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The Rise of Drones

A Study on the Creation of Experimental Zones amid the Regulatory Disconnect

by

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DEDICATION

I proudly and gratefully dedicate this Master's thesis to my parents:
Moris Meryamka & Hanan Gouriye
Were it not for you, I would not have been the person I am today.
Thank you for your love and sympathy!

Jina Meryamka

"Every Home is a University and the Parents are the Teachers"
Gandhi

"كل منزل جامعة و الوالدين هم الأساتذة"
غاندي

بكل فخر و امتنان أهدي هذا النجاح ل أمي و أبي:
موريس مريمكي و حنان كورية
لولاكم لم أكن لأكون هذا الشخص الذي انا هو اليوم.
شكراً لكل ما قدمتموه من حب و حنان!

جينا مريمكي

Summary

The emerging "Rise of Drones" that is to be followed by a forecasted large-scale drone deployment amid the lack of regulatory framework and therefore creating a regulatory disconnect is the purpose of this research. The objective of this study has been to investigate possible options, within the Netherlands, for the creation of experimental zones which allow for legal experimentation. Hereby desk research was done with regard to risks and concerns, the regulatory framework on the different levels of governance, and theory about regulation and experimentation were examined. On the basis of the desk research, interview questions were set up to conduct semi-structured interviews as part of the field research.

The desk research showed that there are several concerns with regard to large-scale drone deployments such as safety, privacy, data protection, and other ethical issues. More concerns consist in the fact of a lacking regulatory framework with regard to experimentation despite the fact of existing theory on experimentation regimes. This case whereby innovation is ahead of law is called regulatory disconnect. To contribute to finding solutions to reconnect, semi-structured interviews with experts from the field were conducted as a field research.

The desk research showed that the expert-interviewees find it crucial that regulators create a regulatory framework which grants liberty space for experimentation in so-called experimentation zones. Hence, discretion is needed to create such test locations and be able to legally experiment. Moreover, the expert interviewees view experimentation as the solution to reconnect since experimentation will provide new data and outcome which can be used by regulators to create a fast and straightforward regulatory framework.

Despite the fact that there is no experimental regulation into force right now, the EU is working on legislation that will allow for the creation of the desired experimental zones that will go into force by the end of 2018. On the national level, the Dutch government also proposed such legislation, which will go hand in hand with the European framework, creating experimental discretion.

Besides the creation of experimental zones, it is of importance to create societal awareness regarding drone deployment which is to result in societal acceptance of these flying robots. To make drone deployment as safe as possible for citizens techno-regulation is proposed as being the solution to control the drone and create high levels of safety. According to the expert-interviewees, the experimental zones will contribute in both creating societal acceptance, by involving citizens and testing the potential of techno-regulation with regard to safe drone deployment.

Last but not least, future research recommendation has been given, namely: (1) applying this research on more Dutch regions or the whole country, (2) research on the progress of artificial intelligence, and (3) closing the gap between experimentation in an artificial setting and risk-free deployment in real-life.

Summarising, the technology is there, the regulatory disconnect is there yet regulatory framework is coming, experimentation is coming, so it is time to make the shift from stagnation to a rise of drones!

Acknowledgments

"Then a lawyer said: but what of our laws, master?

And he answered: "You delight in laying down laws,

yet you delight more in breaking them".

Gibran Khalil Gibran

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Jina Meryamka

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List of abbreviations

AI	Artificial Intelligence
AMC	Acceptable Means of Compliance
ATM	Air Traffic Management
BvL	Bewijs van Luchtwaardigheid - Dutch Certificate of Airworthiness
BvB	Bewijs van Bevoegdheid – Dutch Proof of Competence of the Pilot
BvI	Bewijs van Inschrijving - Dutch Certificate of Registration
DoD	Department of Defence
EASA	European Aviation Safety Agency
EC	European Commission
EU	European Union
FAA	Federal Aviation Administration
GCS	Ground-Control Station
GM	Guidance Material
ICAO	International Civil Aviation Organisation
ICCPR	International Covenant on Civil and Political Rights
ILT (ILENT)	Inspectie Leefomgeving en Transport- Dutch Environment and Transport Inspectorate
JARUS	Joint Authorities for Rulemaking on Unmanned Systems
MS	Member States
NAA	National Aviation Authority
NBR	New Basic Rule
NPA	Notice of Proposed Amendment
R&D	Research & Design
PBA	Performance-Based Approach
RBA	Risk-Based Approach
ROABL	Regeling Op Afstand Bestuurbare Luchtvaartuigen
ROC	RPAS Operator Certificate

RPA	Remotely-Piloted Aircraft
RPAS	Remotely-Piloted Aircraft Systems
SARPs	Standards and Recommended Practices
SCB	Stakeholder Consultation Body
U-space	Urban-space
UA	Unmanned Aircraft
UAS	Unmanned Aerial System
UAV	Unmanned Aerial Vehicle
US	United States
VMS	Veiligheidsmanagementsysteem – Dutch Safety Management System

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1 Introduction

A drone or Unmanned Aerial System (UAS) is an Unmanned Aerial Vehicle (UAV) in which the airborne element consists of two basic types, namely; an UAS with no remote pilot or independent air vehicle, and a Remotely-Piloted Aircraft System (RPAS). RPAS fall under UAS with a 'pilot' remotely controlling the Remotely-Piloted Aircraft (RPA) from a Ground-Control Station (GCS) (SESAR, 2016). In this study, the popularly known term "drone" will be used to refer to all types of UAS for civil use. As for military use, the term "military" will be added, resulting in "military drone".

