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Recommendations for drone operation safety in Finland

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Abstract

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The report explores how Finland's safety regulator Trafi can safeguard the high influx of commercial unmanned aircraft entering Finland's airspace as a result of the development and technology advancements within the industry. Trafi's biggest concern at the moment is to identify how unmanned operators can be informed of the latest air notifications and new enforced regulatory standards.

Trafi was compared to Australia's state regulator who has regulated unmanned aircraft longer than Finland. The results of the research were based on qualitative interviews which were conducted with respected Trafi personnel. The objective of the questionnaire was to observe how current unmanned aircraft operators obtain information regarding safety regulations and standards in Finland, while the aim of the report is to examine how Trafi could improve their communications regarding the matter.

This study gathered and compared data from Finland's and Australia's incidents, accidents and near collision reports to anticipate the incident probabilities in the upcoming years. The actual level of risks related to unmanned aircraft is unknown because of lack of ineffective data gathering. The aviation industry measures safety through statistics on a quarterly and yearly basis but does not extract specific data about unmanned aircraft in Finland.

The objective of the study is to discover how Trafi can lower current risks associated with commercial unmanned aircraft use by providing feasible recommendations for their uses. The results of this study were used to determine how trafi can harmonise safety regulations into the Finnish state to ensure all unmanned aircraft operators can source the necessary information to fly safely and have respect of others in the airspace.

Keywords
Unmanned aircraft, aviation, risk, safety,

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1 Introduction and objective of the study

The possibilities to use commercial unmanned aircraft is endless as the cost to perform tasks and using a smaller crew makes it a superior driver for a wide range of markets. Furthermore, some high-risk operations and tasks within businesses can be executed safer by using unmanned aircraft. (Feist, 2018.) Sales growth of recreational commercial RPAS have intensified, selling approximately 776,00 units between 2016 and 2017 (Statista 2018a). The current global value of recreational and commercial drones is approximately 2 billion dollars and is expected to rise to 127 billion dollars by 2020 (Ludwig 2018, 1-2).

Personal drones will increase in popularity because they are affordable to purchase and can fly up to 5 kilometres per hour. The use of drones for commercial use is highly regulated in some states, however, many industries embed risk management plans into their daily operations to minimise risks. Aviation safety authorities are observing that as the production of unmanned aircraft is growing in the airspace, safety regulations must be embedded accordingly. (Gartner 2018.)

The aviation industry has observed that some commercial unmanned aircraft operators are reckless, as they do not have the knowledge or experience to fly in accordance with flying standards and regulations. Professionals such as air traffic control (ATC), and aircrew have observed many close encounters of commercial unmanned aircraft within close proximity of aerodromes. Some professionals have observed risks such as near misses when approaching an airport. (Broderick 2018). Whilst industry experts such as Civil Aviation Safety Authority (CASA), Civil Aviation Authority (CAA), and Federal Aviation Administration (FAA) are rectifying the current situation. The Finnish Transport Safety Agency (TRAFI) wish to provide a humanistic approach with ruling guidelines by introducing OPS M1-32 flying standards for unmanned aircraft flight operations (Trafi 2016).

EASA observed that across the European Union (EU) safety rules differ and are not coherent. EASA proposed an approach to develop common standards across every state to follow acceptable linear compliance guidelines for safer flying with manned aircraft. After evaluating statistics and professional concerns *Opinion 01/2018* was proposed for every EU state where can apply similar flight rules and procedures for drone operators. The regulatory framework also takes into consideration of risk to individuals on the ground, security, data protection to other considerations with other flight operations in the air. Furthermore, EASA has provided enough flexibility for every state to adapt these rules and guidelines to define restricted flying zones and address operational risk assessments where an operator must comply with prior to flying their unmanned aircraft. (EASA 2018a.) In November 2017, Trafi endorsed the “Drones Helsinki Declaration”. This regulatory framework

is to be implemented in a timely manner to protect inhabitants with a high level of safety, security, privacy and environmental protection concerns (Europa 2017).

This study will focus on commercial unmanned aircraft use in Finland. It will not discuss how military or other Finnish agencies use unmanned aircraft within the state nor will it discuss the benefits of unmanned aircraft for an organisation or society. The research aims to create a set of feasible recommendations to improve safety and security awareness for commercial unmanned aircraft operators by cross examining and comparing how another safety regulator such as CASA implement their rules and standards, followed by how other industries mitigate security and safety concerns.

Risk management frameworks must continually be examined as the misuse and threats of commercial drones are imposing a global scale risk for everyone within their area of operations (Clothier 2014). This will be examined deeper by interviewing professionals from Trafi to identify what improvements and changes must be amended with the current standards and regulations. In examining these issues, the researcher can provide some feasible and suitable recommendations to Trafi that can be implemented to maintain safety and security for everyone.

As the report has numerous aviation terms and abbreviations, the reader can review ‘terms’ in appendix 1 and ‘abbreviations’ in appendix 2.

2 Scope

The misuse of drone flight operations is continually threatening air traffic and furthermore, risking the safety and security in other areas. Not everyone is breaching safety standards, but organisations and safety authorities must have a clear objective to manage and mitigate the rising threats of drone flight operations.

This section will aid the reader to understand how the Safety Management System will aid an organisation to make flight operations for unmanned vehicles safer, recognise different variants of UAVs and in what way they can assist a commercial operator followed by how a drone can be misused and lead to a potential threat on others.

2.1 Safety Management System

Air safety authorities such as Trafi must understand how to approach RPAS with a regulatory framework that can assist in managing different aspects with flight operations. By doing this, it will reduce the cost of incidents, accidents, communication and productivity whilst maintaining coherence with airworthiness. (Ashford 2013, 475-476.)

ICAO implemented *Doc 9859 AN474 Safety Management Manual (SSM)* to deliver guidance how a state, organisation and individual can develop and implement their procedures that are in accordance with the International Standards and Recommended Practices (SARP's) (ICAO 2013a, 1-1). Safety Management System (SMS), is integrated within this document where it describes a systematic and integrated framework to ensure stakeholders such as aviation professionals, regulatory and administrative personnel address aviation activities that relate to safe aircraft operations. SMS must address, safety policies and objectives, safety risk management, safety assurance, safety promotion, determine how SMS will be implemented and planned and define how an organisation will approach every implementation phase. (ICAO 2013a, 5-1 – 5-38.) An example of implementing SMS will be used from an airport regulatory context. An aerodrome operator operates an area wherever commercial aircraft take-off or land that involves transporting cargo or passengers. Aerodrome operators must maintain services, equipment and the organisation by using a system that is designed to ensure risk levels and hazards are preserved at an acceptable level. By building an effective SMS it safeguards a level of safety within the aerodrome where activities, equipment and supplies are not degraded by external agencies. (Ashford 2013, 475-476.) Figure 1 identifies how SMS are delivered from international safety regulators to integrating SMS within an aerodrome.

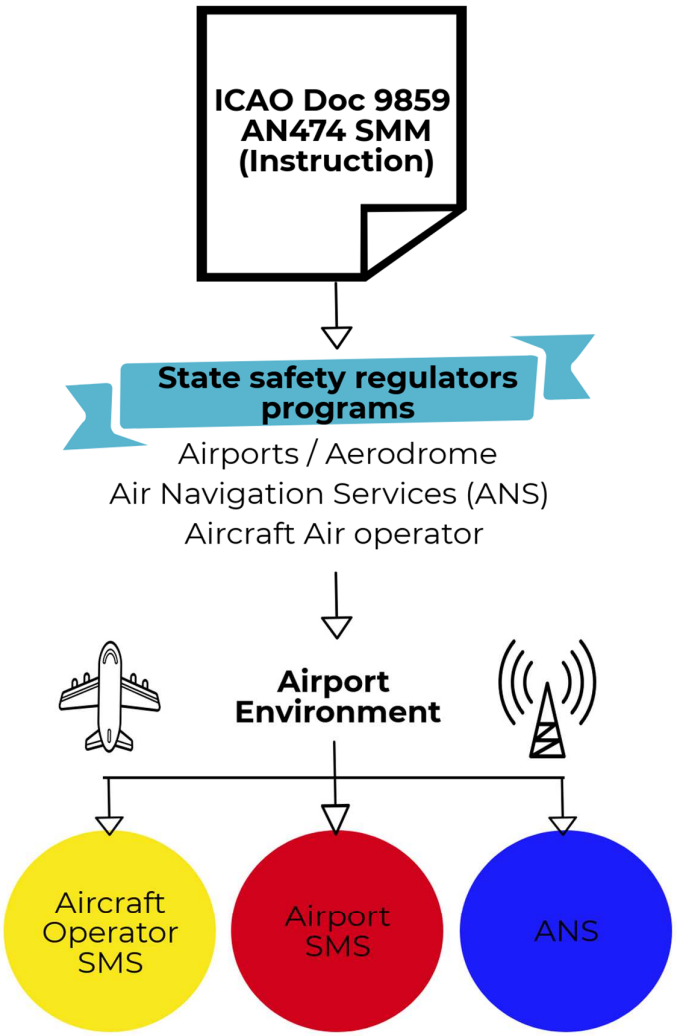

Figure 1. SMS delivery within an airport.

For organisations within the aviation industry, SMS must be tailor-made to meet their needs and requirements. It has been introduced to provide a sequence of clear processors that deliver effective risk-based decision-making tools to continually improve the overall safety in the aviation industry. SMS builds on current processes to be integrated with other management systems to make good business practices. SMS should comprise of the organisational structure, safety policies, procedures, accountabilities, risk management, safety assurance and promote safety to identify and assesses hazards to mitigate risks. It must be understood that SMS is to be treated as a guide and it does not replace relevant oversight regulations. It should be understood that SMS promotes safety practices within an organisation. (EASA 2018b.) Furthermore, management will need to liaise and communicate with aviation authorities to forecast, recognise and accommodate new uprising safety requirements (Young 2011, 477).

Senior management are accountable to provide sufficient resources and support to guarantee employees can identify what are hazards and how they are to be reported. The key qualities that an organisation must consider when building an effective SMS framework is to create a top-down approach to reach safety performance goals and a transparent roadmap that communicates comprehensive practices. SMS is of benefit as it demonstrates that an organisation shares a reasonable duty of care and are readily accessible to improve existing measurers. (EASA 2018b.)

2.2 Unmanned Aircraft

Unmanned aircraft have many names such as: unmanned aerial vehicle (UAV), drone, remote pilot aircraft (RPA), remote piloted vehicle (RPV), remote piloted aircraft system (RPAS); and unmanned aerial system (UAS). At present the appropriate term used for these aircraft is UAS and under the directives of Trafi, the term RPAS is used for recreational and hobby enthusiasts.

There are multiple designs of UAS as the technology and development raises no risk with individuals to conduct flight testing. Military UAVs are usually of greater size than commercial UAS and are more often fixed wing, whereas commercial UAS is predominantly electric multi-rotors or quad-copters and some fixed-winged UAS. (Glaser 2017.) A quad-copter or multi-rotors four or more rotors which are in different sizes that are relatively stable during flight operations which makes it easy to conduct tasks for aerial surveillance and photography (Yar 2016).

Quad-copters differ in size with weight ranging from 1 gram to 3 kilograms and can be operated by human operators or autonomously through preprogramed software with the ability to conduct tasks such as mapping and photography (Sathyamoorthy 2015, 1-2). Multicopters are used for professional purposed due to their reliability and less fault tolerances.

These systems have between six or eight rotors and can be powered with lithium-ion batteries or fuel. Multi-copters and quad-copters can be used for a magnitude of reasons such as; search and rescue (SAR), marketing, film making, surveying, parcel deliveries, imaging structurers, agriculture purposes, policing and environmental protection and conservation. (Corrigan 2018.) Figure 2 displays two outlines of a quad and multi-copter.

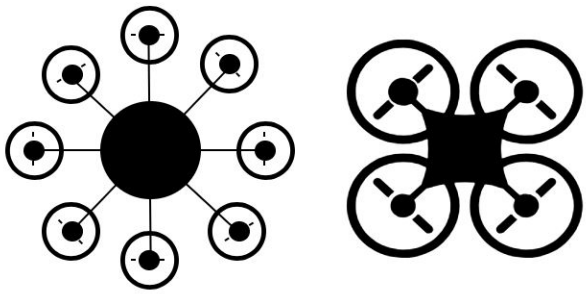

Figure 2. Outline of a multi-copter and quad-copter.

