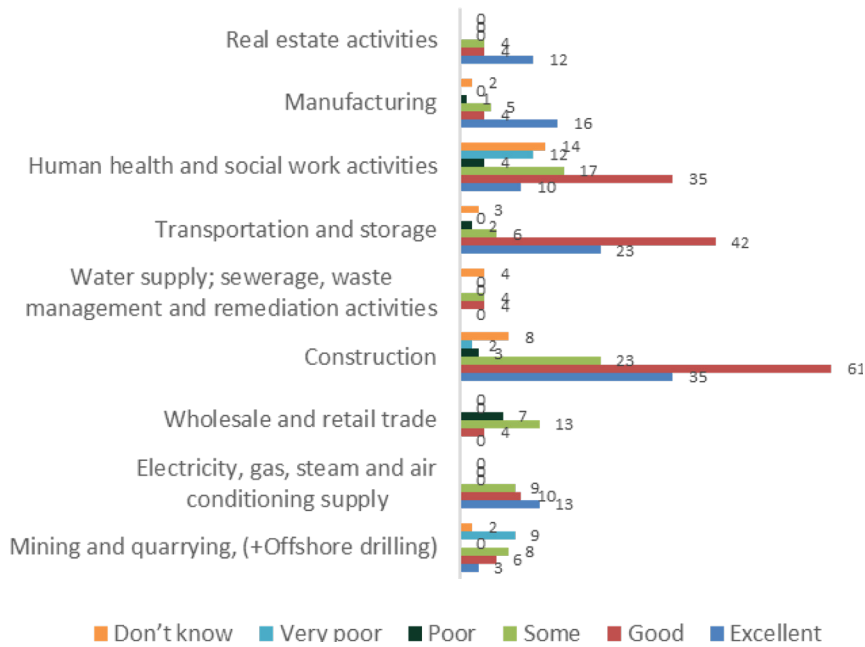


Figure 13 Highest potential industries, Norway



"On a scale from 1-5 where 1 is very poor and 5 is excellent economic value how much economic value do you think drones could create for your company when it comes to:"

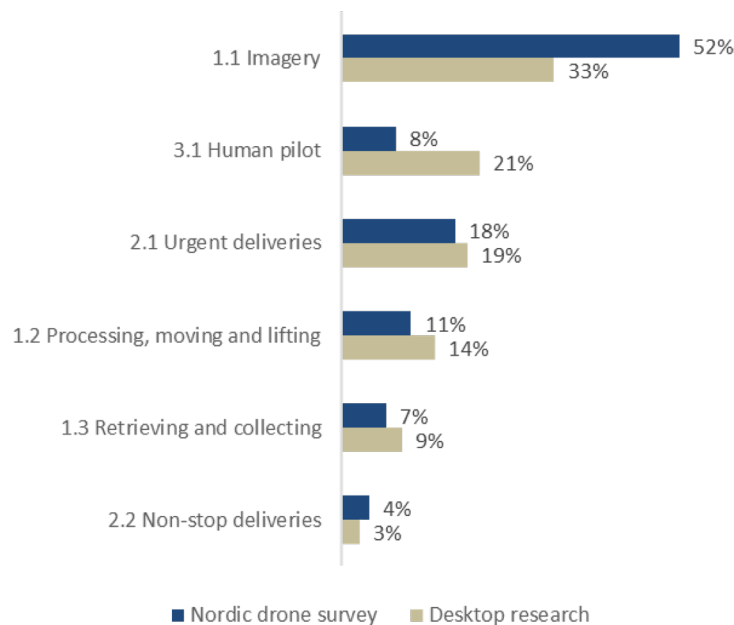
Figure 14 Economic value per industry, Norway



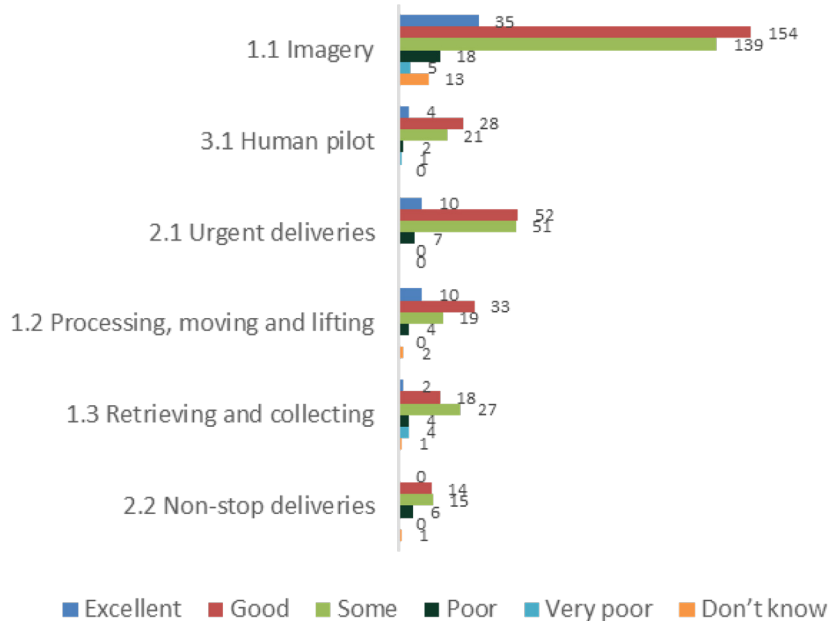
Country specific findings: Finland (N=136)

Highest potential use cases, % of score

Figure 15 Highest potential drone use cases, Finland



“On a scale from 1-5 where 1 is very poor and 5 is excellent economic value how much economic value do you think drones could create for your company when it comes to:”