1.1 Background information

Drone technology which lies at the heart of robotics innovation is rapidly developing during the twenty-first century. Existing regulatory frameworks are not adequate anymore in coping with this "rise of drones" (Clarke, 2014). This is a well-known problem named 'regulatory disconnect', as "law lags behind innovation" (Ranchordas, 2016, p. 875). Innovation is an unstable and constantly changing phenomenon, which is responsible for the creation of uncertainty in the innovation process. To remove this uncertainty, regulators have the mission of keeping up with innovation (Ranchordas, 2016). Ranchordas (2016) argues that regulators should take two factors into consideration: firstly, analysing how the innovation process works and, secondly, the timing of the regulatory action. The innovation process is to be analysed by taking the available information on a particular time in consideration. As for the timing two approaches are suggested; temporary experimental regulations, and the delay of regulatory intervention. Experimental regulations are dispositions that allow experimenting with new legal solutions by giving innovators chances to develop a technology without putting citizens or consumers to risk. In other words, an experimental regulation allows drone testing on a small-case basis to try out new legal solutions and has a temporary character. Thus the first approach offers an early and flexible regulatory response to innovation. In contrast to temporary legislation as experimental regulations and sunset clauses that try to avoid that regulation lags behind innovation, the latter approach delays regulatory interventions to allow the "sunrise" of necessary rules from engaged platforms. A sunrise clause is a disposition whereby a regulation that is made ahead of its time is avoided because 'early' regulation will lack an understanding of the specific technology and its commercialisation. Therefore a time will be set in the future at which point the regulation enters into force. Also, the absence of fitting legislation for a certain activity, i.e. the absence of a prohibition or command, will cause an unlegislated conjunction of permission and dispensation. (Heldeweg, 2015). The mentioned approaches convert uncertainty and change into opportunities for improving regulation (Ranchordas, 2016).

Regulating innovative technologies is not a simple task. Brownsword & Somsen (2009) call it a 'challenge' for regulation to stay connected to innovation, whereby regulations are made to control and change behaviour. Taken very narrowly, regulation refers only to rules that are established by an administrative agency (Smith, 2015). Brownsword & Somsen (2009) put it simply by explaining that regulation is about any instrument to channel behaviour. Such an instrument may have a legal or non-legal character, a governmental or non-governmental source, and may operate directly or indirectly. Regulation, together with law and governance make up the regulatory environment. The regulatory environment is *"an environment in which one class, that of the regulators, endeavours to steer and to* *direct the actions of another class, their regulatees; an environment in which regulatees experience the regulatory signals as external and as bearing in, via their practical reason, on their actions; and an environment that is clearly distinguishable from other regulatory environments, having its own particular identity as the regulatory environment that it is"* (Brownsword & Somsen, 2009). Regulation can be prospective or retrospective, which means forward- or backwards-looking, introducing norms that impact *ex-ante* or *ex-post* to (in)action. Also, regulation can be public or private (Smith, 2015).

1.2 Description of the problem

Besides the problem of the regulatory disconnect, there are several problems associated with the deployment of drones. Drones raise privacy, safety, data protection, and ethical issues. Also, societal rejection and dangers of increased risks of accidents and collisions with other aircraft exist. On the 6th of January 2017, it is reported that a drone collided with a landing passenger plane, a Boeing 737-700, at the Mozambique airport. The right side of the aeroplanes' nose got extensively damaged by the drone (Cuskelly, 2017).

Drones might get out-of-control which might cause them to fall from the sky and injure citizens. On November 2015 it is reported that the eye of an 18-month-old toddler from Worcester, United Kingdom, got sliced in half by the propeller of such an out-of-control drone (Lusher, 2016).

Another problem is that drones can carry a certain amount of pay-load such as sensors, camera's, and also weapons. Different types of sensors are able to collect personal data information of individuals, drones may film people in an unnoticed manner, and weapons increase risks of terrorist-attacks (Dijksma, 2017). It is, moreover, the question of whether the payload itself is of high quality and risk-free in civil drones as well as in military drones. The Yemeni government reported that more than 50 civilians have been killed in United States' (US) drone strikes, whereby the US describes the deaths as being caused 'accidentally' which thus is a technological failure in the payload. Another tragic accident in Yemen is the well-known US drone strike on a Wedding in December 2013 in the city Of Radda, whereby at least 14 attendees were killed and more than 22 (critically) injured (Almasmari, 2013). In Syria (September 2016), US-led coalition drones accidentally bombed advancing Syrian Army troops in Deir Ezzor whereby 60 soldiers were killed and became martyrs, which eventually helped militants of the Islamic State (IS) to gain ground (Hope, 2016).

As can be seen from the above, 'drone threats' are real and, likely to, increase with the large numbers of drones and drone operations, which calls for urgent action in the form of regulatory frameworks. Before continuing to the scope and objective of the research, an important distinction is to be made on the subject of drone users. Within this subject, three drone user categories exist, namely; amateurs, professionals, and manufacturers. A problem here exists in the fact that, in the Netherlands, amateurs are allowed to fly and "test" their drone much easier (provided that they do not fly in no-fly zones) than the professionals and manufacturers which are restricted by laws and regulations and need to apply for exemptions, such as creating experimental zones (Inspectie Leefomgeving en Transport, n.d.). Unless otherwise stated, this research revolves around the professional user category.