Recreational fixed winged UAS are commonly used for users who fly within a designated aerodrome with a take-off and landing strip. Many enthusiasts do not use fixed-winged UAS as they lack the ability to conduct a vertical take-off and landing (VTOL) and the process to be authorised to fly beyond visual line of sight (BVLOS) or extended visual line of sight (ELOS) is challenging. For agencies and governments who use fixed-winged UAS, they are used in desolated environments which helps collect data such as gas pipe maintenance and border protection. To maintain safety inside the UAS, detect and avoidable technology such as sensors are installed to minimise mid-air collisions. (McNabb 2018; Altavian 2018.)

Every unmanned aircraft is equipped with a control system. Control systems can be used in different approaches; remote piloting, semi-autonomous and autonomous. Remote piloting vehicles (RPV) require the operator to continuously provide input to the UAS. This communication between the remote and the UAS is through direct line of sight radio signals. This method of communication and control is commonly used with hobbyists. Semi-autonomous flights require human input such as take-off, landing and evasive manoeuvres, but, when the UAS is airborne, the pilot has the ability the apply autopilot for flight operations. Fully autonomous control requires no human input for tasks and objectives to occur. The computer-based systems within the UAS is 100% in control of flight operations and the human is monitoring. (Gupta 2013, 1648.)

Many autonomous systems need connectivity with network towers, other aircraft and even global navigation satellite systems (GNSS) (Sabatini 2017, 2) to communicate between the operator and the aircraft when flights are BVLOS. Some UAS have the ability to be

controlled from another continent, however, GNSS may have an impact on flights if SATCOM frequencies are all pre-allocated, ionosphere predictions are not analysed or if a satellite is broadcasting incorrect data. (Sabatini 2017, 5-8.)

2.3 Threats

Commercial UAVs can endanger others when an operator does not comply with a state's rules and regulations, or when they do not register their drone to breach security with the intent to cause malicious harm on others. Cases such as these have occurred where a protestor operated a UAV and flew it over a crowd to crash the device during a campaign rally in front of the German chancellor. (Gallagher 2013.) Another operator evaded radar detection systems and crashed into the compound of the White House (Shear 2015). Drone incidents such as this highlight the potential threat how an RPAS can be used if they are in the wrong hands. Mianikov (2015, 4), summarises how effective UAVs can be for terrorist operations;

- Ability to reach targets that are problematic to grasp,
- Opportunity of a wide-scaled attack to inflict maximum carnage,
- Achieve inexpensive long-range accurateness with accessible technology,
- Cost effective compared to manned aircraft and missiles,
- Achieves a mental outcome to scare people and applying pressure on politicians; and
- Covert operations can be effective when UAVs can be launched in confined spaces.

These attacks are directed towards individuals, buildings or infrastructure (Miasnikov 2015, 4). In May 2018, six suspects were arrested in Venezuela for plotting an assassination of President Nicolas Maduro by packing 1kg of explosives into a drone (APNews 2018). August 2018, a terrorist attack in the UK was uncovered where several high-powered drones were going to be flown into a flightpath of a commercial aircraft to replicate a catastrophic bird strike to potentially kill innocent passengers (Williams 2018). Terrorists can attach explosives into a UAV to neutralise targets they deem important. In 2017, a new unit called "Unmanned Aircraft of the Muijahideen" from the Islamic state fighters, launched a drone which glided over the city of Mosul. This drone then released a bomb killing soldiers in an Iraqi army outpost. This was one of many attacks that killed and wounded 39 Iraqi soldiers in a week. (Warrick 2017.)

Furthermore, operators purchase off the shelf (commercial) UAVs to monitor law enforcement to gain intelligence prior to a mission (Miasnikov 2015, 3). Some manufacturers embed geofencing software to prevent users to fly over unauthorised areas. This software is effective for basic operators or individuals who abide with the law, however, when some-

one can hack and disable the programming inside a drone, they can fly and conduct operations in secure areas and not be detected if a facility has not installed adequate security measures. (Sathyamoorthy 2015, 1,7.)

2.4 Cases of misuse

Unmanned systems have been used commonly for military operations but there has been an increased number of where public civilians use these apparatuses for social and commercial reasons due to the falling cost, availability and the functionality is accelerating the trend (Gogarty & Hagger 2011, 1). The growth of drone technology is of benefit for the State, providing operators abide by the drone regulations and safety standards. Nevertheless, there are still multiple cases of rogue drones operating in vicinities where they should not be operating therefore presenting a range of social and ethical concerns. (Financial Review 2017; ATSB 2017.)

There have been many occasions where drones have been misused globally; In the United Kingdom, a drone flew into the path of a commercial aircraft approaching their final landing at Gatwick Airport placing 130 people's lives at risk (Hughes 2018). Kolodny (2017) states unauthorised drones are continually operating over Washington D.C. military bases twice a day, where another military base in the same state detected 43 perpetrators who flew over restricted areas without authorisation. Organised crime affiliations are using drones to fly contraband such as drug and mobile phones to inmates' windows (BBC 2018).

3 Situation in Finland

Presently there are 2,943 individuals who have registered their RPAS for commercial purposes from the current 100,000 drones being used within Finnish. These unmanned aircraft are in a mass range between 500 grams and 150 kilograms. (Hohtari 04 December 2018.)

In accordance to the basic regulation 216/2008, Member States (MSs) of the European Union (EU) are to identify and resolve the issue of drone regulations, regardless of their maximum take-off mass (MTOM). All participating states objective is to build a regulatory framework that is risk performance based to maintain a high level of safety to improve privacy, data protection and security. Furthermore, every MS of the EU has the flexibility to facilitate their operational measures and risk assessments to increase the levels of safety to guarantee airspace is accessible for all users. (EASA 2017.)

This chapter will state how Trafi is presently positioned as a regulator with their current safety and security measures and finally define what procedures will be implemented when the new regulatory framework is enforced.

3.1 Trafi's role as a regulator

Trafi is Finland's traffic authority who is responsible for land, sea and air safety regulations (Trafi 2018a). Unmanned aviation division in Trafi measure and regulate issues that are involving commercial RPAS that weigh 250 grams and over. Trafi regulation OPS M1-32 is the current flying publication that applies to drone operators in Finland. The scope of the publication provides users; definitions, operation consideration, model aircraft flying and exemptions. (Trafi 2016b.) This eight-page document is a basic guideline where it does not provide an in-depth consideration of safety measures to mitigate risks when operating their devices in the air. For this reason, Trafi agreed to the Helsinki Declaration to help mitigate the present and upcoming thoughts by developing a robust framework.

3.2 Current safety and security measurers

The relationship with safety and security are used together to build and integrate an effective plan within an organisation (Source1 2018). The term safety refers to what defences can be implanted before a threat occurs (Collins 2018a). An example of this is when passengers on a commercial aircraft watch the airlines safety video if in the event of an emergency. The term security refers to what measurers are to be taken to protect a place or to ensure people with permission enter or leave an area (Collins 2018b).

Security measures are instigated by individuals with the intent to cause malicious damage. Individuals and organisations are educating themselves to be innovative when carrying out their criminal activities (Nowacki & Paszukow 2018, 187-188.) To ensure safety is maintained accordingly, regulators and organisations must have the ability to identify potential hazards and how they can be managed (Štumper & Kraus 2016, 14).

The Finnish standards of flying objective is to maintain a sound level of safety whilst reducing accidents and incidents in their airspace where it meets both the EU and international standards. Trafi Droneinfo homepage provides users instructions how to fly safely, identify where specified reserved flying reserves locations are and where flight operations are prohibited (Droneinfo 2018a).

There have been reports of individuals within the Finnish state who have had near misses between manned and unmanned aircraft, breached airspace violations and have lost control of their unmanned aircraft (Hohtari 04 December 2018). Figure 3 explains near misses as accidents, breach of airspace violation as incidents and loss of control as a serious incident.

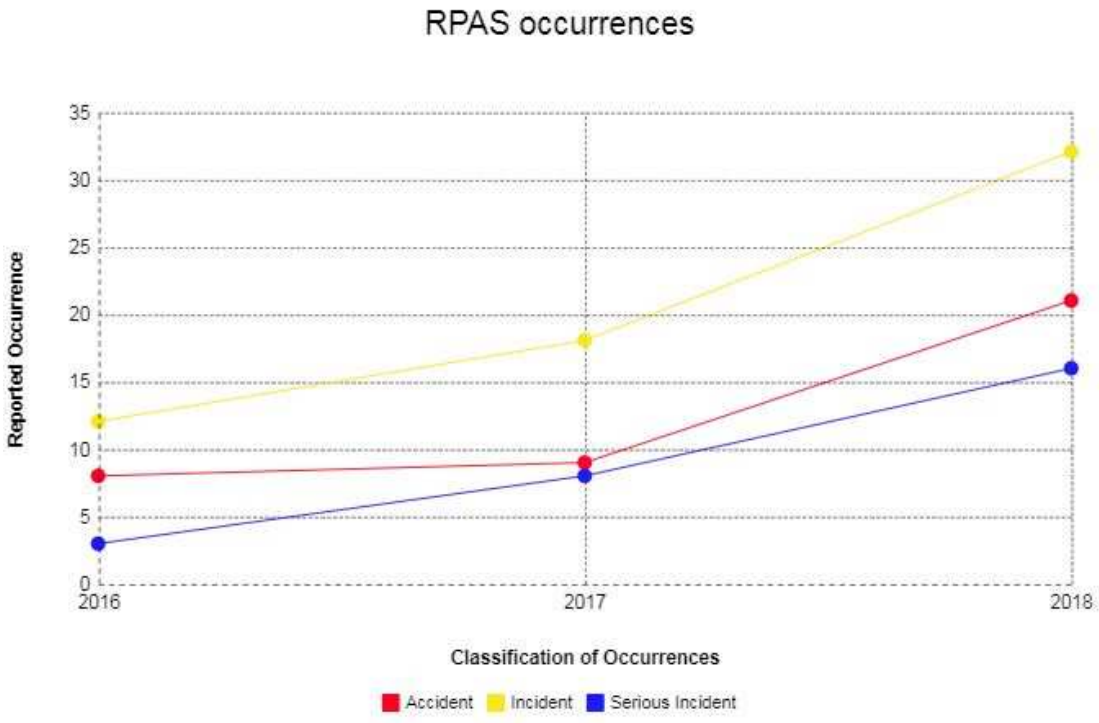

Figure 3. RPAS occurrences in the Finnish State (Hohtari 04 December 2018).

The number of accidents of incidents and serious incidents demonstrate individuals are reporting occurrences, however, Figure 4 displays that there are some operators who are

not heeding to the rules and understand it is mandatory to submit an occurrence report (Hohtari 04 December 2018).

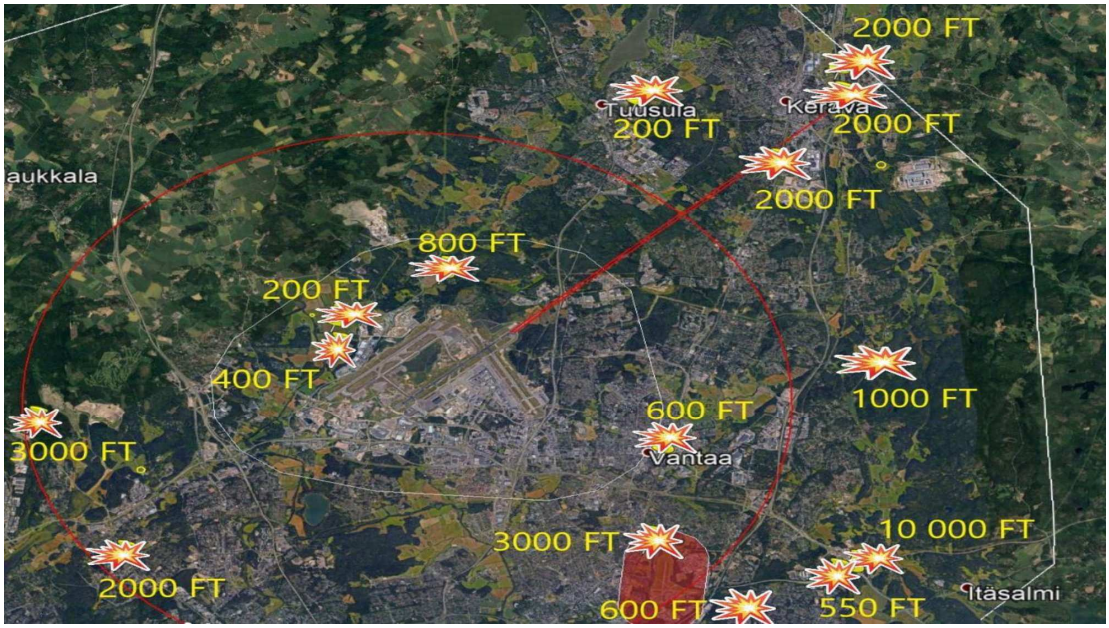

Figure 4. Incidents and near miss with reported altitude (Hohtari 04 December 2018).