#### Highest potential industries, % of score

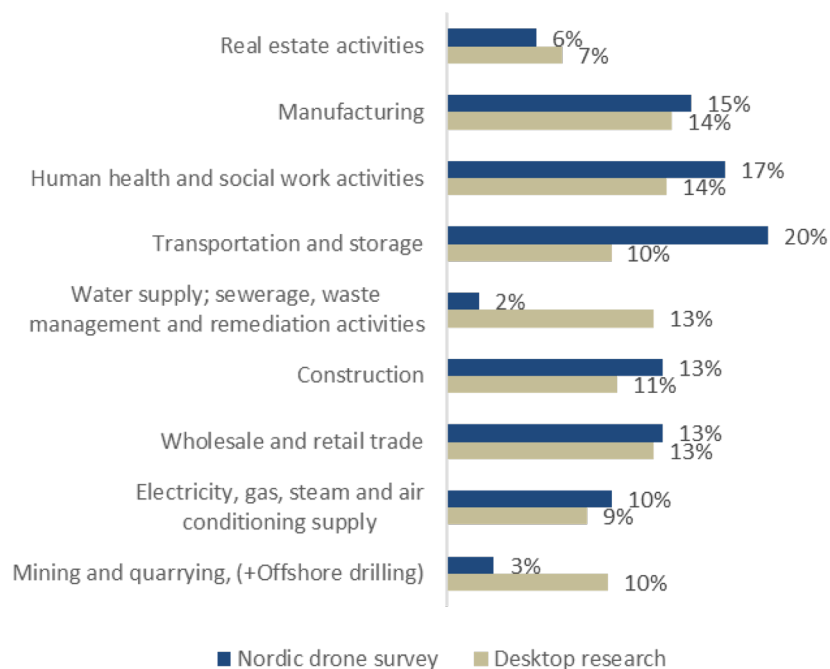
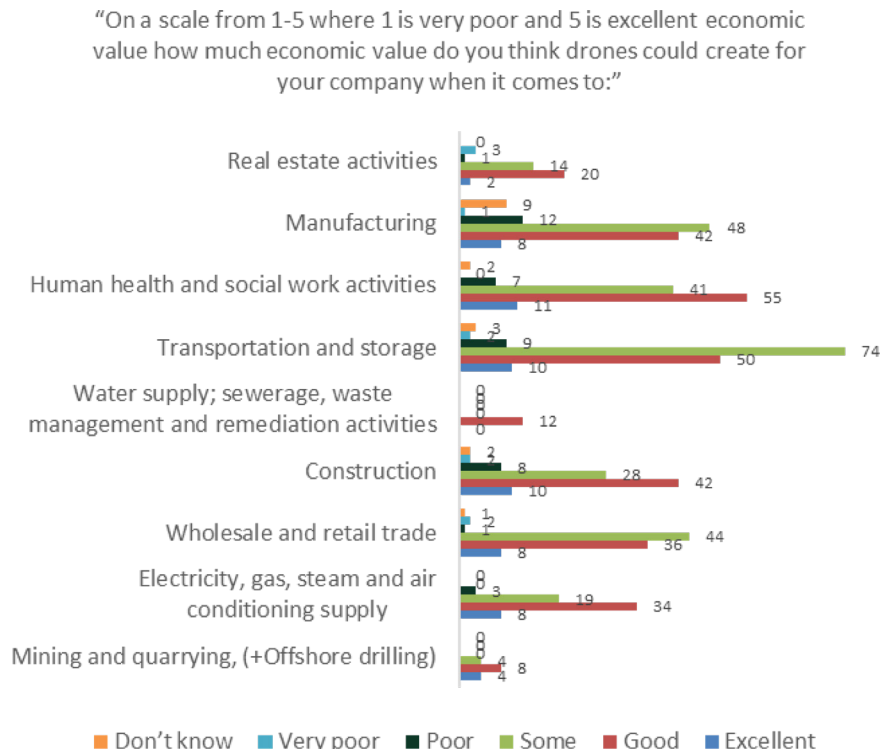




Figure 18 Economic value per industry, Finland



#### Country specific findings: Denmark (N=87)

Figure 19 Highest potential drone use cases, Denmark

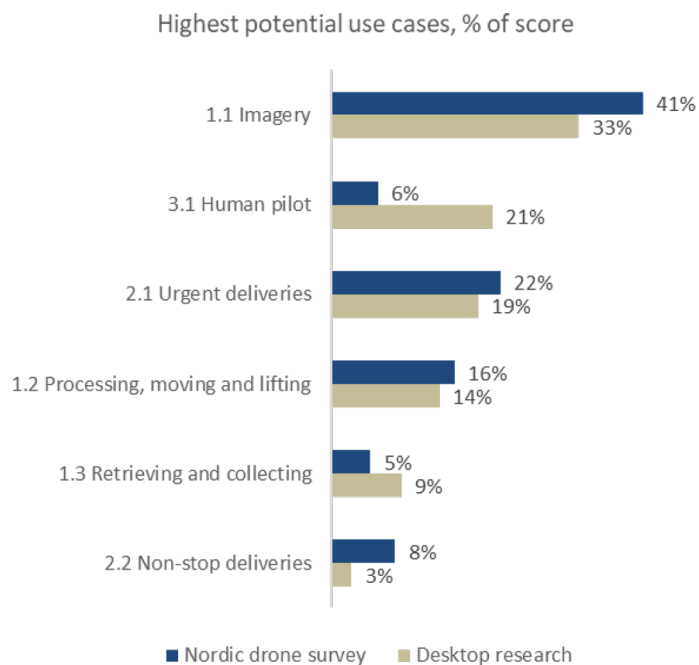


Figure 20 Economic value of use cases, Denmark

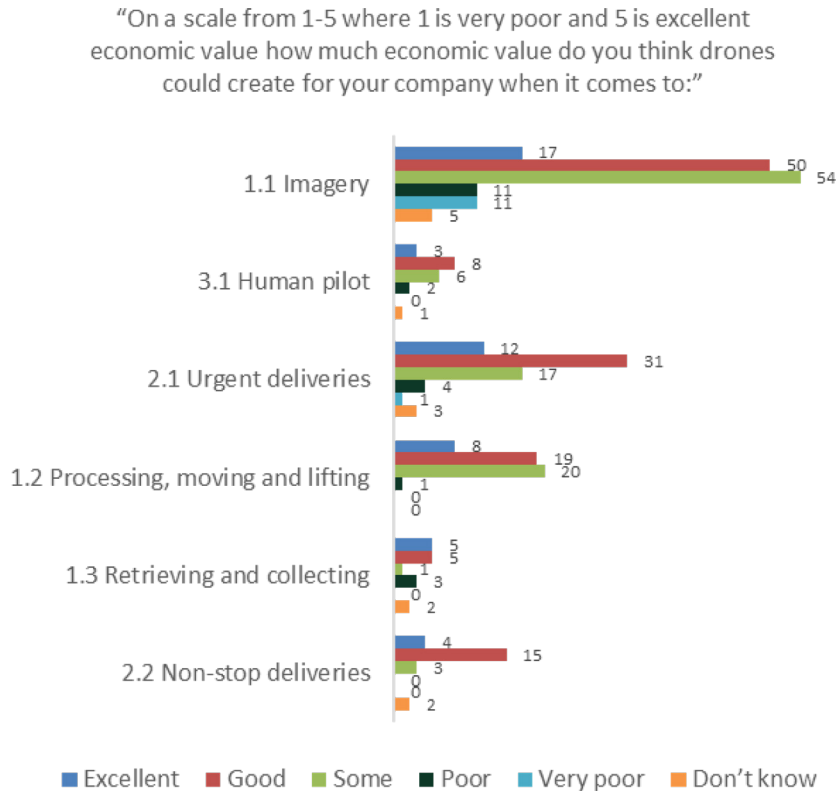
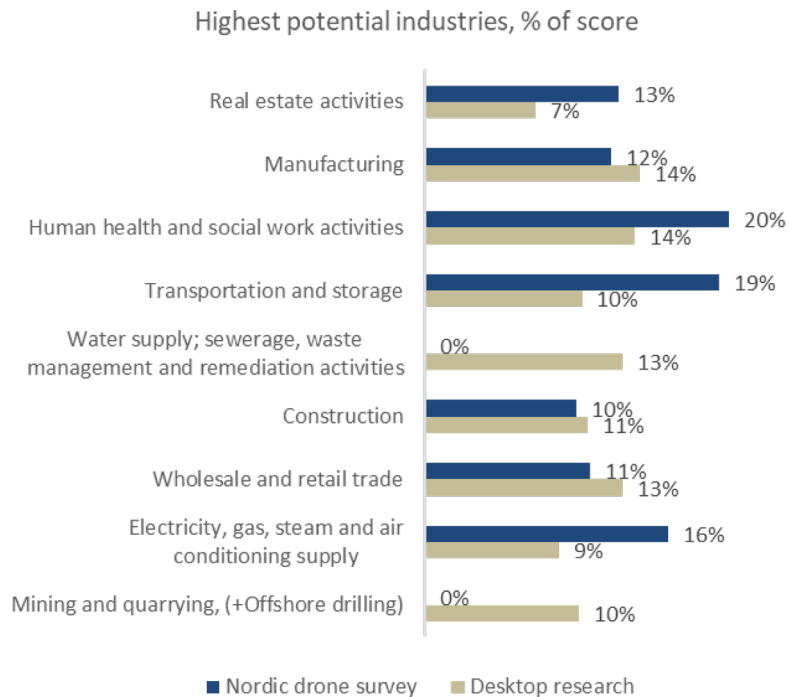