1.3 Scope and objective of the research

The research will take place in the Netherlands, Twente Region, where there are already some public-private partnerships that do research on the technology of drones and the possibility to implement their usage in society. A central key player in Twente is Space53 which, together with innovation partners, works on accelerating the innovation process of drones. Space53's innovation partners include the University of Twente, Saxion University of Applied Sciences and the Enschede municipality. Together they form a project group called *"Werkgroep Lobby en Regelgeving"* (i.e. lobbying and regulation). This partnership between Space53, educational institutions, and the government is about collaboration on the development of socially relevant unmanned systems for civil uses. For the large-scale application of drones two preconditions are important namely, societal acceptance and relevant regulation. At this moment experimentation in the Twente region is possible at the Marssteden Business Park, Twente Airport and the University of Twente Campus, but not at any appreciated moment (Space53, n.d.).

The objective of this research is to investigate possible options to sequentially experiment with drones for civil use, particularly regarding safety and privacy, in larger, and more vulnerable and less controllable areas, such as from airport, to campus, to the city centre, etc., as well as the contribution of experimentation to solving the dilemma of regulatory disconnect. Therefore the main question of the research is;

> *"What are the options to, within the Netherlands, develop zones for experimentation with civil drones while safeguarding the safety and privacy of the air traffic and citizens, and how does the development of these zones contribute to the solution for the dilemma of regulatory disconnect?"*

To be able to answer the main question as complete as possible and examine the options for the creation of legal space as experimental zones, the following sub-questions are formulated;

1. *What are the risks and concerns associated with large-scale drone deployment?*

By answering this question, a brief introduction to the risks and concerns with regard to drone deployment will be examined, which makes the purpose of this study more clear. Except for the popular safety and privacy risks, more concerns exist depending on the different drone applications.

2. *What is the current state of regulations concerning drones within the different layers of governance, with an emphasis on the creation of experimental zones, and how do Dutch and European regulations contribute to the creation of this legal space for the Twente Region?*

By answering this question, a full and clear image will be created upon the existing laws and regulations, and therefore it will be possible to analyse possibilities for the creation of experimental zones according to legal frameworks within the different layers of governance emphasizing the supranational and national levels. Despite the fact that this research focuses on the Netherlands, it is of importance not to limit the examination of legal frameworks to the national level only. Instead, in this study all levels of governance will be examined with an emphasis on the Netherland, since Twente Region lies there. The regulations of other governance levels than the national, are of importance because they are (somehow) related. As will be explained in chapter two, the existing Dutch regulations will be (mainly) replaced with European regulations. The European Union (EU) in turn does not only work with its Member States (MSs) but has relations with the inter- and supra-national levels that exist in the fact that all the involved organisations work together on creating legal frameworks. In other words, it seems that the concerned parties within the different layers of governance see the importance of cooperation and information sharing for a most successful large-scale civil drone deployment. Hence, to create a most complete image of what is developing with regard to this deployment, this study is not limited to examining Dutch and EU regulations only but emphasises it since the Twente Region falls in the jurisdiction of both levels.

3. *What are the different types of regulatory regimes that can be applied to experimental zones?*

Exploring the different types of regulatory regimes is crucial to, first: create an understanding regarding the different regimes and their legal instruments, and second: help propose legal frameworks with regard to the creation of legal space being experimental zones in this case.

4. *How does the creation of experimental zones contribute to solving the problem whereby law lags behind the technological innovation of drones, according to actors and key stakeholders in the field?*

Last but not least, answering this question is crucial for the creation of experimental zones by any means, as well as the contribution of the time-transcending dilemma of innovation *vis-à-vis* regulation. Important here is to examine whether, according to the experts, specific types of experimental regimes do contribute to (re)connecting, or not.

Experimental zones are essential to experiment in a safe and accountable manner. Considering the fact that the objective of this research is mainly consistent with the objective of the aforementioned key-players, the definition of 'experimental zones' is the same as that of these players: *"A geographically demarcated area for a concretised group of cases where the possibility exists to temporarily derogate from the status quo while considering the collection of useful data with the objective to review whether this derogation should be permanent, general (or ended)"* (Space53, 2017, p-2).

In such an area (experimental zone) it is possible to mitigate risks through permanently present services, such as emergency services and geo-fences, to make it easier to get exemptions for experimentation. Within the current Dutch law and regulations experimentation without prior exemption is prohibited for professional users. Moreover, requesting exemptions within the law should be done on the basis of a full risk assessment whereby worst risk scenarios are assumed. Thus, (permanent) experimental zones will make experimentation faster and easier, and the experiments will provide information about the safe and risk-free applicability of drones into the 'real world'. (Space53, 2017).

1.4 Methodology

To clarify the fundamental issue of this research, an important step was taken early in the process, by deciding on the definition of "experimental zones". The chosen definition was taken from the work and documents of *"Werkgroep Lobby en Regelgeving"* since this study is related to the Space53 project. This research is a qualitative research which is a combination of desk research and empirical research. The data collection method used combined analysing documents to obtain the theory via the snowball method and conducting semi-structured interviews with experts from relevant fields. To answer the research main question, four sub-questions were set up together with deciding on the aforementioned definition of an experimental zone. For the first and third sub-questions data was collected by analysing the most recent scientific articles through the snowball method. Data for the second sub-question was obtained via the Internet by exploring laws and regulations as well as proposals on the different levels of governance. And for the fourth sub-question data was obtained by conducting semi-structured interviews with six experts from the field.