The number of RPAS operators are increasing and all pilots must abide with the rules known as ABC of flying. Theses flying standards allow drone operators understand what are their limitations and what they must be aware of. The ABC rules are; the operators drone must be marked with the owners name and contact information, visual line of sight (VLOS) must be maintained at all times with flying altitude not exceeding 500 ft. AGL, flying above a crowd of people is prohibited, flying operations must not be any closer than 3 nautical miles (NM) from an airport unless the local air traffic controller (ATC) grants permission through request, RAPS flight operations must not disturb any helicopter emergency service, operators must maintain situational awareness of their surroundings when flight operations are near helipads and small airfields, drones exceeding over 3kg are not to fly above heavily populated areas; and drone operators are responsible to avoid contact with other aircraft in the local airspace. (Droneinfo 2018.)

When aerial work such as surveying or photography is being used with an unmanned aircraft, flight operations are more regulated as the risks whilst flying have increased. These identified personnel who use their RPA for commercial use must notify Trafi with the use of RPAS and update all personal details such as new aircraft or change of address, operators are to be in possession of third-party insurance in accordance with (EC) 785/2004, maintain flight logs in accordance with OPS M1-32 (3.1.9) and report any incidents to Trafi. (Trafi 2018b.)

When conducting aerial work over populated areas and crowds, flying beyond visual line of sight (BVLOS) and exemptions from maximum mass and exceeding altitude limitations there are additional requirements for operators. As these tasks are special instances, Trafi require individuals to compile risk mitigation assessments, identify emergency procedural plans, reserve airspace to maintaining operational instructions and safety assessments for a minimum three months. (Trafi 2018b.)

Within Finland's airspace, there areas known as *no drone zones* (NDZ), *prohibited*, *restricted* and *danger zones*. These zones are commonly known as a no-fly zone (NFZ) (Droneinfo 2018c). Prohibited zones are forbidden for flying within area where there are security concerns. A restricted zone is an airspace that is not active all the time and are commonly used for military purposes. Danger zones are a defined airspace where it is too dangerous to fly for air activities at specific times. (International Flight Resources 2018.)

A NFZ is a designated airspace within a territory, region or area that aircraft are not permitted to fly without authorisation. This rule is enforced for both manned and unmanned aircraft systems. (Mueller 2013, 1.) NFZ airspace restrictions can be used for purposes when international coalition come to an agreement that there is a military confliction or war (Mueller 2013, 2), if a natural disasters arise such as the eruption of Eyjafjallajökull (Scott 2010, 19), for an organisation to enhance security of personnel for airfields, military bases and prisons (Doyle 2005; AOPA 2018); or to minimise human encounters risking endangered species (Environment and heritage 2016).

NFZ in Finland are forbidden for flight operations due to the geographical locations of nuclear powerplants, government use and oil refineries. UAV pilots have the perception their devices will be repelled as their computer systems inside will not permit them to operate in these designated areas. This misinformation does confuse operators as many of their systems do not align with the states regulations. (Droneinfo 2018c.) Figure 5 illustrates the three different zones situated around Helsinki.

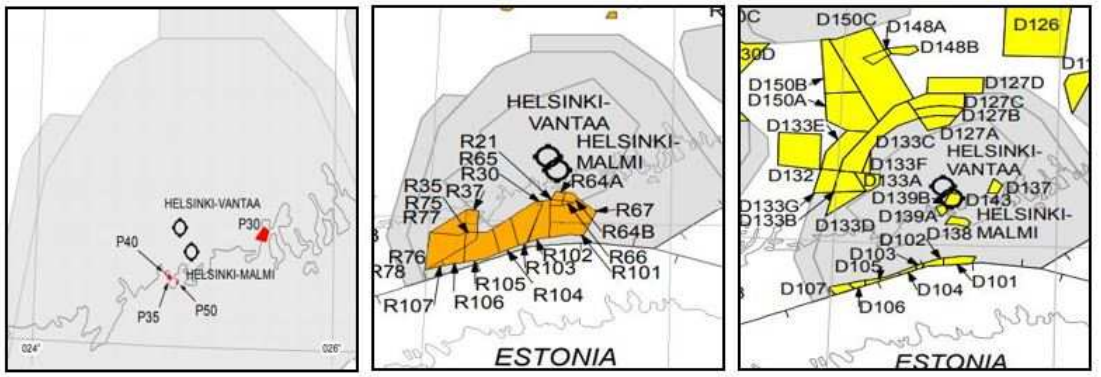

Figure 5. No Fly Zone categories around Helsinki (Droneinfo 2018c).

When flying in unfamiliar areas, some operators fail to observe risks within their surroundings. To increase awareness, visible signage such as NDZ are used to inform individuals flying operations are forbidden at designated areas. In 2017, Trafi fixed NDZ signage in English at the Senate Square in Helsinki. The signs were targeting international tourists as this audience is not familiar with the Finnish rules and policies. Ombudsman Petri Jääskeläinen recommended that Trafi take action to fix the signage to display additional texts in both Finnish and Swedish as they are in breach of the state's constitution, Language Act and the Administrative Law. Figure 6 displays NDZ signage that can be visible to inform drone operators flying is forbidden in allocated areas.

Figure 6. No-drone zone signage in Finland state (Droneinfo 2018c).

Currently there are five permanent NDZ in Helsinki metropolitan area. Helsinki Airport, Malmi Airport, Kruununhaka, Munkkiniemi and Meilahti. (Droneinfo 2018c.) Figure 7 displays where a drone cannot operate around the Helsinki Metropolitan area.

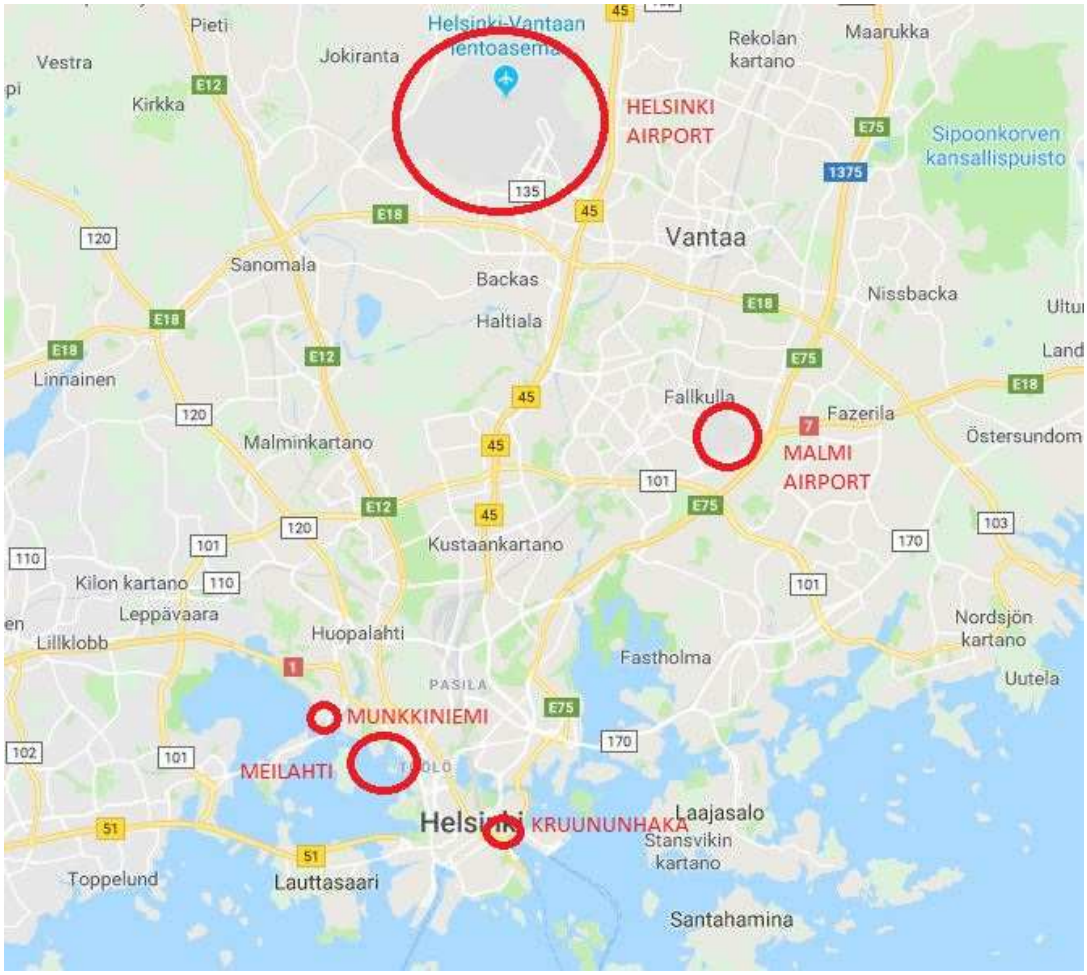

Figure 7. No Drone Zones around Helsinki.

Drone enthusiasts have the ability to download a smartphone application called *Droneinfo*. Operators can discover information relating to flight restrictions, announcement of an operator's flight, maps of prohibited locations, sourcing model airfields, the ABC of flying rules and RPA, detailed rules and regulations with flying and current weather. (Droneinfo 2018d.) Figure 8 displays what a user can observe when using Droneinfo app for flight operations.

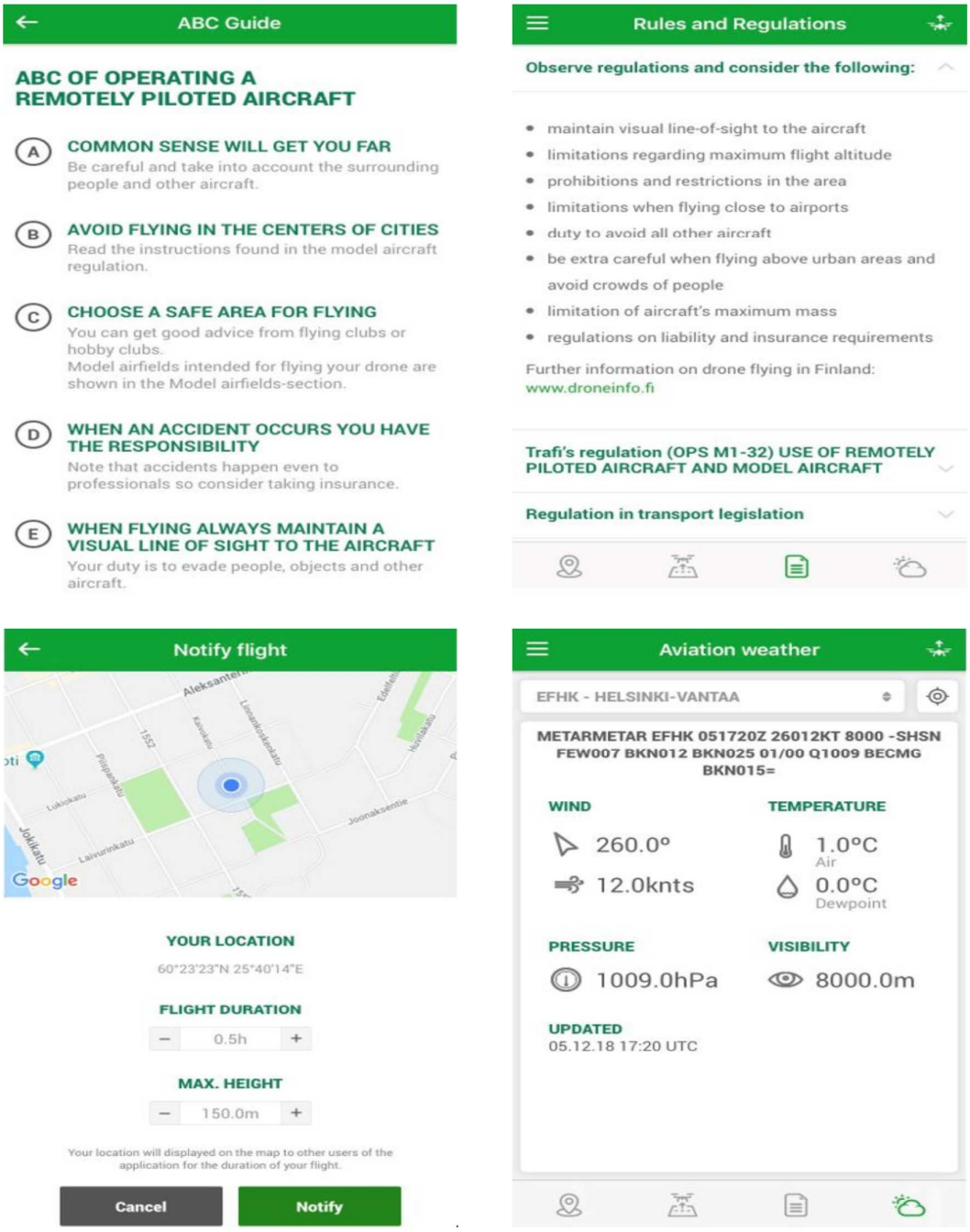

Figure 8. "Droneinfo" smartphone application (Accessed: 05 December 2018).