Figure 21 Highest potential industries, Denmark



"On a scale from 1-5 where 1 is very poor and 5 is excellent economic value how much economic value do you think drones could create for your company when it comes to:"

Figure 22 Economic value per industry, Denmark



#### Country specific findings: Sweden (N=105)

##### Highest potential use cases, % of score

Figure 23 Highest potential drone use cases, Sweden

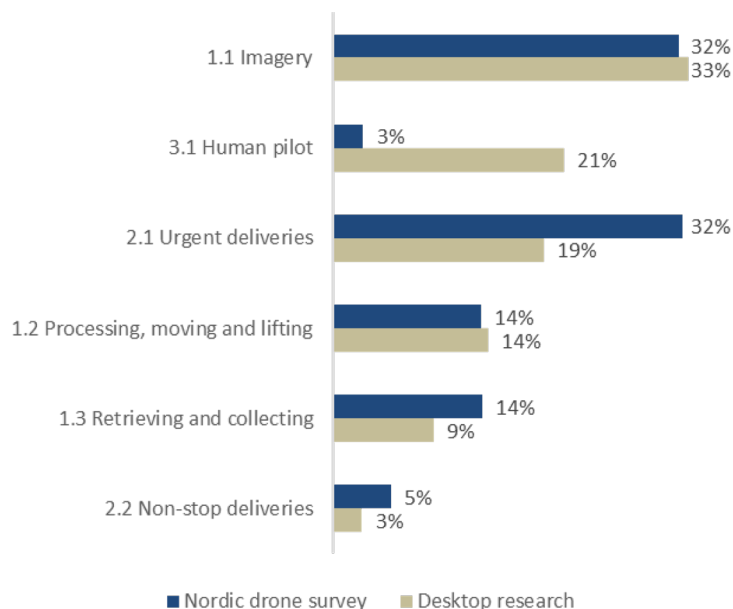


Figure 24 Economic value of use cases, Sweden

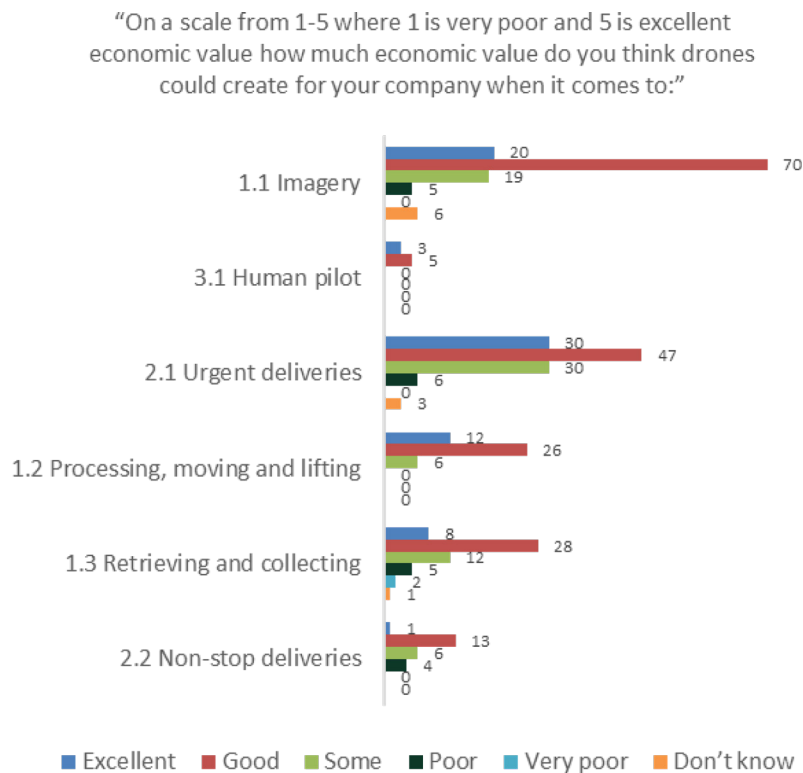
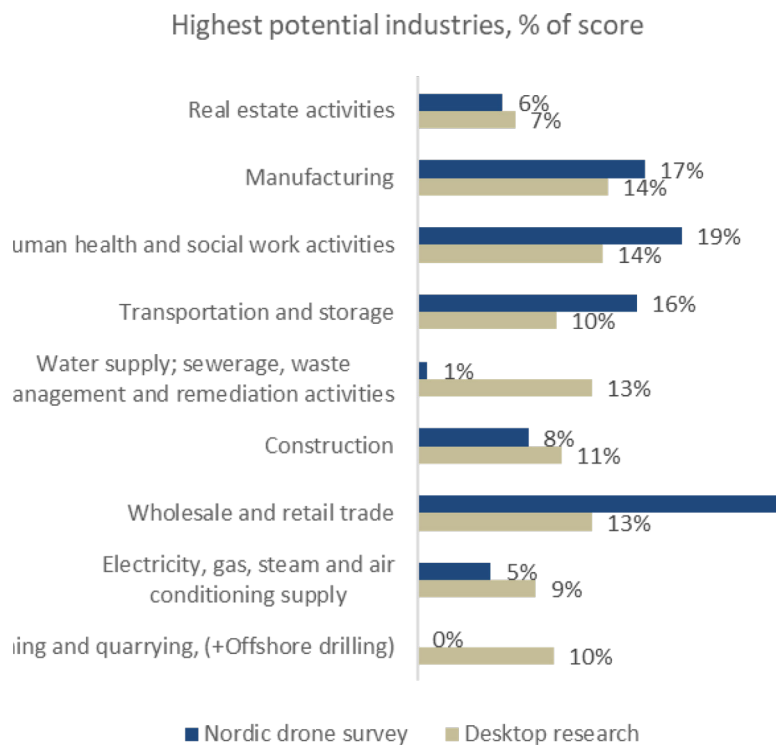
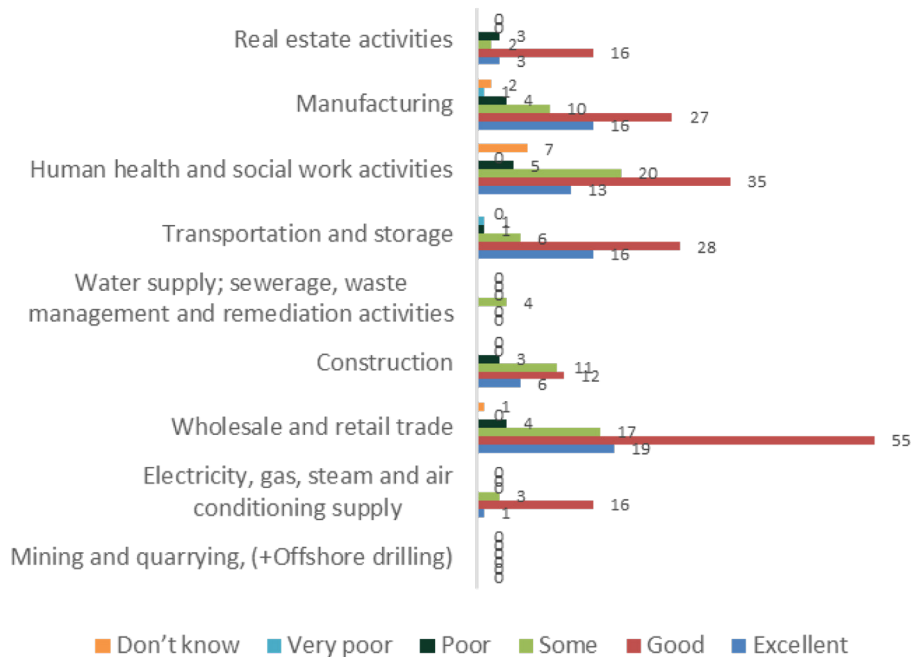