A number of interviews were conducted in order to clarify the expert's view on the subjects of the experimental zones, techno-regulation, ethical issues, the level of regulatory framework, and the regulatory-disconnect. The interviewees have been chosen to be key-players from "werkgroep lobby en regelgeving" since this study is limited to the Twente Region and relates to Space53's interest in this project. However, the actors have been chosen from different backgrounds to be able to observe the issue from different perspectives. Thus public, private, and educational actors were interviewed. For this reason, the questions and focus were not the same for all the actors. Even though we tried obtaining information upon all the subjects from all actors, the emphasis on one subject or the other differed according to the knowledge, experience and expertise of that particular actor. Being able to have this play of changing the emphasis on the different questions and have more in-depth discussions and conversations about a particular subject is an important characteristic of semi-structured interviews, which is the reason for choosing this type of interview. All six interviews were conducted in May 2018.

Following the decision on whom to have conversations with, the possible respondents were contacted via e-mail. At this stage, they were only four. Within one week all four respondents replied positively and were ready to be interviewed. The first interview had been conducted at the Enschede municipality with project leader 'experimental zones' and Senior Policy Advisor at the municipality. The main focus of this research was the public aspect: ethical issues and the role of the municipality in guaranteeing her citizens' safety and privacy while contributing to the innovation of the public domain. The second interview has been conducted with two experts (simultaneously): one being from the Facility Management Staff, and the Program Manager Campus and Innovation, both at the University of Twente. This interview was intended to be with one interviewee only, but this actor responded by saying he would retire in three weeks and proposed to have a double interview with his successor as well. During this interview, both respondents proposed an extra interviewee, which became the sixth respondent. The third interview was conducted with the CEO of Space53. The emphasis in this interview was on the experimental zones and their importance. The next interview was conducted with Safety and Coordinating Radiation Officer at the University of Twente. The main emphasis here was on the possibilities to obtain exemptions for the University campus and the different assessments that should be done before operating with drones. Last but not least, the fifth interview was with Associate Professor Unmanned Robotics Systems at Saxion University of Applied Sciences. Here the main focus was on technology-regulation and how realistic it is taking the technological features into account. Another important subject was the importance of creating societal awareness with regard to robots, particularly drones. All interviews were conducted at the actor's offices.

Records of the conversations were made with a mobile device: the smartphone. During the interviews, attention by the interviewer was paid to body language and facial expressions to obtain unspoken information such as enthusiasm and belief in the actors' own proposed ideas. After every interview, notes have been taken on the basis of the obtained audio and put together as presented in chapter three of this thesis. The actors have no objection against being mentioned by name and profession in this study. But to protect their privacy, a transcription of the interviews will not be included and the audio files will be destroyed as soon as this study comes to an end. However, the actors' quotes and opinion will be mentioned in this research.

1.5 Reading Guide

From this point on this thesis will continue with four key chapters followed by the Appendix. The next chapter (2) provides a theoretical framework based on the objective and research questions of this research. This chapter briefly enriches interested readers outside of the field with basic information on the matter in section 2.1 whereby section 2.1.3 connects to the first sub-question, section 2.2 to the second sub-question and section 2.3 to the third sub-question. The third chapter demonstrates the expert's views with regard to the creation of experimental zones, techno-regulation, ethical issues around drone deployment, regulatory-disconnect, and about the layer of governance that should provide a regulatory framework which relates to the fourth sub-question as well. Having provided the theory and answered the sub-questions a discussion of the previous will be found as chapter 4. Last, the concluding chapter, 5, will provide answers to the research sub- and main questions and a conclusion of this study as a whole will be given followed by the limitations of this study and interesting aspects as further research recommendation.

2 Theoretical Framework

In this chapter, a brief introduction to drones will be provided in section 2.1, which contains information about the right nomenclature for drones (2.1.1), the main and different drone applications (2.1.2), and about the risks and concerns associated with large-scale drone deployment (2.3.3), whereby section 2.3.3 relates to the first sub-question. The brief introduction will be followed by section 2.2 containing a description of the existing drone laws and regulations on the different layers of governance – i.e. international (2.2.1), transnational (2.2.2), supranational (2.2.3), and national (2.2.4)-, as this section relates to sub-question two. Last but not least, section 2.3, which refers to the third sub-question, will provide some elements of theory regarding regulation, its different types/approaches and the importance of experimentation, including different types of experimentation.

2.1 Introduction to drones

As is implicit to the scope and objective of this research, this section is to introduce readers outside of the field with a brief informative account to the field of (civil) drones. This will be done by examining the right nomenclature of drones in section 2.1.1, followed by section 2.1.2 that will provide information on the different drone applications. Section 2.1.3, which seeks to answer the first sub0question, will examine the main risks and concerns with regard to large-scale drone deployment.

2.1.1 Nomenclature

As said in the introductory chapter, Unmanned Aircraft (UA) have been described in several ways including drones, UAV, UAS, RPA, and even RPAS (Dalamagkidis, Valavanis & Piegl, 2012). But what is the right nomenclature? UAVs, or drones, refer to a flying machine that flies without a pilot or passenger on board or, in other words, pilotless aircraft. UAV which is a term that has been used for several years is defined as follows (Dalamagkidis, Valavanis & Piegl, 2012 p-2);

“A reusable aircraft designed to operate without an on-board pilot. It does not carry passengers and can be either remotely piloted or preprogrammed to fly autonomously”.

Later, a few years ago the US Department of Defence (DoD), the Federal Aviation Administration (FAA), and the European Aviation Safety Agency (EASA) chose to use the term UAS. However, the FAA defines UA as (Dalamagkidis, Valavanis & Piegl, 2012 p-2);

“A device used or intended to be used for flight in the air that has no on-board pilot. This includes all classes of airplanes, helicopter, airships, and translational lift aircraft that have no on-board pilot. Unmanned aircraft are understood to include only those aircraft controllable in three axes and therefore, exclude traditional balloons”.