3.3 Regulatory framework

On 22 November 2017, Trafi signed EASA regulatory framework to deliver a suitable guideline concerning the drone market. This means further steps must be actioned transparently, in a timely manner to maintain order concerning security concerns between the EU and state authorities. EASA states that roles and responsibilities of participants involved with drone operations must have the necessary tools to protect residents with the upmost heightened of security, safety, privacy and environmental protection. EASA have requested that MS defence, safety regulators and security actors collaborate to building a standardised solution for safe and effective practices. Such solution could be preparation for autonomous drones. (Trafi 2018, 1-3.) The Helsinki Declaration can be reviewed in appendix 3.

In December 2017 a collaboration with the Council, European Commission and the European Parliament, proposed the 'Basic Regulation': The basic regulation refers to documentation: Opinion No 01/2018 *Introduction of a regulatory framework for the operation of unmanned aircraft systems in the 'open' and 'specific' categories* was enforced throughout the EU. (EASA 2018, 1.)

This basic regulation is a new regulatory framework to define what measurers must be mitigated to minimise the risk of drone operations through two categories; *open* and *specific*. Open category refers to competencies and technical requirements for a remote pilot, operational rules and limitations such as if approval to fly by the safety regulator. Specific category refers to completing a risk assessment plan when a remote operator has a license to fly with privileges where flying is prohibited. However, this framework will provide MSs some flexibility within their territories to determine where flying is prohibited or limited. (EASA 2018, 1, 5.)

The motive to modify the guidelines was that UAS development weighing less than 25 kilograms were rapidly developing compared to traditional aviation machines such as airplanes and helicopters (EASA 2018, 6). In the recent years, every EU MS have remained accountable for drone regulations that weigh less than 150 kilograms (Collins 2018). In June 2018, the Council of the EU approves EASA reform to introduce a balanced and risk mitigated plan to help the aviation sector of drones to grow. By implementing such proposal, it allows states to understand elementary principles to maintain security, privacy, data protection and environmental protection. (CEU 2018.)

> Ivaylo Moskovski, Bulgarian Minister for Transport, IT and communications states: "The rules will ensure that flying remains safe even when our skies become increasingly busy" (CEU 2018).

4 Investigate how CASA and other industries achieve safe practices

Comparisons are a valuable tool to understand similarities and differences in a different perspective. Making comparisons will allow the researcher to make decisions and exercise judgements when forming interpretations from data and ideas. (Jamieson 1999; Charmaz 2006, 54.) This chapter will review what are the current drone regulations that are enforced by CASA, to understand how operators can gather information about RPAS use and understand what are their current safety and security measures.

4.1 CASA

International Civil Aviation Organisation (ICAO) Manual on RPAS, states;

> '*The RPAS operator must comply with all requirements established by the State of the Operator regarding its operation'* (ICAO 2015).

Inside Australian territories and states, organisations and individuals must follow *The Civil Aviation Safety Regulations 1998* (CASR) which is under the *Civil Aviation Act 1998.* This regulation and act are administered by CASA to provide guidance how an organisation must manage their daily aviation operations. Furthermore, CASA have produced Advisory circular 101-10 detailing regulatory requirements (CASA 2018g).

The estimated number of drones in Australia is between 50,000 to 100,000 with a fraction of these operators having a license (Mizen 2018). When piloting laws were introduced into Australia, over 6,000 operators became registered and alerted CASA of their intent to fly commercially. 106 of these certified operators have conducted over 5,800 remote flights around Australia. (CASA 2018f.) Recreational drone users do not require to register their RPAS; however, they are required to understand rules and responsibilities of flying operations (Droneflyer 2018).

RPAS rules and regulations are planned to provide safety for people in the air or on the ground. CASA provide varying rules on condition if an operator is flying recreationally or commercially. The three categories of flying drones in Australia are; *flying for fun (recreational), aircraft under 2 kilograms (kg)* and drone over 2 kg. (CASA 2018a.)

Drone flying standards (CASA 2018b), Air Services Australia (ASA) (2018) and Federal Aviation Administration (FAA) (2018) state RPAs operators must be; within visual line of sight (VLOS), fly 100 ft. away from other people, not fly higher than 400 ft. AGL, never fly where emergency operations are occurring and flight operations must be at least 3 NM from a movement area-controlled aerodrome or helicopter landing site (HLS). If operators

wish to fly in restricted areas and over the exceeding heights, they must seek approval in advance.

Commercial drones under 2 kilograms are described as the “excluded” category. Users must apply for an Aviation reference number (CASA 2018c), submit flight route and fly within the standard operating conditions. (CASA 2018d.) For users who operate drones over 2kg, operators require; a remote pilot licence (RePL), are employed with someone who is in possession of Remote operation certificate (ReOC) and submit a flight route for authorisation. ReOC representative of an organisation agrees to CASA’s flight requirements with activities using approved RPSs. (CASA 2018e). The current state of licensed RePL, ReOC and excluded operators in Australia are;

- 7,699 personnel have a current remote pilot licence,
- 1,308 individuals are in possession of a remote operation certificate;
- 10,915 drone operators currently use commercial drones that weigh under 2kg and are authorised to operate in the ‘excluded’ category.

In 2016, 180 near misses were reported in Australia where the operator was unable to be located. Over the period of 2017, CASA received over 700 complaints from drone use and issued 21 fines for misuse. (AFR 2018.) Figure 9 reviews reported safety occurrences involving RPAs from 01 January 2016 to 8 October 2018 in Australia.

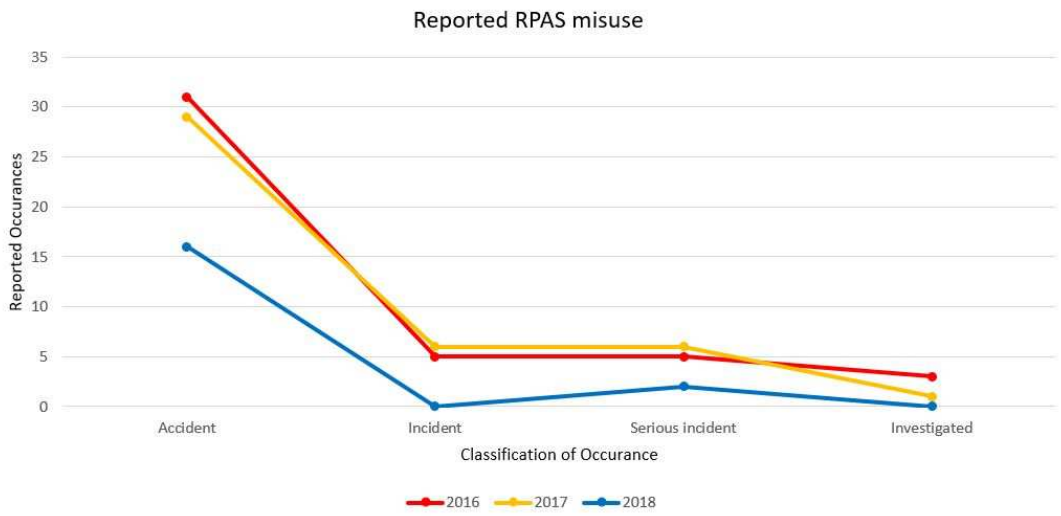

Figure 9. Safety occurrences involving RPA (ATSB 2018b, c, d).

Prior to any flight operation, pilots are provided with tools to understand what their limitations are such as temporary flight restrictions (TFRs), flying height restrictions or restricted flying areas and notice to airmen (NOTAMs) (Airservices 2018). Figure 10 displays-controlled airspace map with classifications.

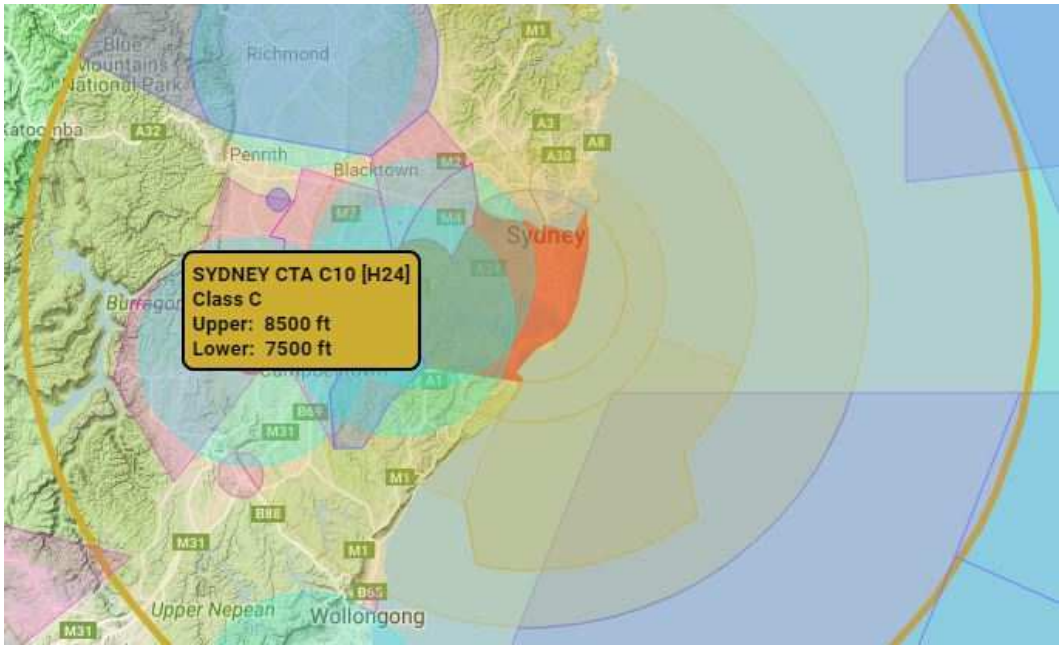

Figure 10. Flying limitations (Aircheck 2018).

Aviation regulators have discovered it can be challenging to disseminate up-to-date information. In 2017 CASA launched a safety campaign on Facebook to promote their smartphone application called “can I fly there?”. This application has been downloaded 587,638 times. This application allows a user to gain access to operating rules, maps, restrictions and other tools to maintain situational awareness. (CASA 2018f, g.) Figure 11 displays what users can observe using “Can I fly there?” application to determine if a location has flight restrictions.