Figure 25 Highest potential industries, Sweden



"On a scale from 1-5 where 1 is very poor and 5 is excellent economic value how much economic value do you think drones could create for your company when it comes to:"

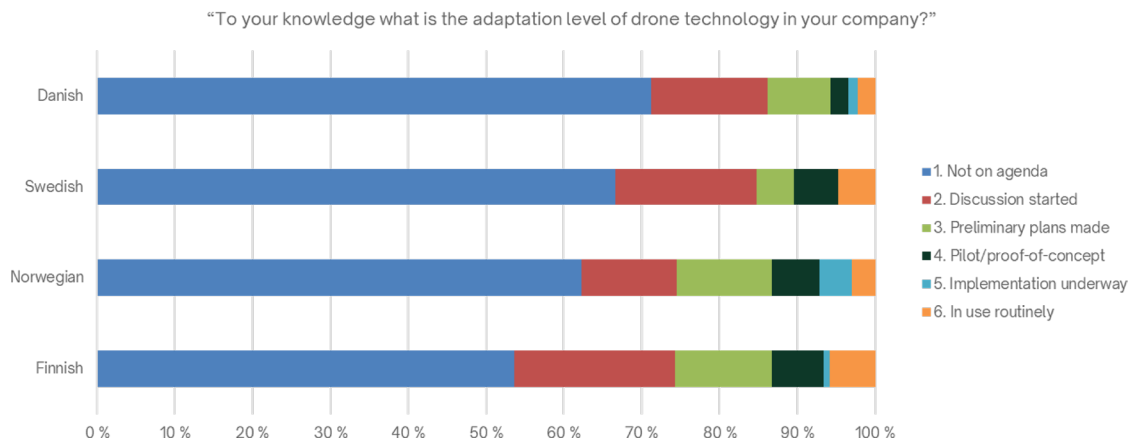
Figure 26 Economic value per industry, Sweden



Additional findings:

Roughly 10% of respondent companies are currently testing or using drones

Figure 27 Adaption level of drone technologies in different countries, Nordics



Heavy industries seem to have adapted more compared to service-oriented industries



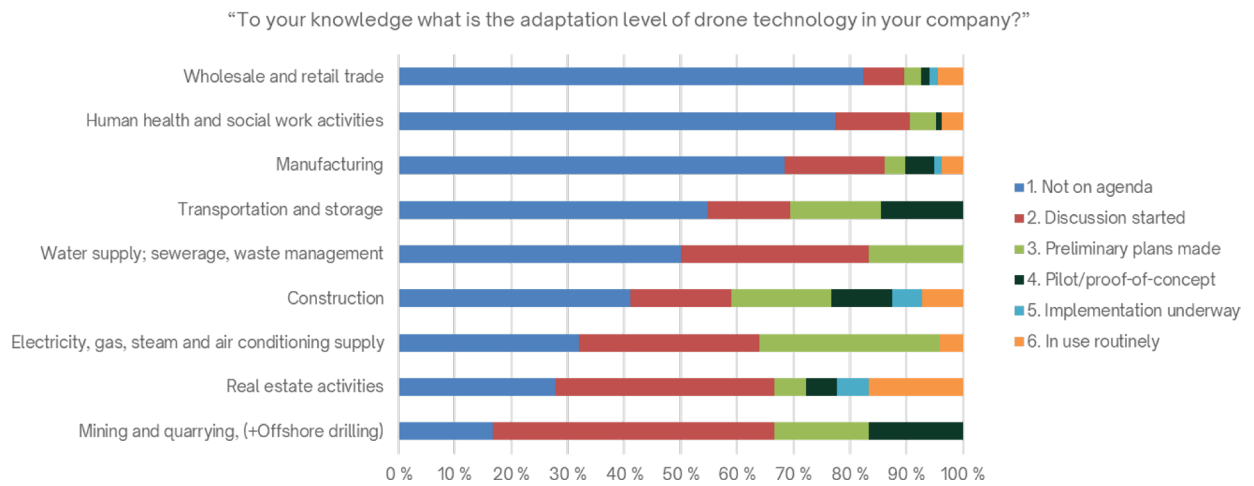


Figure 28 Adaption level of drone technologies for industries, Nordics

The outlook implies that drones will impact all industries to some extent

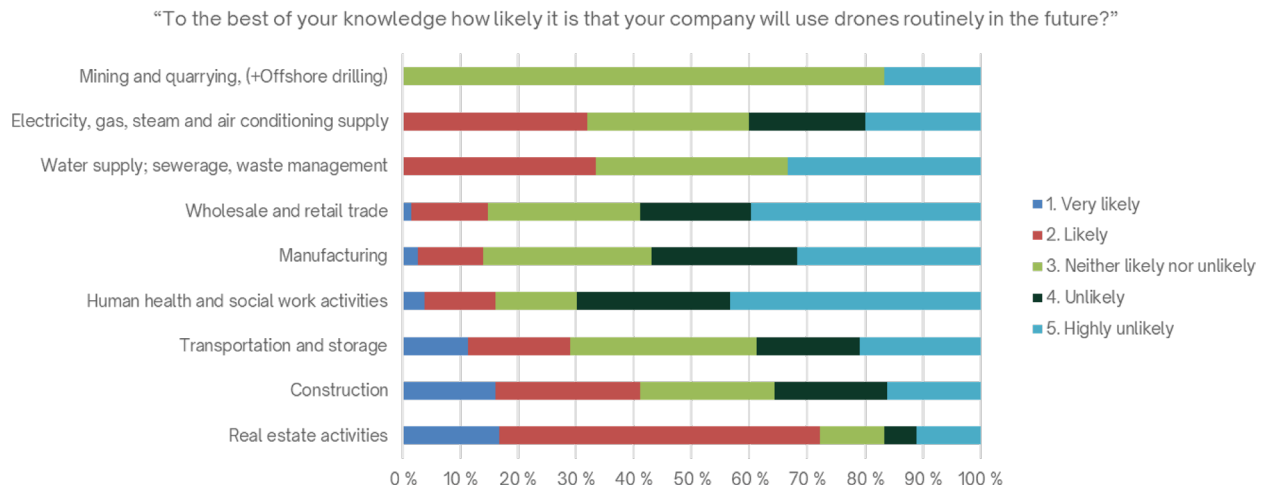


Figure 29 Perceived likelihood of using drones daily, Nordics

#### 1.2.4. Understanding of benefits and challenges of introducing drone-based transportation systems in the Nordics

Challenges of introducing drone-based transportation systems in the Nordics (cf Table 1):