Whether the EASA defines UASs as (Dalamagkidis, Valavanis & Piegl, 2012 p-2);

“An Unmanned Aircraft System (UAS) comprises individual system elements consisting of an “unmanned aircraft”, the “control station” and any other system elements necessary to enable flight, i.e. “command and control link” and “launch and recovery elements”. There may be multiple control stations, command & control links and launch and recovery elements within UAS”.

Having thrown some light on the official definitions of UA in two of the most important key player entities (EU and US), it seems that there is no right or wrong nomenclature. (Dalamagkidis, Valavanis & Piegl, 2012). Hence, as mentioned in the first chapter, in this thesis the term “drones” will be used for civil drones, and “military drones” will indicate drones for military use.

2.1.2 Drone Applications

The applications of drones are many and very diverse; from military to civilian and public domains (Dalamagkidis, Valavanis & Piegl, 2012). The drone industry is developing very fast, particularly in the area of small and cost-effective drones. This causes that business and public institutions invest in drones to maximize processes and reduce risks (SESAR, 2016). The fact that drones are equipped with camera’s, for instance, has led to the deployment of drones for surveying, mapping, and inspections as commercial use. In the European Drones Outlook Study (2016) it is expected that by 2050 a total of 7 million recreational drones will be in operation. For commercial and professional use some 400.000 drones are expected for government and commercial missions in Europe. Speaking in terms of possible numbers of economic impact and drones in the most influential missions, it is forecasted that 100.000 drones will be employed in the agricultural sector, circa 10.000 drones will be performing in the energy sector, for on-demand package delivery ends 100.000 drones are expected, and 50.000 drones will be deployed to ensure public safety and security. This growing drone industry is expected to contribute to the European marketplace with a value of annually EUR 10 billion by 2035 and annually over EUR 15 billion by 2050 (SESAR, 2016). More examples of drone application ambit traffic and wildlife surveillance, search and rescue, inspection of infrastructure, and cinematography (Gharibi, Boutaba & Waslander, 2016). The applications may also be very clever encompassing documenting ephemeral beach art, contraband delivery into prisons, restaurant services, monitoring mountain yaks, and internet access in remote areas (Moran, 2016). The “clever applications” are possible due to the existence of model aircraft for recreational use (Moran, 2016). So, it is seen that taking this development seriously is very important. Whether this also requires regulation depends on the relevant risks and concerns that come along with the deployment of drones.

2.1.3 Risks and Concerns

Despite the fact that the various drones applications and capabilities seem to be the solution in a lot of sectors and a cause for the growth of the economical European market, it is important to be critical and put some question marks since it might be too good to be true. It is crucial to keep remembering that drones are flying robots that may invade the personal space of humans, and also of animals. These robots are also able to “see”, so who will ensure citizens that they are put to good use and not to spy or even attack people? (Moran, 2016; Du & Heldeweg, 2018). In other words, drones can be seen as a threat that raises safety, privacy, data protection, and ethical issues.

2.1.3.1 Privacy

Privacy is a fundamental right which is safeguarded by laws under “the right of privacy” or “the right to private life”. These rights are enclosed in Article 17 and 23 of the International Covenant on Civil and Political Rights (ICCPR) on the international level, and in Article 7 of the European Charter of fundamental rights of the European Union and in Article 8 of the European Convention of Human Rights of the Council of Europe on the European level (Du & Heldeweg, 2018; Finn, Hert, Jaques & Wright, 2014).

Finn et al. (2014) define privacy as *"the presumption that individuals should have an area of autonomous development, interaction and liberty, namely a "private sphere" with or without interaction with others, free from state intervention and from excessive unsolicited intervention by other uninvited individuals"* (p-24). Moreover, the four dimensions of privacy are identified, namely; information privacy, bodily privacy, location privacy, and the privacy of communication. However, taking emerging technological innovation and development into account, it is necessary to expand privacy to seven types, namely; privacy of the person, privacy of behaviour, privacy of personal communication, privacy of data and image, privacy of thoughts and feelings, and last but not least the privacy of association (Finn et al., 2014).

Having shed some light on the concept, dimensions, and types of privacy, the question is; how can drone technology and/or use trespass the privacy of individuals?

Drones raise some privacy issues -regardless of their (field of) application- since the drone operators often use mounted sensors to process, use and store the information they have captured. Privacy issues follow from several questions; who is operating the drone? how advanced is the drone; why is it used; where is the drone being used? (Finn & Wright, 2016). The level of privacy violation depends on the technological equipment a drone is carrying; the more advanced the drone is, the more vulnerable an individual's privacy is (Finn et al., 2014). Drones equipped with several sensors might collect data about citizen's behaviour, health (via temperature data), home lives, and locations (geographical data). A drone with facial recognition sensors for crime investigation, for instance, collects more detailed information than a drone equipped with an optical camera for observing pipelines (Finn & Wright, 2016). This kind of threats for citizens might cause a so-called "chilling effect", whereby individuals believe that they are being watched constantly even when there are no drones around, and therefore they start to adjust their behaviour accordingly (Finn & Wright, 2016; Finn et al., 2014): thus not realising their fundamental freedoms. Another societal concern is "function creep". This refers to the fact that while drones are collecting information –directly or indirectly- for a certain purpose, the same information may be used for another purpose. For example; a drone that is deployed to observe infrastructure ends up filming workers (Finn & Wright, 2016; Finn et al., 2014).