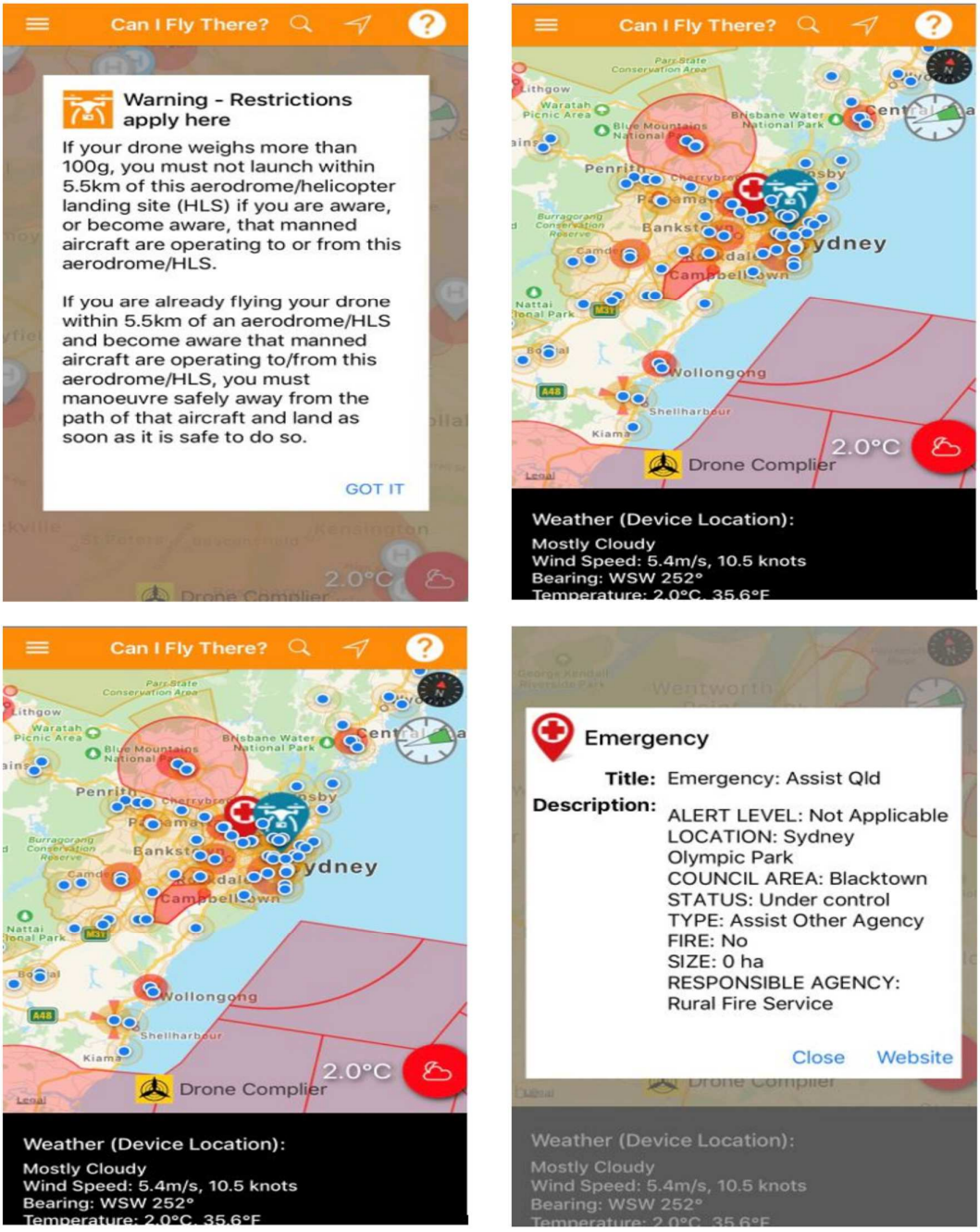

Figure 11. Can I fly there? Smartphone application (Accessed: 05 December 2018).

4.2 How authorities address hazards

The drone market is rapidly growing (Business insider 2016), and in the following years RPAS flights will be expected to surge over populated areas. Many safety risks related to RPAS flight operations are managed by multiple authorisation systems and are not harmonising safety collectively. (Wild 2016.) RPAS technology is advancing to ease pilots'

operations. Nevertheless, this makes regulatory standards challenging to address safety hazards. 56 regulators safety standards are low to average due to being reactive instead of proactive with upcoming drone technologies. When regulators lead and control the risks due to drone operations, the number of incidents and accidents will decrease. (Plioutsias 2016, 85.)

Drone safety regulations emphasise what limitations an operator must consider, without being proactive and imposing limitations directly (Plioutsias 2018, 16). Some operatives are confident their automatic systems in their UAV will prevent them from flying too close or into prohibited areas. National regulations differ to one another; in France, safety authorities require manufacturers install software such as geofencing to maintain flight safety, where Germany authorities ask operators to “respect special no-fly zones and special restrictions”. (Jones Day 2017.) Organisations must abide by safety regulations within their own state, however, some organisations may face challenges of their own and must tighten security within their own area of expertise. Two industries that will be discussed and how they countermeasure UAV breaches of security and safety are airports and prisons.

Aviation safety authorities and police departments receive reports stating RPAS operations are flying too close to airports, airplanes and helicopters without prior permission (Campion-Smith 2016). Security breaches and collisions are of concern (Plioutsias 2018, 3), if a drone was in the path of an aircraft, it could risk lives in the air and on the ground if a drone struck; engines, tailplane, rotors, windscreen, undercarriage and flying control surfaces (CAA 2018). London Southend Airport are trialling Skyperion anti-drone product through their Air Traffic Control (ATC). This counter measure is a blend of optical sensors and radio frequencies (RF) to spot UAV movements around their airspace. (Corfield 2018.)

For security authorities in a prison to distinguish between friend or foe of aircraft and drones in their airspace, monitoring systems must be imbedded to maintain security. Aircraft and drones have individual signals that can be detected by radio frequency or be seen by video cameras. When a rogue drone is detected, the prison can locate the operating pilot whilst emitting a light at the RPAS camera to avoid unauthorised footage being leaked. (Keating 2017.)

Les Nicolles prison in Guernsey is fighting against contraband smuggling such as cell phones, drugs into their prison. By using countermeasures such as RF jammers to stop operators flying their drone and jams global positioning systems (GPS) frequencies that let drones fly autonomously. When the countermeasures commence, it disturbs the control between operator and drone. The drone then returns to its position where it had signal with the operator. (Doctorow 2018.) Anti-drone technology such as *Sky Fence*, produces a

600-metre barrier around and over a prison in order to detect illegal drones and deflect them away from their secure area (Rubens 2018).

4.3 Consideration to manage risks

Organisations are under immense pressure to transform as their environment and surroundings are evolving. Regulators stipulate how processors and procedures are to be managed. Management must determine how to pursue this with current processors through *flexibility, responsiveness, adaptability* and adding *value* for their organisation. (Dervitsiotis 1998, 34.)

Risk management tools emphasise the importance of embedding risk management practices within an organisation to focus on what improvements and impacts may surface and how they must be challenged. By creating a more rigorous decision-making plan, the better the organisation can identify opportunities and threats. By building an effective risk management tool, it improves the ability to comply with safety compliances and improve incident management by reducing risks. Figure 12 illustrates how an organisation can identify potential risks and how risks can be managed.

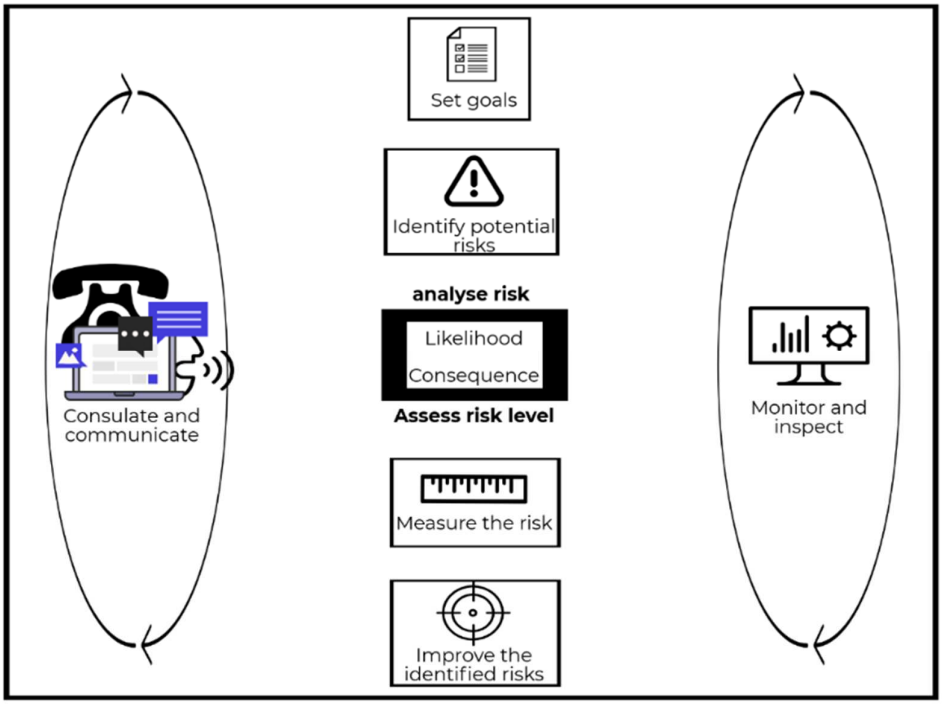

Figure 12. Risk management process (Flouris & Kucuk Yilmaz 2011).

Organisations must track what new innovations can be implemented to enhance the current operational threat. By identifying when their impact of operations and growth is outdated, they must determine what new advanced technologies can enhance their surrounding environment. (Deloette 2012, 3-5.)

Organisations must provide a holistic approach for sustainability. Successful driver methods address political, operative, cooperative and governing requirements. By integrating philosophy and cultural context, it assists in building sustainable developments. Balancing risk and opportunity will allow an organisation to build innovation through emerging trends of technology and developing regulatory requirements. (Flouris & Kucuk Yilmaz 2011, 59-61.)

5 Research methodology

Creswell (2009, 4-5) and Silverman (2010, 122-125), explains the distinction between qualitative and quantitative research; Qualitative research discovers and recognises meaning of an individual or group attributes to a social or human dilemma. The process of collecting data is identifying; emerging queries, procedures and data gathering. Qualitative research reports typically are structured, but can be flexible. Whereas quantitative research analyses theories objectively by exploring the relationship between variables. The variables are then measured so data can be analysed through statistical measures. The structure of the report is fixed which must relate to the introduction. Researches who utilise Quantitative research method engages assumptions by testing theories in a non-bias environment to regulate alternative explanations to replicate the findings. Table 1 explains the differences in the two research methods.

Table 1. Quantitative and qualitative methods (Creswell 2009, 15).

Quantitative Method	Qualitative Method
Pre-determined	Emerging methods
Instrument based questions	Open-ended questions
Performance / attitude / observational and census data	Interview / observation / document / audio-visual data
Statistical analysis	Text and image analysis
Statistical interpretation	Themes, patterns interpretation

The research method chosen for this thesis will be conducted through a qualitative approach. By applying the theoretical framework into the research approach, it allows the researcher to evaluate the current threats and security measures and how they can apply these principles in their regulatory framework accordingly. Research techniques selected for this research includes content analysis related to air safety and interviews to define the current measures of safety.

In this chapter the researcher will discuss how the research method will be conducted, identify how obstacles will be overcome, clarify the need to use reliable and valid resources, state how interviews will be conducted, and outline how data collection and analysis will shape the research aim.

5.1 Qualitative research

Qualitative research data often concerns the understanding of an in-depth analysis that can provide a greater insight of the subject rather than gaining a broad and generalised scope. When developing measurement instruments such as the questionnaire, it would be useful to understand past and current data such as accident and incident rates to prioritise questions within the questionnaire. (Boddy 2016, 430-431.) Marshall & Rossman (2006, 10-11) states when analysing data through qualitative research, challenges may surface with quality through

- creating a conceptual framework that is in-depth, succinct, and well-designed
- developing a strategy which is methodical, feasible and malleable
- Ability to consolidate the chapters to provide a clear report to persuade readers

Data will be gathered through; Australian and Finnish flying standards, professional opinions through academic articles, subject matter experts, regulatory websites and interviews. Interviews will be a primary source to gather qualitative data whereas standards and peer reviews will act as secondary data.

Prior to commencing research, it is essential that clarity is defined for the readers to discover the purpose. *Inductive* reasoning helps this process by identifying the emerging conclusion through data collection and combines new data with existing theories. (Berg 2001, 199-200.) By identifying something of interest and remaining focused with the subject, it allows the report to remain concise and reach an in-depth explanation to the problem (Keller 2014).

Data collection methods are the core of the research enquiry and must be used for gathering data. The four primary qualitative methods to gather data are; observation, participant observation, in-depth interviewing, background and context and review of documents. (Marshall & Rossman 2006, 97-98.)

Drawbacks and glitches can occur when transcribing data collection. Drawbacks such as transcription errors can change what the subject said in their interview. The misinterpretation of jargon, slang, words and phrases can impact transcription error. The researcher must transcribe as soon as possible after interviews to ensure it is error free as possible. Glitches such as equipment failure with recorders stops working as the batteries die can be an issue to computer malfunction. It is suggested to ensure all equipment is serviceable and the researcher must be prepared to have an alternative plan if dilemmas arise. (Marshall & Rossman 2006, 110-113.) Transcriptions must be applied into written documentation and it is advised the researcher capturers; speed, tone, timing and pauses. This process can take time and can be difficult to write but it is preferable that the researcher performs this procedure. (Bailey 2008, 129.)