##### Indoor and onsite work

- 1.1 Imagery (Overall challenge: LOW): There are little to no technological, organizational or environmental challenges to further utilizing drones for aerial imagery
- 1.2 Processing, moving and lifting (Overall challenge: MEDIUM): High upfront investments to technology and competitive pressure from existing solutions with similar value propositions pose challenges
- 1.3 Retrieving and Collecting (Overall challenge: MEDIUM): Low relative advantage compared to current solutions, e.g., warehouse robots, and high investment costs oppose major challenges for adoption

##### Outdoor delivery

- 2.1 Urgent deliveries (Overall challenge: MEDIUM): Logistics industry must

undergo a major shift in the way they operate in addition to heavy upfront investments and low compatibility to existing technical solutions. Major infrastructure, e.g., Unmanned Traffic Management, is still missing

- 2.2 Non-stop deliveries (Overall challenge: HIGH): Niche use scenarios due to high investment coupled with relatively low payloads oppose major challenges for adoption. Major infrastructure, e.g., Unmanned Traffic Management, is still missing

##### Human transport

- 3.1 Human pilot (Overall challenge: MEDIUM): Transportation industry must undergo a major shift in the way they operate in addition to requiring new capabilities and investing heavily into technology

## 2. Mapping tech- and ecosystems

The intention of this work package was to provide a complete database of the tech-stack and stakeholders of the Nordic drone ecosystem. Given the fast-moving pace of the industry, the ongoing implementation of new regulations, the difference in maturity of the drone industries in the Nordic countries and the vast scope such a list could not be compiled to a full extent. Nevertheless, a good insight of the drone ecosystem has been achieved and summarized below. The results were analysed, and a GAP analysis resulted in recommendations for boosting the Nordic drone eco- system further.

The tasks of the work package were as follows.

- Map current situation: Identify and reach out to stakeholders to get input. Structure technical requirements and capabilities with the main stakeholders.

- Analyze: Perform a gap analysis on requirements vs capabilities in the Nordics. Prioritize gaps to create recommendations
- Recommendations: Provide recommendations on which gaps to focus on and suggest further activities. Get buy-in and commitment from stakeholders on their activities.

### 2.1.1 Method

- Collection of information for list of Stakeholders
- Information received from WP1, High-value use- cases
- Acquiring Flight permits from all ANSP: s in the Nordics
- Business organisations input
- Target use-cases (construction, agriculture, transport),
- Workshops, semi-structured interviews.



## 2.1.2. Results

### Asymmetric information

Asymmetric information collection was, as described, a challenge in this work package. The approach to structuring the ecosystem in the Nordic countries has some vital differences which resulted in incomplete lists, where no comprehensive comparison or cohesive ecosystem map could be formed. The differences are notable, and an overview can be seen below. This overview can only be seen as a snapshot in time since the fast-moving pace of the area creates a volatile ecosystem landscape. For example, the implementation of U- Space is rapidly changing, the business organisations are developing and maturing, and open-access operator lists are subject to data- and privacy issues.

### Stakeholder buy-in

During the work in this work package, differences were identified in the implementations of new drone regulations by the NAA:s (National Aviation Authorities) in the Nordic. The NAA:s were also an important stakeholder in providing information to the ecosystem mapping. The Nordic NAA:s; **Traficom, Transportstyrelsen, Trafikstyrelsen, Luftfartstillsynet**, were repeatedly invited to participate in our

work, but due to the massive workloads in the regulatory activities they were, understandably, not able to contribute. This is also further described in the Regulatory recommendations section of this report.

### Ecosystem overview

The drone ecosystem includes the various stakeholders, components and technologies that are involved in the development, production, operation, and maintenance of drones, also known as unmanned aerial systems (UASs).

A completely new layer of the drone ecosystem has also been introduced with the U-Space regulation, which regulates the safe introduction of drones in the airspace. This new layer will be the enabler for large scale introduction of drone services beyond visual line of sight (BVLOS) and automated drone flights also referred to as IAM – Innovative Aerial Mobility. For the ecosystem this means that the stakeholders extend dramatically, affecting not only CAAs and operators, but also police, military, aviation industry, insurance companies, regional authorities, logistics and mobility industry, citizens, and the general population at large.

|                                           |   | == |   |   |
|-------------------------------------------|---|----|---|---|
| Business organisation                     | x | x  |   | x |
| Open-access drone operator list from ANSP | x |    |   | x |
| Drone testbed                             | x | x  | x | x |
| Funding for U-Space implementation        | x | x  |   | x |





Key components of a drone ecosystem include:

- **Regulatory bodies:** Drones are subject to various regulations and laws related to their operation, such as airspace restrictions, privacy concerns, and safety standards.
- **Operators:** Drones are used for a wide variety of applications, such as aerial photography, delivery, inspection, mapping, and search and rescue. Operators ensure that the pilots are professionally trained, and that the organisation fulfils all the legal requirements and upholds safety standards.
- **Manufacturing companies:** The production and maintenance of drones involves a range of specialized skills and technologies, including materials science, electrical engineering, and robotics.
- **Software:** This includes the software and firmware that control the operation of the drone, such as its flight control system, navigation system, and payload management.
- **Data management:** Drones generate a large amount of data during flight, which needs to be managed and stored efficiently. This includes data storage systems, data analysis tools, and data security measures.
- **Hardware:** This includes the physical components of the drone itself, such as the body, propulsion system, sensors, and communication systems.
- **Standardisation bodies:** The regulation of drones require harmonisation so that the same procedures are used to ensure safety of the systems.

- **CISP** (common information services provider) and **USSP** (u-space services provider), the legal entities that ensure that a U-Space can be implemented.

Overall, the drone ecosystem is a complex and rapidly evolving field that involves the integration of hardware, software, data management and regulation to enable aerial services while maintaining air and ground safety.

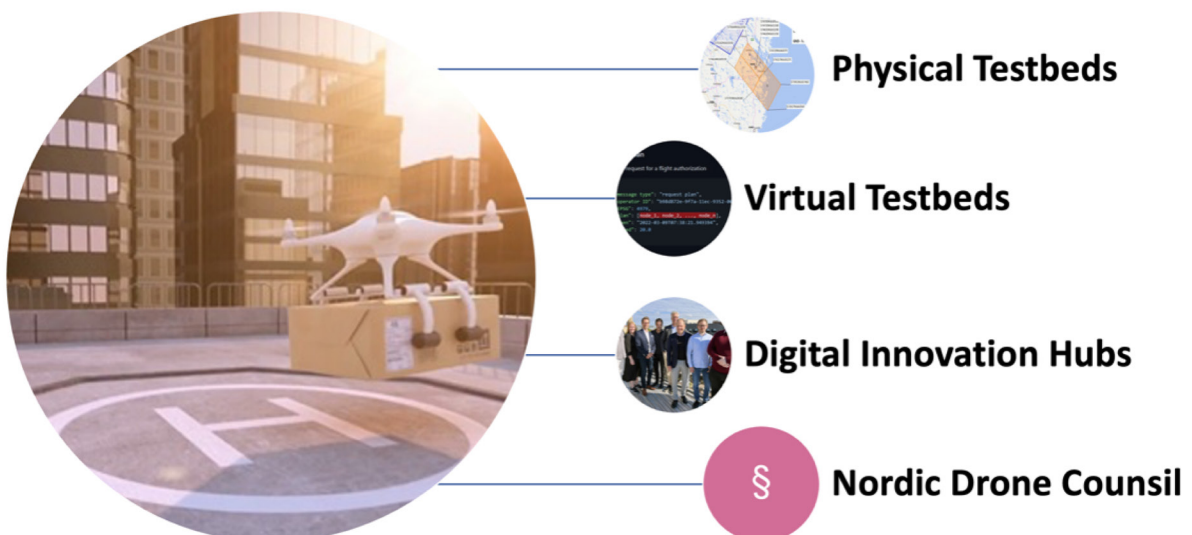
### 2.1.2.1 Recommendations on boosting the drone eco-system