2.1.3.2 Data Protection

Drones, with a specific payload, are able to collect personal data of individuals and this falls under the privacy of personal information, which is a specific dimension of privacy concerned with the collection, processing, and distribution of individuals' data. However, in terms of rights, data protection, or the data protection right, is a specific right and is not fully covered under the right of privacy. Despite the shared characteristics of data protection and privacy, they are called twins, but not identical. Privacy is more about the intimacy and secrets of an individual, whereas data protection is about the need to protect citizens from both the public and private sectors, while they are using, processing, storing and disclosing citizens' personal data (Finn et al., 2014).

The appearance of the protection of personal data happened during the 1960s and 1970s due to the growth of computer use. In other words, emerging technologies increasingly infringed on the right to privacy. Hence, from the rights of privacy and autonomy, the right to personal data protection came forth to protect the processing, use, storage, and disclosure of citizens' personal data from the abuse of public and private sectors. These data protection laws, or regulations of technological developments, evolve constantly with the emerging technological developments. These rules are not generally prohibitive, rather they "organise and control the way personal data are processed" (Finn et al., 2014, p-42).

In Article 29 of the Working Party on the Protection of Individuals, concerns regarding the processing of personal data have been confirmed as such;

"There is unquestionably a real need to focus on the threats that an uncontrolled proliferation of drone applications could bring about for individuals' fundamental rights and freedoms. From a data protection point of view, what is relevant is not so much the use of RPAS as such, but mainly the different technologies they can be equipped with (i.e. high-resolution cameras and microphones, thermal imaging equipment, or devices to intercept wireless communications) and the subsequent collection and processing of personal data that may take place" (Finn et al., 2014, p-43).

The technologies drones are equipped with to collect data are basically existing technologies. Rather, what makes drones a bigger threat to personal data, is the capability to fly and invisibly collect data. Moreover, data transfer between drone and operator also occurs invisibly. This nature of drone technology, which in itself is new, is called "double invisibility" of drones since the data subject has no clue. Hence the EU presents the General Data Protection Regulation (GDPR) which obligates manufacturers and operators to take privacy into account by including it into design features and execute data protection impact assessments for any data collecting drone operation (Du & Heldeweg, 2018; Finn & Wright, 2016).

2.1.3.3 Ethical issues

Finn et al. (2016) have set out the following ethical concerns regarding the use of drones: safety (risks), public dissatisfaction, illegal intrusion in wildlife (Du & Heldeweg, 2018), and discriminatory targeting. Looking at the issue of safety, Bolkcom has reported that unmanned aircraft causes a 100 times more accidents than manned aircraft. Reasons for this are that drones are not being maintained as often as manned aircraft. Thus the risks of physical injuries to civilians and commercial aircraft are increased. Moreover, the risk of cyber-attacks is also increased, since as mentioned above, the drones are robots that capture personal information data. Another safety concern of drones is their potential to carry lethal and non-lethal weapons, even though drones themselves are not directly weapons. An example is a time bomb carried by a drone for a terrorist attack. Thus safety concerns are intertwined with ethical issues. Also, civil drones are often associated with military drones which decrease the public acceptance of drones and might create the chilling effect and public dissatisfaction, which simultaneously is the next ethical issue regarding drones.

Despite the public acceptance of drone deployment in rescue missions or disaster detection and monitoring, a major rejection exists with regard to deployment in warfare and spying possibilities on citizens by governments and/or major corporations as Google (Finn et al., 2016).

The third ethical concern is discriminatory targeting, which means that the individuals operating the drones might only put them to surveillance tasks in disadvantaged neighbourhoods which causes a biased capturing of information (Finn et al., 2016). Using drones, the police or authorities may often target "usual suspects", such as young people, migrants, and members of the working class, resulting in discrimination and stereotyping. Thus the third, and also the second, ethical concern might create political and legitimacy tensions between citizens and authorities. (Finn & Wright, 2014).

Last but not least, the illegal intrusion of wildlife concern which is that the wildlife could be affected by drone use since Nano-Biomimetic technologies are advancing. Nano-Biomimetic technologies make it possible to recreate drones that are a look-a-like to animals, for example, bug-like drones, which are completely undetectable and will be mistaken for the animal they are made to look like (see figure 1). Biomimetic drones have greater surveillance capabilities since they are invisible, but also greater spying capabilities which not only creates an intrusion into wildlife but also a threat to individuals' and countries' safety, privacy and data protection (Finn et al., 2016).

Figure 1 Swarm of biomimetic drones (source: BBC)

As seen from the above, drone deployment comes with serious risks and concerns that are not to be neglected and should be faced. Therefore various laws and regulations within the different layers of governance have been made and are in progress to ensure safe and controlled drone operations, which will be presented in the next section, 2.2.

2.2 Laws & Regulations

Different rules, laws, and regulations are made about developing, production, and use of drones. However, as mentioned before, major concerns exist around the privacy and safety of citizens across the globe in times of growing drone use, whether it is for professional or for recreational use. Rules and regulations are (being) developed on the different levels of governance: international, transnational, supranational, and national. This section will elaborate on the regulative organisations and authorities at the different levels, which relates to sub-questions one and two (2.2.4) of this study. Regarding the supranational level, this thesis will focus on the EU, and regarding the national level, the focus will be on the Netherlands.