A key process with qualitative research is deciding on a research design. By shaping the study in social research with questions, assumptions, limitations, data collection and data analysis process. The overall achievement is to describe a phenomenon. (Creswell 2009, 15-16.) Qualitative research requires a thorough data collection process to examine subjects' behaviours. This allows the researcher to understand processes, motivations and actions rather than collecting quantified data. (Goodson & Phillimore, 2004, 3.)

Furthermore, practical implications such as ethical aspects must be taken into consideration to protect subjects' identities. Subjects participation of the study must be confidential and informed verbally and in writing before the case commences that participation is voluntary and have the ability to withdraw at any stage. (Bengtsson 2010, 10.) Figure 13 illustrates processors for a qualitative planning framework.

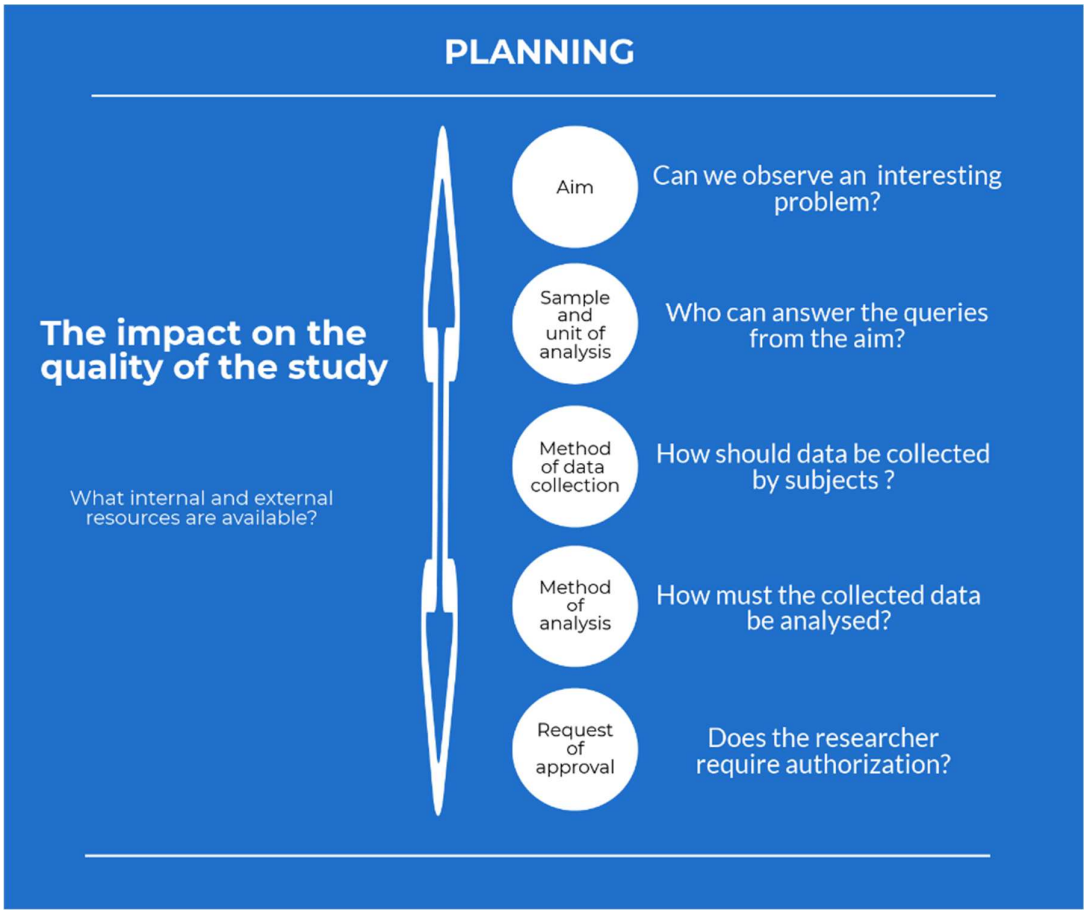

Figure 13. Process of qualitative planning (Bengtsson 2010, 9).

5.2 Confidentiality

When researching areas of interest that involve human participants, confidentiality is the responsibility of the researcher. This assurance to participants allows individuals to discuss and share their personal thoughts in a safe environment without jeopardising scrutiny or identity. (Van Den Hoonaard 2014, 94-95; Ummel 2016, 807-808.)

Confidentially will be adhered to through a confidentiality agreement which can be found in appendix 4. Furthermore, to maintain personnel's identities with the interview transcripts, they will be named subject 1, subject 2 and so on.

5.3 Reliability and validity

By examining several online resources such as; academic articles, case studies and literature, it allows the researcher to gather awareness of the current situation (Malhotra (2012. 73). Up-to-date real-time data is readily accessible online to understand current trends and determine where a focal point is situated. Nonetheless, researches must be cautions of unreliable data, as it can be of hinder the overall research purpose. To minimise the use of unreliable resources, the researcher will gather data through;

- HH Finna: to gain access to journals, academic articles and loan textbooks from professional authors
- National and international regulator websites such as CASA, EASA, FAA or Trafi
- Media such as The Australian, The Washington Post or Yle
- Subject matter expert websites

5.4 Interviews

Bengtsson (2016, 10) explains there is no outline or standard with the size of subjects or objects used with content analysis as long as the key issue of the aim is achieved by the study. Maylor & Blackmon (2005, 183), and Silverman (2005, 154-158) discuss that the common technique to gather research is through open question interviews.

Qualitative questions are open-ended where the participant responses are perceived to discuss in their own natural words (Griffee 2005). The researcher must determine if structured, semi structured or unstructured interviews will be used through qualitative interviews.

Structured interviews discuss the same questions in orderly fashioned by using the same wording for every question to all participants (Corbena 2003). The strengths of structured interviews are that the researcher can control the questions and issues, thus making it easier to review data that has been gathered. The limitations to structured interviews are that the structure is not flexible and the schedule must be followed. (McLeod 2014.)

Semi-structured interviews are used to clarify personal experiences from a participant to provide more specified insights to build on the research. Open questions are used to provide a deeper and descriptive analysis of the situation. The researcher must determine what questions can be used to probe to gather as much information as possible that relate to the topic of interest. (Bernard 2000 32; RECOUP 2008.)

Unstructured interviews are flexible compared to structured interviews as the interview can deviate in the interview depending on the participants answer. This allows a participant to respond in more depth and provides real characteristics to the researcher to understand the current situation. Furthermore, it increases validity to clarify answers and move towards the direction the researcher wishes to move. The limitations from unstructured interviews are they are time consuming to analyse the data and if the interviewer does not have the adequate skills to know when to probe an area of discussion, the researcher may not find true meaning. (McLeod 2014.)

Whilst conducting interviews, the researcher allows the interviewee to discuss topics openly. Interviewees must be informed that ethical and confidentiality of their participation is assured. Throughout the interview, the researcher must consider of an appropriate interview setting, remember to record the interview and physically taking notes where needed. (Hackley 2003, 77.)

The researcher will conduct structured interviews to control the interview whilst having the ability to observe the subject's behaviour over a period of time and gain insights of the subject's opinion. Interviewing questions should take no longer than 10 minutes with each participant. After interviewing the participants, the researcher can then identify similarities and differences between participants to confirm how they believe their safety practices are being delivered to personnel in the Finnish state.

5.5 Data collection and analysis

Data analysis operates concurrently when data gathering, compiling reports and making interpretations. By gathering raw data from field notes or transcripts, it allows the researches to decipher data of similarities and indifferences to find themes. By validating data and information accuracy the researcher will have the ability to find meaning of the aim. (Creswell 2009, 183-185.)

The researcher must be vigilant that the questionnaire is formulated well to find meaning of the studied topic. Researchers cannot be guaranteed their method can capture the actual situation from the interviewees as their interpretation of questions may not relate to the researchers view and aim. Furthermore, additional misrepresentations may rise when subjects do not; give their own personal throughs and opinions, the interviewee provides

inaccurate or untrue data or providing answers they believe the researcher wishes to hear. (Bengtsson 2016, 10-11.)

The researcher aims to find what current safety methods and tools Trafi is using to disseminate relevant safety material for unmanned aircraft flight operators. By doing this, the researcher can compare similarities and discrepancies with CASA in their current safety measures. By doing this, the researcher may find suitable and feasible solutions to enhance their safety awareness for flight operations.

5.6 Identifying similarities and differences

By using a constant comparative method, the researcher will begin to create comparisons at different levels of analytic work. It is advised to compare data at the commencement of starting research and after the completion of interviews. Furthermore, it is advised to avoid assumptions prior to meeting respondents, instead it is ideal to observe how the interviewee understands the current situation. By doing this, it minimises the bias attitude by judging a person's actions and attitude through the pre-assumptions. By having an open mind and observing their pains through their eyes, it allows the researcher to recognise their experiences therefore, allowing to view new insights of interpretation. (Charmaz 2006, 54, 100.)

By interacting within the fields of study it allows the researcher to understand the current situation, assess what is occurring in them to define meaning to apply actions (Charmaz 2006, 179). Within a business environment, identifying key findings from the study is essential for them to understand what contributing factors are having an effect within their realm with an explanation as to why (Gray 2009, 270-272).

This process will be conducted as a point-to-point pattern approach to compare how Trafi and other industries in chapter 4, conduct their operations to maintain consistency and order.

6 Results

Results of the observations and findings must be measured and explained whether the aim of the report was met. The findings are based on the theoretical framework analysis including information from the interviews.

From reviewing SMS, comparing theoretical framework data of the two state regulators and identifying how other industries address RPAS hazards, it verifies how they communicate safety practices to UAS operators. These comparisons will be identified in three categories; 1. Situation of current drone misuse, 2. Safety and security measures, and 3. Regulatory notification.

On 09 November 2018, the researcher conducted the interviews with two members of the Trafi drone department in Helsinki. The interviews were made structurally and were transcribed on the same day of the interview. After assembling the data, the researcher was able to identify similarities and differences from the two members of Trafi drone department. Furthermore, the researcher was provided with additional information of the current RPAS situation in the Finnish state, however this was presented directly after the interview and it was not recorded.

6.1 Comparisons with regulators

Prior to reviewing the data in depth, it is beneficial to illustrate the differences between Australia and Finland. Information such as landmass, average daily take-off and landings at main airports regulation data and occurrences will provide the reader a better understanding that these two states are different, however have challenges of their own to face. Figure 13 illustrates a brief overview of Australia and Finland.

	Finland	Australia
General		
Land-mass	338,424 km2	7,686,850 km2
Population	5,400,000	+23,000,000
Common Languages	Finnish, Swedish, Sami (English. Russian)	English (Cantonese, Mandarin, Italian, Greek, Arabic)
Source	Waltner 2018	Study in Australia 2018
Main Airport flight operations		
Average aircraft take-off & landing per day	211 at Helsinki Airport	949 at Sydney Airport
Source	Finavia 2018	Airservices 2018a
Regulator data		
Drone safety regulator	Trafi	CASA
Established	3 years	2002
Estimated number of drones	Est. 100,000	50,000 – 100,000
Registered drone operators	2,300	Over 6,000
Individuals with remote pilot license (RPL)		7,699
Individuals with remote operation certificate (ReOC)		1,308
Operators that use drones in 'excluded' category	Approval on request	10,915
Source	Hohtari 04 December 2018	Mizen 2018; Droneflyer 2018; CASA 2018e, f
Smartphone application		
Name of application	Droneinfo	Can I fly there?
Downloaded times	10,000	587,638
Source	Droneinfo 2018d	CASA 2018f, g
Reported RPAS misuse 2014 - 2018		
Accident	43	103
Incident	71	24
Serious incident	28	17
Investigated	Unknown	6
Injuries from occurrences	Unknown	0
Source	Hohtari 04 December 2018	ATSB 2018e
Reported RPAS misuse 2018		
Accident	21	26
Incident	32	5
Serious incident	16	2
Investigated	Unknown	0
Injuries from occurrences	Unknown	0
Source	Hohtari 04 December 2018	ATSB 2018a

Figure 13. Assessment of Finland and Australia.

Reviewing data from Trafi, we can observe that there has been an increase of aviation accidents, incidents and near misses, but we cannot identify what aircraft variants are causing the increase of these events. Some pilots have stated they have witnessed UAS operating over 6,000 ft. AGL, 7,500 ft. higher than the regulated flying height. CASAs current data distinguishes there has been a decline of issues relating to UAS safety since 2016. Furthermore, both states have identified that there have been many cases that have not been reported due to UAS misuse, however they cannot identify these operators due to the devices not being registered. The situation in both states is that operators are beginning to understand they must report incidents. Figure 14 illustrates the comparison of drone misuse in Australia and Finland.