To boost the Nordic drone ecosystem, investments should be made in the cross-sections of stakeholders, where the different actors in the system meet. Examples of this could be;

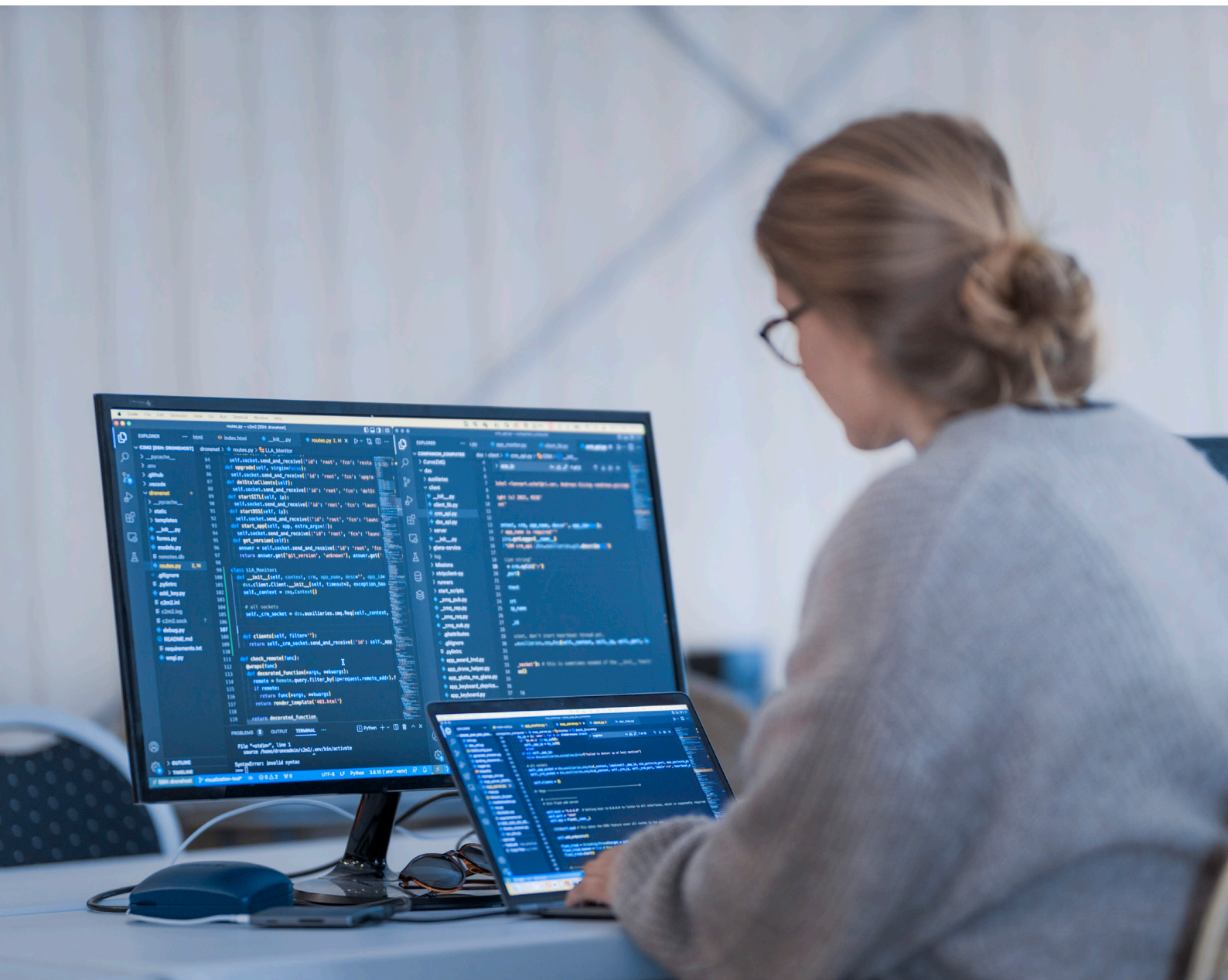
- Supporting the dialogue between business organisations, regulatory bodies, and governments.
- Fund virtual testbeds where operators, end-users and regional airspace designers can test and verify u-space concepts.

- Promote cooperation between physical drone test beds, drone manufacturers and policymakers.
- Further boost drone innovations through Digital Innovation Hubs and promoting policy changes in regions.

A tangible suggestion could also be to form a Drone Council as a new entity to the ecosystem. In Netherlands, a Dutch Drone Council has been established as an NGO (Non-governmental organisation) to form a link between the government, the business organisations, and the legislative bodies in order to advise on how to best implement Innovative Aerial Mobility and Services in a safe and efficient manner. Given the different maturities in the drone ecosystems throughout the Nordics, a joint Nordic Drone Council could be formed in order to increase cooperation, boost implementation of drone innovations, advise on regulatory decisions in the Nordic regions and to strengthen the drone industries.







### 3. Nordic requirements

The successful deployment of drones in logistics missions requires an effort to quantify the special requirements for UAVs, with a focus on atmospheric icing and technologies for the power system based on fuel cells or batteries feeding the electric motors, versus internal combustion engines. Atmospheric icing has been confirmed as a critical aspect to be addressed: when flying at 120m above ground level, the larger share of the territory in the Nordics already experiences icing 13 days per year, and the frequency of icing quickly increases in higher flight levels. In low level flight operations with smaller drones, the risk of icing will be mitigated with use of weather data during mission planning, and icing awareness (realtime readings from airborne sensors, & aircraft metrics) and protection of critical flight sensors. Flying-wing UAV aircraft architecture seems well suited to minimize the effect of icing. In small helicopter-type UAVs (~200kg weight), the power required for ice prevention seems largely proportional to the power in helicopters certified for flight into known icing conditions. The protection of such UAVs against icing seems realizable with currently available technology, at a cost of

a noticeable reduction in payload and flight range. The power systems based on aviation fuel or fuel cell will likely be used for flight endurance over 30 minutes, whereas batteries continue to find its niche in the shorter missions. In both cases, low temperatures will limit operational capabilities. Fuel cell power systems are getting closer to the performance of aviation fuel, with the promise to integrate with the future hydrogen economy. Improved design of fuel containers capable of storing liquid hydrogen will help closing the gap.