2.2.1 International

Internationally the International Civil Aviation Organization (ICAO) is set up by states in 1944 and is a United Nations (UN) agency which deals with the governance and administration of the Convention on International Civil Aviation, also known as the Chicago Convention which was signed by 52 states in 1944 (Du & Heldeweg, 2018; ICAO, n.d.). ICAO works on reaching a safe, efficient, economically sustainable, secure, and environmentally responsible civil aviation sector through Standards and Recommended Practices (SARPs) and policies, by cooperating with the assembly of 191 member states and industry groups. ICAO member states use these SARPs and policies to make sure that the operations and regulations of their local civil aviation are conformed global norms. In the aviation's global network, this usage allows that more than 100,000 daily flights fly reliably and safely in all world's regions (ICAO, n.d.).

2.2.2 Transnational

Transnationally the Joint Authorities for Rulemaking on Unmanned systems (JARUS) exists as an unofficial public law International organisation. JARUS, consisting of 52 countries, is a group of experts from the National Aviation Authorities (NAAs) as well as regional aviation safety organisations (JARUS, n.d.). JARUS recommends safety, technical, and operational requirements for the safe integration and certification of drones at aerodromes and in the airspace. Their goal is to provide guidance material to help every authority in writing their requirements and avoiding duplicate efforts. Besides the 52 countries, EASA and EUROCONTROL contribute to the development of JARUS. The Stakeholder Consultation Body (SCB) which represents all industry communities of interest was established in 2015 to support all JARUS activities (JARUS, n.d.).

EASA takes the works and developments made by ICAO and JARUS into account. Also, cooperation between the mentioned organisations exists (EASA, 2017).

2.2.3 Supranational

The European Commission (EC) tasked EASA to develop regulations for drone operations including "low-risk" regulations (JARUS, n.d.). EASA consists of 32 member states; 28 EU member states + Switzerland, Norway, Iceland, and Lichtenstein; it was established in 2002. Besides its MSs, more than 800 aviation experts and administrators work with EASA, and the agency has a worldwide presence in five key locations. EASA's mission is to ensure the highest universal safety protection level for EU citizens and the environment, regulating and certificating among MSs, creating a level playing field and facilitating the internal aviation single market, and to work with other regulators and international aviation organisations, e.g. JARUS (EASA, n.d.).

2.2.3.1 Notice of Proposed Amendment 2017-05 ‘Unmanned aircraft system operations in the open and specific category’

The EC, MSs, and stakeholders have requested EASA to develop a regulatory framework for the operation of drones which EASA introduced in May 2017 as the Notice of Proposed Amendment (NPA) ‘Unmanned aircraft system operations in the open and specific category’ (EASA, n.d.). The NPA proposes a regulatory framework for drone operations in the open and specific categories and is meant to replace the existing fragmented regulatory frameworks in the different European MSs by the end of 2018 (EASA, 2017). It is a “follow-up” of the in August 2016 proposed ‘ ‘Prototype’ Commission Regulation on Unmanned Aircraft Operation 2016’. Moreover and as mentioned before, the works and developments made by ICAO, JARUS, and the FAA are taken into account (EASA, 2017; EASA, n.d.).

To extenuate the risk of operations, three operation categories (open, specific, and certified) are specified in the NPA. Before an operation takes place the open, or low-risk, category does not require any authorisation. The specific, or medium risk, category states that before the operation takes place an authorisation is required by the competent authority. Also, the operator should either have a certificate with liberty space (see section 2.3.2.1 for definition) or conduct and include a risk assessment. In the last category, certified, the risk is so high that the following three conditions apply; a licensed remote pilot, a certification of the drone, and an approved operator by the authority (EASA, n.d.).

Pioneering on other frameworks, the NPA combines Aviation and Product legislation. In accordance with the New Basic Regulation (NBR), the implementation of design options for small drones occurs by complying with technical requirements called CE marking. This means that a certain drone is designed in accordance to market product legislation (CE marking). Moreover, for drone identifying purposes the CE mark (C0 to C4) will be attached to the drone as well as a do’s and dont’s poster in all drone boxes. The leaflet contains on drone class-based rules for operators (see Appendix I) (EASA, n.d.).

The NBR will enlarge the regulatory scope of the NPA for the category of drones below 150 kg, and offer new regulation with specified rules for which the NPA offers an introductory regulation. The NBR is a regulatory framework that seeks to define measures for risk mitigation in both the open and specific categories to increase the safety of drone operations, create an EU market whereby drone costs are reduced and cross-border operations are allowed, and to create a legislation among the MSs that is harmonised. The certified category is only mentioned in the NPA. With section VII Unmanned Aircraft, Articles 55 to 58 (Delli & Marinescu, 2018) of the NBR dedicated to the regulation of civil drone operations, it is clear that the regulatory framework intends to regulate UA in the open category through a combination of operational rules, limitations, technical requirements for the drone itself, and conditions on the competence of the remote pilot. UA in the specific category is to be regulated through operator certificates and risk assessments to be made before the start of a drone operation. The NBR defines two acts that pursue adoption procedures, namely: a delegated act and an implementing rule. The delegated act is to define conditions on (1) the availability of drones on the market and (2) drone operations by third-country operators. The implementing rule defines drone operating rules and registration conditions (Delli & Marinescu, 2018; EASA, (n.d.)). EASA (n.d.) ensures that the new regulation intends to increase the level of safety with regard to drone operations, contribute to the drone market, address concerns with regard to privacy, safety, data protection, and environmental protection held by citizens, and the implementation of a regulatory framework that is proportionate, operation-centric, and risk- and performance-based (see table 1, section 2.2.4.4). Last but not least, the new regulations offer flexibility to MSs in the creation of zones where drone operations are facilitated, limited, or prohibited.