Situation of drone misuse	Trafi	CASA	Comments
Increase / decrease of accidents	Increase	Decrease	Trafi – Regulators are unsure of the situation as aviation accidents are collected collectively with manned aircraft (fixed and rotary). Regulators believe increase of accidents are caused by UAS operations CASA – deceleration in 2018 as operators are being provided tools with smartphone application
Increase / decrease of incidents	Increase	Decrease	Trafi – Regulators are unsure of the situation as aviation incidents are collected collectively with manned aircraft (fixed and rotary). Regulators believe increase of incidents are caused by UAS operations CASA – deceleration in 2018 as operators are being provided tools with smartphone application
Increase / decrease of serious incidents / near misses	Increase	Decrease	Trafi – Regulators are unsure of the situation as aviation incidents and near misses are collected collectively with manned aircraft (fixed and rotary). Regulators believe increase of serious incidents / near misses are caused by UAS operations. Some of these cases regulators are unsure of accuracy of spotting's as pilots mid-air state UAS operations are over 6,000 ft. AGL where others in the same vicinity spotted balloons CASA – deceleration in 2018 as operators are being provided tools with smartphone application
Increase / decrease of investigated serious incidents	-	Decrease	Trafi – no serious accidents have been investigated CASA – drone operators are using application to find NOTAMs and other flight condition considerations
Number of registered commercial operators	2,300	Over 6,000	

Figure 14. Drone use comparison.

Both Trafi and CASA provide clear instructions and illustrations of how an operator may fly in accordance to their state's rules and regulations on their homepage websites.

Trafi Droneinfo homepage is challenging for new drone enthusiasts as there is no direct link for a user to follow. However, when a user finds Droneinfo homepage, a user is provided with clear illustrations of flying safely, flying and non-flying areas. CASA's drone homepage allows a user to identify and determine what type of flying they wish to conduct with detailed information such as if a user wishes to fly commercially with an unmanned aircraft weighing under two kilograms. If users wish to understand drone flying standards

more, or if they wish to become a registered drone operator, a user has the ability to find this information with an attached link.

Trafi are unclear as to how many RPAs and users are within the Finnish state. Trafi has observed their smartphone application has been downloaded on Apple App store over 10,000 times, but they are unaware how many individuals have downloaded their app for android through Google Play store. Trafi smartphone application requires more safety features such as NOTAMS. NOTAMS do change at short notice and it is of interest for an operator to be situationally aware at all times. Figure 15 displays the current safety and security measures a drone operator has available through their homepages and smartphone applications.

Current safety and security measurers	Trafi	CASA	
Provide individuals clear safety standards online	YES	YES	Trafi – ABC rules and guidelines are written clearly and provide clear illustrations of how an operator must fly accordingly. Aerial work guidelines are defined well if an operator must fly outside of the basic flying regulations such as operating BVLOS and flying over populated areas CASA – Recreational operators are provided clear instructions and illustrations of how to operate their drones. Operators who fly within the excluded and commercial categories are provided adequate resources and references of what is required for their purposes
Standards and tools are easy to identify online?	YES	YES	Trafi – Trafi website is challenging to find resources if a user is searching for information in English. Finnish and Swedish operators can source standards easier. All tools are identifiable on Droneinfo homepage links. Trafi website does not provide a user real-time data such as NOTAMs, temporary flight restrictions or where an operator can report unsafe activities from other pilots CASA – Website has a tab which relates to drone operations with all tools necessary for an operator.
Are safety tools for flight operations readily available on smartphone applications?	YES	SOMEWHAT	Trafi –Trafi smartphone applications does not provide a user real-time data such as NOTAMs, temporary flight restrictions or where an operator can report unsafe activities from other pilots. New flight standards are not easily identified from the smartphone application. Smartphone application has been downloaded over 10,000 times. The application has information for operators such as; flight paths, model airfield locations, rules and regulations, weather forecast, ABC guide and flight notifications CASA – Tools are not in one centralised location online. Sourcing all tools may be challenging for some operators to find. Smartphone application has been downloaded 587,638 times. The application has the following information; rules, flight log, 7-day weather forecast, glossary, terms and conditions and information regarding drones for fun, commercial sub 2kg and sub 2kg notification form. Flight locations detail if an operator can fly in areas if NOTAMS, limitations and temporary flight restrictions are enforced.
Are safety tools mandatory?	YES	YES	Trafi – Required for aerial work CASA – For 'excluded category' (commercial operations under 2kg) and for drones over 2kg
Are operators able to find standards and flying tools through smartphone applications?	YES	YES	
Signs of No-Drone zones	Yes	Yes	Trafi – Clear and visible display of signs around area of no-fly zones CASA – Displays posters and clear signs around heavily populated areas.

Figure 15. Safety and security measurers comparisons.

The current situation with Trafi notifying operators with safety updates is that only registered operators are provided the information. If other users wish to be provided such information, they must request emails or review rules and guidelines. CASA provide their information through their social media pages and website. Neither on of the safety regulators provide any safety updates on the smartphone applications. Figure 16 display how CASA and Trafi notify their targeted audience

Notifications of regulatory updates	Trafi	CASA	
Do registered operators get updates with updated SFIs?	YES	YES	Trafi - Email CASA - Email
When new standards and procedures change, how are non-registered operators notified?			Trafi – non-registered operators must visit Droneinfo and read regulations. Website does not provide newsletter links of changes CASA – Paid social media, homepage website. CASA homepage website provides newsletter links of these changes
How do operators' source new changes with standards	SFI	FB / homepage	Trafi – User must review flying standards to understand changes concerning flight rules and regulations CASA – CASA drone homepage, newsfeeds and social media (FB)

Figure 16. Notification and updates comparisons.

6.2 Interviews

The interview will discover if members of the Trafi drone department believe their current safety and security regulation measures are sufficient with the high influx of drone operators. This will be examined through recognising if unmanned aircraft pilots have the knowledge of flying safely and if they are aware of where they can obtain information to fly in accordance to flight regulations. Furthermore, the section will determine if there are any tools or devices to minimise drone misuse such as operators flying in restricted areas.

Prior to reviewing the interviews, the researcher assembled figure 17 for the reader to identify how the researcher prepared process prior, during and post interview session.

	Subject A	Subject B	
Did the Researcher understand the situation of the research prior to interviews?	N/A	N/A	Researcher has familiarised himself with the concepts regarding Trafi hinderances in conjunction with the user's misuse of drones and not adhering with rules, regulations and procedures.
Date and location of Interviews			09 November 2018 Trafi Helsinki Meeting confirmed 26 October 2018
Were interviews conducted face-to-face or through other means?	Face-to-face	Face-to-face	Interviews conducted in Trafi Helsinki briefing room
Interview questions open-ended and allowed subjects to discuss questions at their own free will?	yes	yes	Interview questions were open ended and structured. Questions allowed the participants to discuss the topic of interest freely The qualitative interview allowed the researcher to gather intelligence and personal views from the two representatives from Trafi
Were interviews recorded?	yes	yes	Digital voice recorder loaned through H-H Porvoo library Interviews were recorded.
Accuracy of transcribing of interviews			The researcher reviewed the recorded interview to ensure the transcripts are 100% accurate to the digital recording. Whilst transcribing data, researcher amended participants names to subject 'A' or 'B'.
Digital recordings of interviews deleted after compiling transcripts?	Yes	Yes	All digital evidence was destroyed.

Figure 17. Researchers preparation prior, during and post interviews

The interviewees recognise the fact that there have currently been no accidents is a success however, both interviewees agree that there has been an alarming number of incidents occurring in the Finnish state within the three years of regulatory standards in Finland. Both subject A and B have observed that pilots are gradually understanding the importance of submitting reports of misuse, however there has been individuals who still continue to not fly in accordance to flying standards.

> Subject A states: *'notifications of someone flying where they are not permitted is rising… we are happy about operator's incident reports but arh… if a commercial airline goes down because of a drone operating where they are not supposed to, its worrying…'*

This statement is demonstrating that not all operators are flying in compliance with safe flying standards. Both interviewed members are concerned of the quantity of near misses with manned aircraft whilst airborne. Trafi did not state if they have personally researched,

benchmarked or compared themselves with other drone safety regulators as they are waiting for further guidance from EASA.

Both subject A and B believe not all operators are using the application pre-flight and during flight operations. The subjects believe professional drone users are using the application more than recreational users.

> Subject A stated: '*I met some older traditional air model hobbyist, and, umm, he did not know of this regulation'*.
>
> Subject B stated: '*The regulation is quite new, its about three years old and it has not really been established yet. People don't understand its like a car regulation which has been around forever'*.

Reviewing both subject A and B responses, professionals are more observant and aware of the Droneinfo application and there was no evident answer of how many recreational operators are aware or are using Droneinfo application. Furthermore, subject A and B have also observed that some recreational UAS enthusiasts do not process the knowledge of the state's regulations.

Both subjects have taken the initiative to communicate with retail shops that sell drones, to ensure operators are provided with information of where to obtain flying safety rules.

> Subject B stated: *'giving out more information with leaflets in shops who are selling drones putting a little more responsibility on the shops… Then people will know what to do and how to do it.'*

Delivering educational UAS leaflets to retailers who sell drones provides information for UAS enthusiasts. They understand there is a website and smartphone application to get detailed flight operation instructions. Not all UAS operators will abide with the current rules and regulations.

> Subject A stated: *'They are small, easy to build, fast and have them deliver the nasty package and it's very difficult to stop it.'*

Both subjects believe the misuse of drone will continue if someone has a motive. If an individual or group wish to cause harm and or malicious damage, they will find a way to achieve this. The observation of if militaries are having difficulty to stop drones from infil-

trating NFZ, the civilian state will continue to be challenged with this if anti drone technologies are not effective. Many Finnish government agencies have requested assistance from Trafi. It became evident that Trafi as a regulator are waiting for the new regulation to be enforced by the European council.

6.3 Summary

By reaching out to professionals within their field of expertise it offers a stronger understanding how they react to the current threats and issues they are challenged with. Trafi is conducting its duties and tasks outlined and in accordance from EASA. These observations illustrate there is neglect on all UAS enthusiasts as they must understand flying regulations when operating their unmanned aircraft. Finally, if negligence continues from every party involved, Trafi will continue to observe increases of incidents and a possibility of air collisions causing a catastrophic occurrence.

7 Recommended solutions

The study was to determine how Trafi can provide users with adequate tools to improve awareness for flight operations. After reviewing all the results and theories about UAV operations the researcher has extracted three main areas of recommendations for Trafi. Recommended solutions will be addressed through; fix tabulated data, smartphone applications and safety awareness categories.

7.1 Tabulated data

As stated earlier, the researcher was unable to gain statistical information concerning UAS safety issues from Trafi as all aviation air related issues are collectively shown. It would be beneficial to categorise different aircraft variants to differentiate risks between manned and unmanned aircraft. This would benefit both operators and regulators to gain a better situational awareness of current and up to date flight operation risks. Also, by monitoring statistics, regulators such as Trafi, would gain a clearer picture of where the highest risks lie and find a feasible solution to fix these areas.

7.2 Improve smartphone application

Many individuals are using the current smartphone application and it would be of benefit to have all critical flying information. It is difficult for Finnish operators to determine if there are NOTAMS or temporary flight restrictions that are enforced. Currently if a member wishes to gain this data, they must source this from Air Navigation Services in Finland. By delivering this vital flying information, it allows a user to confirm the whereabouts of other flying operations within their vicinity of flying operations.

To ensure all users understand the changes of flight regulations, Trafi should consider to provide a newsfeed and notification toolbar on the smartphone. This allows users to be provided with up-to-date information when a change occurs. Furthermore, if users wish to be provided additional information, individuals should have the ability to sign up for emails through the application. By doing this, it demonstrates that the smartphone application can address issues and concerns relating to an individual's difficulty in gaining a deeper insight with the changes of flight standards.

Another improvement could be to allow users of the application to notify any issues such as accidents or near misses through the application with ease. Reporting should be made easy with a low barrier to ensure as many issues as possible will be reported.

7.3 Promote awareness

Some air and ground accidents will occur regardless of an individual's skills, but if Trafi can further brand their safety awareness through different approaches, individuals will recognise how to fly accordingly and safely.

As previously stated, some enthusiasts are unaware of the smartphone application and flight imitations for UAS. Currently, Trafi ensures retailers provide information pamphlets to an individual who purchases these aircraft for recreational and commercial use. To increase further awareness, it could be beneficial to apply stickers onto the UAS box as some users may lose the pamphlet. This simple yet affective approach may allow an operator to understand that flying is like driving a vehicle as there are rules. By doing this, it will help Trafi increase safety awareness.