**A white paper has been uploaded to the public repository Zenodo. It is publicly available at <https://doi.org/10.5281/zenodo.6077534>.**



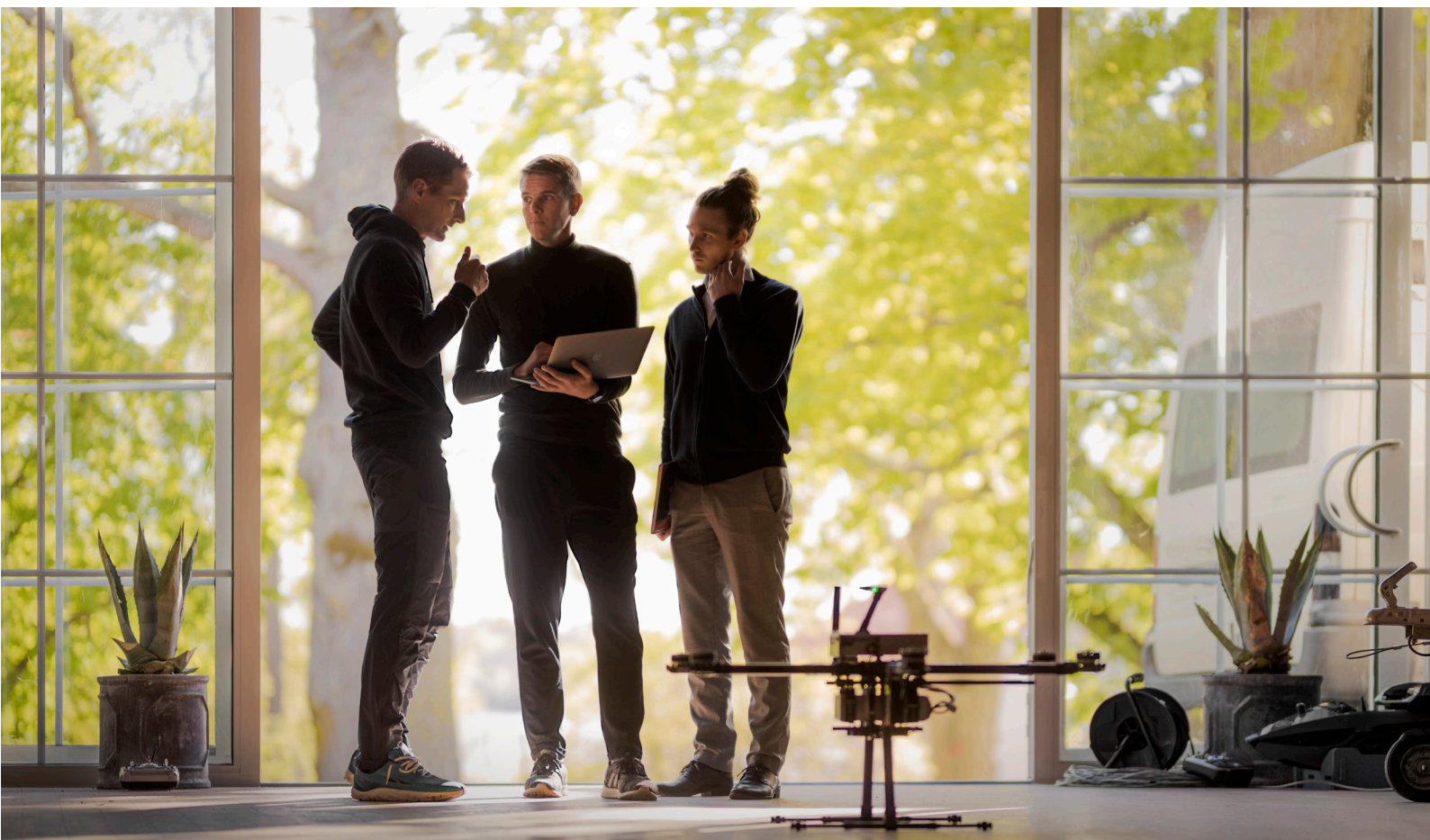
## 4. Regulatory recommendations

The intention of this work package was to identify regulatory constraints and challenges regarding operations in another EU country and cross-border operations.

### 4.1. Method

During the project several drone operations were identified which were conducting either cross-border operations or operating in another EU country than where the operator was registered. Representatives for these organisations were interviewed, and challenges and constraints were identified based on the operator's experience. These findings were

then compared with EU regulations 2019/947 and 2019/945 and each case interpretation differences of target countries were identified. Besides Drone regulations, the airspace usage of the target countries was studied and the impact of airspace usage on drone operations was identified. Findings were gathered by topic expert interviews and findings gathered via real-life operational authorization applications from Finland, Sweden, Norway, Estonia, Latvia, Poland and Austria.



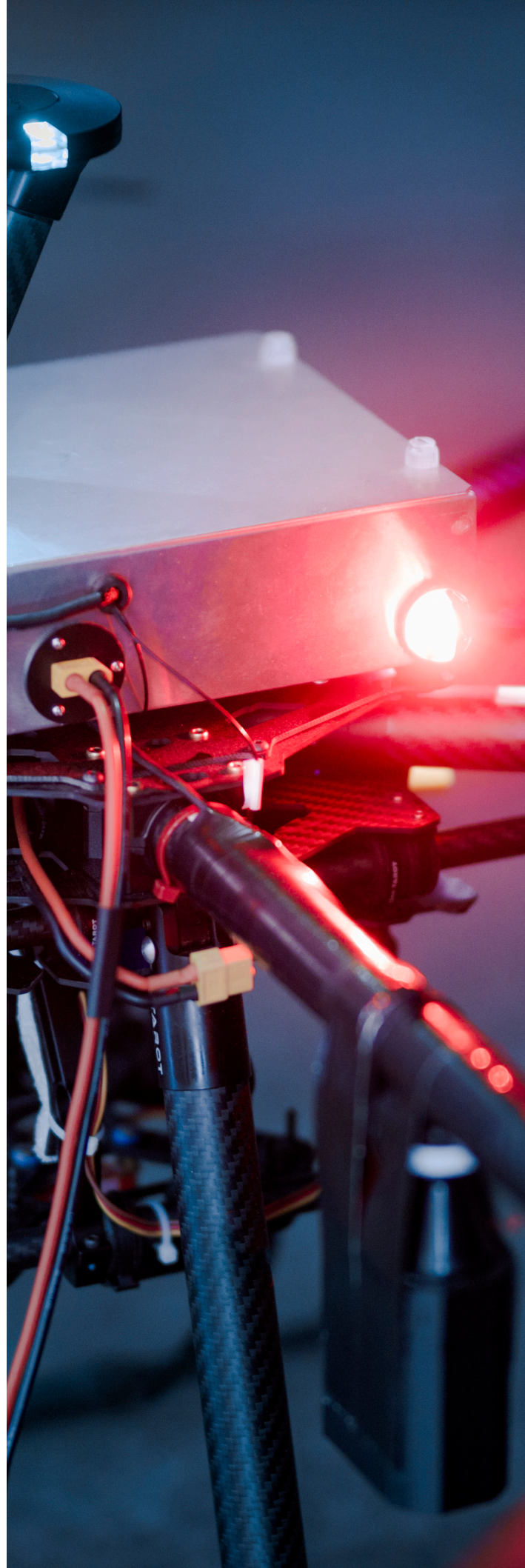


## 4.2. Results

### 4.2.1. Background of the cross-border operations

For now, cross-border operations, or operations in another Member State country, apply only to the Specific category. In the Open category, there is no need for National Aviation Authority (NAA) interaction or permits. This means that operators operating in the Open category can operate in any EU country without requesting permission from the target country. The Certified category is not published and therefore Certified category operations were excluded from this project.

Based on Article 13, cross-border coordination is relevant to some Specific category operations. These are Pre-defines Risk Assessment (PDRA) and Specific operation Risk Assessment (SORA) operations. Standard Scenario (STS) operations permits are based on the declaration of the member state where drone operation is registered and there is no need for interaction in a member state of operation (the country where a foreign drone operator is planned to operate). Light UAS Certificated operators (LUC), can declare with LUC privileges operations by themselves and therefore there is no need to interact with the National Aviation Agency in the member state of operation.



|                  |      | <u>MS of registration</u>                                  | <u>MS of operation</u>  |        |
|------------------|------|------------------------------------------------------------|-------------------------|--------|
| <b>OPEN</b>      |      | No permit                                                  | No NAA interaction      |        |
| <b>SPECIFIC</b>  | STS  | Declaration                                                | No NAA interaction      |        |
|                  | PDRA | Operational Authorisation                                  | Article 13 cross-border | Art 13 |
|                  | SORA | Operational Authorisation                                  | Article 13 cross-border |        |
|                  | LUC  | LUC with privileges                                        | No NAA interaction      |        |
| <b>CERTIFIED</b> |      | Certified Operator<br>Certified Aircraft<br>Licensed pilot |                         |        |

The procedure to get operational authorisation outside of the country where the drone operator has been registered is following:

1. The operator applies for operational authorization (OA) in a member state where the operator has been registered.
2. The National Aviation Authority of the registration country approves the operational authorisation.
3. After the NAA of the registration country approves the Operational Authorisation, the drone operator can apply for permission in other member states.
4. The National Aviation Authority of the target operation country issues confirmation of the acceptability.
5. Once confirmation is issued, the NAA of the registration adds confirmation of acceptability to Operational authorization.
6. And finally, the drone operator can start operations in the target operation country.

When a drone operator applies for cross-border operation from the target country, the operator has to include the following documentation:

1. Operational Authorisation in Member state of registration.
2. Local condition in Member state of operation.
3. Operational manual.
4. Relevant changes to the chapters from the Operational Manual including adapted operational procedures to ensure mitigation measures are still valid in target country of operations.
5. Evidence of compliance with updated procedures.

NAA in the target operation country is not expected to review the full risk assessment, but to limit its activity to check that updated mitigation measures are satisfactory.





#### 4.2.2 Differences between EU countries

Differences were identified between Finland, Sweden, Norway, Estonia, Latvia, Poland and Austria. Dronnair is a Finnish startup company, which provides high- quality Unmanned Aerial Surveys services. Dronnair conducted the operation in Finland, Sweden and Norway. The publicly funded project GF2.0 is a very large demonstration project funded by SESAR JU. GOF2.0 conducted operations in Austria, Estonia, Finland, Latvia and Poland.

Although EASA has published AMC (Acceptance Means of Compliance) and GM (General Material) documents providing instructions on how to implement regulations in Europe, there are large variations in interpretation and support across Member States. The most significant difference is how NAA supports applicants. In general, Nordics NAAs are supportive and consult on how to proceed so that operational objectives can be achieved. However, some countries have a more bureaucratic tradition, where the NAA will mostly only inform if a permit can be granted or denied, without any interest to support

the success of the applicant. Most of the target NAAs battle with a shortage of skilled resources, which has negatively impacted the growth of UAS operators.

Based on the applications, it was also found that there is a large variation in how the ground risk class of the SORA is defined nationally. Based on the countries studied, the definitions of populated/ sparsely populated areas varied, as AMC/ GM does not provide quantitative guidance. This impacts not only the Operational volume and ground buffers but also the requirements for enhanced containment.

Air risk class assessment and mitigation possibilities vary a lot between target countries. NAA understanding and assessment of how SORA arrives at Air Risk Class varies. In CTR, some countries classify <120m operations close to the CTR borders as ARC-b, and some countries as ARC-c. therefore the size requirements for an air risk buffer to ARC-d (and enhanced containment) are not very predictable. Also, the willingness of NAA and ANSP to accept ATC-provided separation as

ARC-a or ARC-b in controlled airspace varies.

There are also differences in how the countries manage dynamic airspace. The use of Temporal Danger/Restrict airspace to provide ARC-a varies from fast straight-forward in Finland to almost non-existent in Sweden or Austria. In some countries, the only tool to reserve airspace for drone operations is the Geographical UAS Zone. For example, Sweden prefers to use Geographical UAS Zones or in some cases Tempo-R. Based on Dronnair topic expert, Sweden is planning to test how Tempo-D could be used for UAV BVLOS flights. For cross-border operations and operations in other EU countries, it is recommended to contact the NAA to ensure what kind of practices the target country has in order to manage access to airspace for advanced UAS operations.

For those operators operating in several different member states, Light UAS operator certificate (LUC) is recommended. LUC (Light UAS operator certificate) is a powerful tool for companies operating abroad. A LUC operator maybe granted privileges to approve their own operations. However, LUC operators must have LUC Manual, Internal Authorization, Safety Management System and Compliance Monitoring Program and therefore meeting these requirements and maintaining the certification may be a big challenge for small companies.

U-space and UTM will be a challenge in cross-border operations because there are so far no standard protocols. For the time being, it is still difficult to forecast how U-space and UTM will interconnect different countries, but we may expect political

pressure for standards of protocols and integrations.

Other restrictions and permissions, like radio frequencies, privacy and geography should be considered when planning to operate in different member states. To plan operations in another country or cross-border operations, the operator must be familiar with also these restrictions and policies. For example, in Finland, you need to have a separate permit to use a mobile network in manned or unmanned aircraft. In Sweden, you need to have a permit from the Land Survey (Lantmäteriet) to share, upload, distribute or sell aerial images and videos and in the UK, property-owners are owning low-level airspace over their land, so you need to have a property-owner's permit to fly. Also, some nature preservation laws may supersede aviation laws.

Nature parks may have their policies to use UAVs that may deny operations in another member state.

#### **4.2.3. Recommendations**

As recommendations, there are significant differences between NAAs on culture, resources and interpretations. Existing close cooperation between NAAs of different countries makes cross-border permits easier to issue. Follow the guidelines and templates provided by EASA. Consider LUC if operations are similar in every EASA country. Also pay attention to other restrictions and permissions, such as radio frequencies, nature preservation and land use for operations. Reserve sufficient time for permits, because the dialogue between you and NAAs will take time.

## 5. Main results and conclusions

The project has generated plenty of new knowledge and competence relevant to the Nordic Drone sphere. Another central piece of result is the strengthening of a Nordic drone network.

The project has also successfully networked and dissemination beyond Nordic borders, highlighting the frontlines of Nordic Drone competences to the international drone industry.

NDI has pinpointed and described central technical and legal challenges for the wider implementation of drones in the Nordic. NDI also described the strengths and weaknesses of the Nordic market possibilities and found that differences within the Nordic Drone sphere could constitute the basis of a value chain generating a major market advantage.