Another approach would be advertising on social media through Ad campaigns. Paid media may seem unnecessary. However, Trafi as a regulator will have a higher reach to find their customers. As stated previously, when CASA conducted a similar campaign to promote safety and their application, over 580,000 people downloaded the application. This process will assist Trafi when their new framework is active and they need to reach out to their customers.

After liaising with the interviewees of Trafi, not all UAS users have social media. These individuals somehow might be a member of a model club. It is suggested to source all model club emails to disseminate newsletters with updates relating to UAS risks, misuse and upcoming changes. By doing this, it demonstrates to these individuals that safety regulators are approachable and they have the ability to help Trafi disseminate this information to personnel who may not understand that there are regulations or if there have been changes to flying operations.

8 Conclusion

Key figures show that purchases of commercial unmanned aircraft are growing on a global level (Ludwig 2018, 1-2). As the development and technology of drone's advances, a number of different industries are able to take advantage of this to conduct their duties more accurately, faster and safer (Feist, 2018). However, some operators are not flying in accordance to legislations and standards. Figure 2 validates this last statement, the Finnish state is observing a rapid increase of incidents, and both subjects from the interview believe incidents will not decline for some time.

The purpose of the report was to examine how Trafi can communicate safety to individuals within the Finnish state to mitigate the overall risks associated with unmanned aircraft mid-flight or on the ground.

Trafi's objective is difficult. They must maintain safety and security under the direction of the international, EU and state regulatory standards (Droneinfo 2018a). For an organisation who has only been active for three years, it is difficult to collect data and statistics that could possibly aid them to develop their rules to address these issues more efficiently.

The primary recommendations for Trafi is to improve their current smartphone application to provide real-time information followed by providing clear tabulated data with occurrences where a drone has been involved. Allowing users to submit flight paths and identify their current flying operations with their app, it allows ATC, manned and unmanned pilots to be notified of unexpected flight operations within their vicinity. By breaking down accidents and incidents with aircraft variants such as manned rotary wing, manned fixed wing or RPA, it allows regulators to understand the complex events to rectify them accordingly.

Suggestions for future research would be to gain deeper and more detailed knowledge of actual statistics regarding drone misuse in Finland. This would aid Trafi even further in the pursuit of finding the most efficient way of developing their communication and implementation methods for new safety standards and regulations. It would also be of interest to compare how other state regulators outside of the EU structure themselves as some of these regulators have extensive knowledge that can assist Trafi to address communication discrepancies between regulator and operators.

Figure 16 identifies three alternative categories that a researcher could discover meaning with current, possible and future topics. Topics such as using drones with artificial intelligence to managing drones when they outnumber commercial manned aircraft will allow professionals to understand what possible actions they may need to put into place.

Topics that can be Researched now	Topics that could be researched now	Topics that could be researched in the future
Drones for future sustainability	How safe can autonomous drones be when transporting organ and blood delivereries?	How will RPAS be managed when they outnumber manned commercial aircraft on a global scale?
Artificial Intelligence and the future of drones	How can drone regulators compete with more advanced drone technology than with their current standards and policies	Compare safety standards, regulations with other drone regulators
Why drones still face regulatory hurdles	Safe integration of drones into the global airspace	How statistical data of drone occurrences can assist a safety regulator with for a safer flying environment
Gathering of statistical data with drone occurrences	Finding a sustainable SMS framework with drones	

Figure 16. Alternative research topics.

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Appendices

Appendix 1. Terms

BVLOS	Operate a remote aircraft where the operator maintains connection using technical aids
CASA	Australian aviation safety regulator of aircraft operations inside Australia and Australian aircraft overseas.
Data analysis	defined with quantitative approach to analyse contextual data. Quantitative procedure includes, statistics, standards, ranges, frequencies and percentages.
Drone	Aircraft without a human pilot. Drone must have a ground-based operator and a system of communication between operator and drone.
EVLOS	Flying whilst using a spotter. The spotter and pilot must have reliable communications (radio / mobile) when discussion is not achievable
NOTAM	Unclassified notices to alert pilots and authorities of hazards at locations or along flight routes concerned with flight operations.
Research principles	Components associated with methodology and design. These included, but not limited to; purpose, research questionnaires, selecting issues.
SMS	A sequence of clear organisation or industry wide processors which deliver effective risk-based decision-making tools for a business.
SRM	Process within SMS that describes, identifies the hazard, assesses a risk, analyses a risk and how to control a risk.
Search and rescue	Assists individuals who are in distress or in imminent danger.
VLOS	Flying a remote piloted aircraft where the operator can maintain visual interaction without any technical aids

Appendix 2. Abbreviations

Act	Civil aviation act 1998
ASA	Air Services Australia
AGL	Above Ground Level
BVLOS	Beyond visual line-of-sight
CAR	Civil Aviation Regulations 1998
CASA	Civil Aviation Safety Authority
CASR	Civil Aviation Safety Regulations 1998
Defence	Department of Defence
EVLOS	Extended Visual Line-of-sight
ESRP	Enterprise Sustainability Risk Management
FAA	Federal Aviation Administration
Ft.	Feet
HLS	Helicopter landing site
NFZ	No-Fly Zone
NOTAM	Notice to Airmen
NM	Nautical miles
RPA	Remotely piloted aircraft
RPAS	Remotely Piloted Aircraft System
RPV	Remotely piloted vehicle
SAR	Search and Rescue
SMS	Safety Management System
SRM	Safety Risk Management
TRAFI	Finnish Transport Safety Agency
UAS	Unmanned aerial system
UAV	Unmanned aerial vehicle
U-SPACE	New services and specific procedure framework designed to support safe, efficient, routine and security when a large quantity of drones have access to an airspace.

VLOS	Visual line of sight

Appendix 3. Helsinki Declaration

Trafi
Finnish Transport Safety Agency

EASA

HELSINKI DECLARATION

"Seizing digital technologies to deliver advanced drone operations safely and securely"

Helsinki - 22 November 2017

The conference:

Welcomed:

- the progress made in delivering the regulatory framework and the commitment of the European Parliament and the Presidency of the Council to deliver, by the end of 2017, a political agreement on the high level requirements for drones;
- the ongoing consultation process of EASA on requirements for the operation of drones in the open and specific categories using an integrated risk management;
- the timely delivery of the U-Space Blueprint and the preparation of the update of the ATM Master Plan by the SESAR Joint Undertaking; and
- the launch of the first U-Space and urban air mobility projects with EU funding;

1. **Industry should start delivering the drone services market**

Stressed the need for EU leadership and European competitiveness to achieve further steps towards the digitalization of the economy, based on software based solutions and high quality data;

Noted that the coming months are crucial for companies to assess fast evolving investment opportunities in drone and U-Space services;

Welcomed the first initiatives of industry to demonstrate drone and U-Space technologies, such as Beyond Visual Line of Sight (BVLOS), and business cases to enable early commercial applications;

2. **Timely delivery of an enabling regulatory framework**

Noted with concern a growing fragmentation along national boundaries of the EU drone services market, also due to security considerations, indicating the urgent need for close cooperation between European and national authorities;

Called for the urgent conclusion to the Council / Parliament negotiations on the EASA Basic Regulation, laying the foundation for a new European legislative framework for drone services; and urged EASA to carry out all necessary follow-up work;

Confirmed the need for national and European regulators to establish the conditions for successful demonstrators;

Welcomed the opportunities to digitize procedures as much as possible, to ensure transparency and reduce administrative burdens for both authorities and operators, and to support the decarbonisation of transport e.g., by insisting on zero emission drones in the U-Space;

Invited the European authorities to come forward, as a matter of urgency, with indications of future regulatory plans which (1) are based on the need for open standards and suitable quality levels of the required information; and (2) reflect the probable roles and responsibilities of the actors involved in drone operations and U-Space provision and the ways in which drones may operate in the airspace, so that the authorities have the necessary tools to protect citizens with high levels of safety, security, privacy and environmental protection;

Stressed the need to guarantee fair access to all airspace users;

Urged for flexibility in the provision of U-Space services on the basis of local market demand and, as far as practically possible, for competition between U-Space providers to ensure that services are delivered at the best possible cost-benefit ratio while allowing fair and timely access to airspace for drone operators;

Invited security, defence and safety actors to intensify their cooperation up-front and up-stream and work towards effective and standardized solutions, for example on cyber-security issues;

Called for strengthened international regulatory cooperation with ICAO, JARUS and Non-EU States;

Emphasised the need to complement the regulatory activities by effective safety promotion measures to educate and increase awareness;

3. Learn from bottom-up initiatives

Observed that public acceptance of drones relies on safety, security, privacy and environmental protection being effectively tested and subsequently deployed in "real-life" locations and scenarios;

Called for the establishment, as soon as possible, of a European U-Space Demonstrator Network, inter alia to provide a forum to share knowledge and to give feedback, based on the practical expertise of demonstrators, as the regulatory framework and standards are developed;

Considers that such demonstrators should cover all aspects of drone operations and be developed in close collaboration with local authorities, including in the context of the European Innovation Partnership - Smart Cities & Communities projects;

4. Driving and prioritizing R&D drone projects

Invited industry to further invest in projects contributing to the safe integration of drones, in particular for the 2018 edition of the ATM Master Plan being prepared by the SESAR Joint undertaking;

Stressed the importance of the role of the private-public partnership approach for R&D (including large scale demonstration of technology) under SESAR and the need to involve all innovative actors including SMEs and new entrants, as well as the need for appropriate funding under the next multi-annual financial framework in order to accelerate the pace of technology development;

5. Conclusions

Called for clear and simple rules that keep the burden for citizens, operators and authorities as light as possible, and that lower the threshold for entering the EU drone services and U-Space markets;

Confirmed the commitment of all stakeholders present to open the EU drones services market by 2019 by working in parallel and with maximum cooperation on three pillars:

1. The legal requirements for drones and drone operations, for the safe and effective use of the airspace, and for the delivery of cost-effective U-Space services;

2. Further investment in demonstrators that systematically help to open the drone services market, as well as in longer term R&D projects that prepare for more autonomous vehicles and more dense traffic; and

3. An effective standard setting process that is adapted to fast evolving digital technologies from all sectors, and uses and adapts existing standards where available.

Stressed the need for protection of citizens based on safety, security, privacy and the environment.

Appendix 4. Confidentiality agreement

Interview Consent Form

Research project title: Safeguarding skies with commercial drone operators in Finland

Researcher: Kim Allanson

Participant: .....

This interview will be conducted on 09 November 2018 at 1030. I have assessed that there will be no associated risks with your participation, but stopping or withdrawing from the interview is at the participants request.

I would like to thank you for agreeing to participate in this interview for my research project. For ethical procedures and research practices, you agree to partake in being interviewed and understand how the information gained by the interview will be used. This interview consent form allows you to understand the purpose of your involvement and that you consent to the conditions of your participation. For your interest, would you read the information form and sign afterwards to verify you approve the following:

- The interview will be recorded and a transcript will be produced.
- The transcript will be sent where you will have the opportunity to correct any details or errors
- The interview transcript will be analysed by Kim Allanson as research investigator
- Interview transcripts will be limited access to Kim Allanson and academic colleagues from Haaga-Helia University of Applied Sciences as part of the research process
- Any direct quotations, content discussed and summary from the interviews will be anonymised so you cannot be identified. Any information discussed from the interview of position or identity will not be revealed
- The recording content used through the interviews will be destroyed after transcripts are completed
- If variations to the conditions above occur, further approval will be asked.

Quotation Agreement

By initialling in the boxes, next to the statements, you agree and understand your words may be quoted directly;

	I request to review notes, transcripts and other data collected during the research pertaining to me
	I agree to be quoted directly
	I agree to be quoted directly only if my name is not published with subject# is used
	I agree that the researcher may publish documentation containing quotations by me

The content of your interview (all or part) maybe used;

- In an academic thesis report

Note! At completion of thesis report, lecturers will analyse all data for grading. After grade is given to the researcher, the thesis report will be archived. All confidential segments of the thesis will not appear in archive.

By signing this form, I agree;

- I am voluntary taking part in this project
- I understand I can stop the interview at any time and I do not have to participate
- I have read the information above
- I do not expect to receive any gifts, bribes or payments for my participation
- I can request a transcript copy of my interview and edit information if necessary to ensure my confidentiality is agreed upon
- I have the ability to contact the researcher if I have questions in the future

_____

Participant printed Name

_____ _____

Participant signature **Date**

_____ _____

Researchers signature **Date**

Contact information

If you have further enquiries or questions about this study, please contact

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