Coming back to the NPA, it is outside the scope of this paper to quote all the articles of the regulation, or to explain all its aspects in detail. Rather a selection of relevant articles, with regards to the experimental zones, will be made with a brief explanation of their content.

Article 1, subject matter and scope, explains what this regulation is about. Evidently, it is a regulation of UA operation in European sky airspace, it explains technical requirements and procedure for drone operations in the first two operation categories, it provides conditions for the market availability of drones in the open category, and states that the regulation does not apply to indoor drone operations, nor to certified drone operations (EASA, 2017).

Article 4 describes six principles for UA operation. The first principle states that the responsibility for a safe operation rests upon the operator of the drone. The second principle is about the operator's registration of the UA operation in order to be identifiable. The third and fourth principles state that the drone should be equipped with electronic identification means and geo-fencing function. The fifth principle states that the operator shall report the authority on occurrences and other information on safety regarding the drone. The sixth and last principle holds that authorities may assign airspace areas for UA operations according to Article 12 of the same regulation (EASA, 2017).

The last and for this research most relevant article to be mentioned is Article 12 of the NPA. Article 12 presents special zones for drone operations, which can be the contemplated experimental zones. Since this article contributes to the core of this research it will be fully cited (EASA, 2017, p-94-95):

Article 12
Airspace areas or special zones for UAS operations
1. If an operational or other risk related to UAS operations requires mitigation measures, the Member State may designate airspace areas or special zones:

> *(a) where certain UAS operations or types of UAS operations are not permitted without prior authorisation or are not permitted at all;*
> *(b) where access is allowed only to certain UAS classes;*
> *(c) where access is allowed only to UAS equipped with an electronic identification and/or geo-fencing system;*
> *(d) where UAS operations shall comply with specified environmental standards; or*
> *(e) where UAS operations are exempted from one or more of the open-category requirements of this Regulation, and where operators are not required to hold an authorisation or submit a declaration.*

2. Member States shall publish the information on prohibited or restricted airspace and/or designated special zones for UAS operations, as well as on the required authorisations, in a manner and format established by the Agency.

A last important note for this research is Paragraph 6 of Article 15 about the applicability of the regulation. Article 15.6 states that MSs willing to create special zones according to Article 12 have to publish this information (about the zones) within three years (ultimately in 2021) after the regulation enters into force (EASA, 2017).

Within the EU, any regulation that is and will be made on any aspect of drones should consider the fundamental human rights of the EU, e.g. privacy, personal data protection, safety, the right of insurance and compensation, etc.

2.2.4.4 National

Proceeding with regulatory framework on the national level, which connects this section with the second sub-question, the Netherlands has its own drone regulation regardless of the fact that EU regulations are binding for MSs, because EU regulatory framework (NBR) grants flexibility to the MSs as already mentioned in section 2.2.3.1.

The fact that drones are (flying) robots, the laws and regulations on drones are placed under the *"Wet Luchtvaart"* or the Aviation Act of Statute. Within the act three drone operation categories are to be distinguished, namely;

- Recreational, which falls under *"Regeling Modelvliegen"* that contains the ruling on drones with a maximum weight of 25-kilogrammes (kg) which are allowed to fly to a maximum height of 120 meters (m).
- Professional, which fall under *"Regeling Op Afstand Bestuurbare Luchtvaartuigen"* (ROABL) that contains rules regarding drones with a maximum weight of 150 kg which are allowed to fly to a maximum height of 500 m.
- Professional light, which falls under *"Regeling Minidrones*" that contains the rules upon drones with a maximum weight of 4 kg and a maximum fly height of 100 m.

Both professional categories require a 'RPAS Operator Certificate' (ROC), albeit that for professional light a ROC-light is required. In case the organization that is professionally using the drone does not want to hire a drone-pilot, a pilot licence is required as well. Also, a no-fly zone map (see figure 2) is made as part of ROABL (September 2016) (Ministerie van Infrastructuur en Milieu, n.d.). The no-fly zones are valid for recreational, professional, and professional light use. Another shared point is that all three categories are only allowed to operate in daylight. For more details on the Dutch drone regulation, see the factsheet in Appendix II.

As seen from the above, the professional categories need a ROC or ROC-light to be allowed to operate. In the Netherlands, this is not the only certification that is needed, which makes it difficult for innovators or research institutions to experiment. Examples of other exemptions to be received from the Dutch Environment and Transport Inspectorate (ILT or ILENT) before flying a drone are: Certificate of Airworthiness of the drone (BvL), Certificate of Registration or the drone (BvI), Proof of Competence of the pilot (BvB), and Safety Management System for organization/owner of the drone (VMS) (Droneregulations, 2017). Moreover, a full risk assessment is to be made in the area where the operation/experimentation is going to take place (Space53, 2017).

All these regulations are time-consuming and affect "free" experimentation. Therefore a new development is emerging: *"Besluit Testlocaties Drones"*. In English, a regulation on assigning special zones where organizations, innovator, and research institutions are allowed to experiment in a low-threshold manner. Special time-consuming exemptions will not be needed anymore. Moreover, this regulation will connect perfectly with Article 12, section 1, under e, of the NPA published by EASA, since the Dutch regulations are going to be replaced by the European regulatory framework, but the key features of this Crown Decree may then become part of the Dutch implementation of that EU framework.

In conclusion, it can be seen that regulators are interested in the element 'experimental zones' and therefore new regulations on both the EU and Dutch level are expected. As regards types of regulatory instruments, and in connection with the third sub-question of this study, some further elaboration on the basis of regulatory theory will be given in the next section, 2.3.

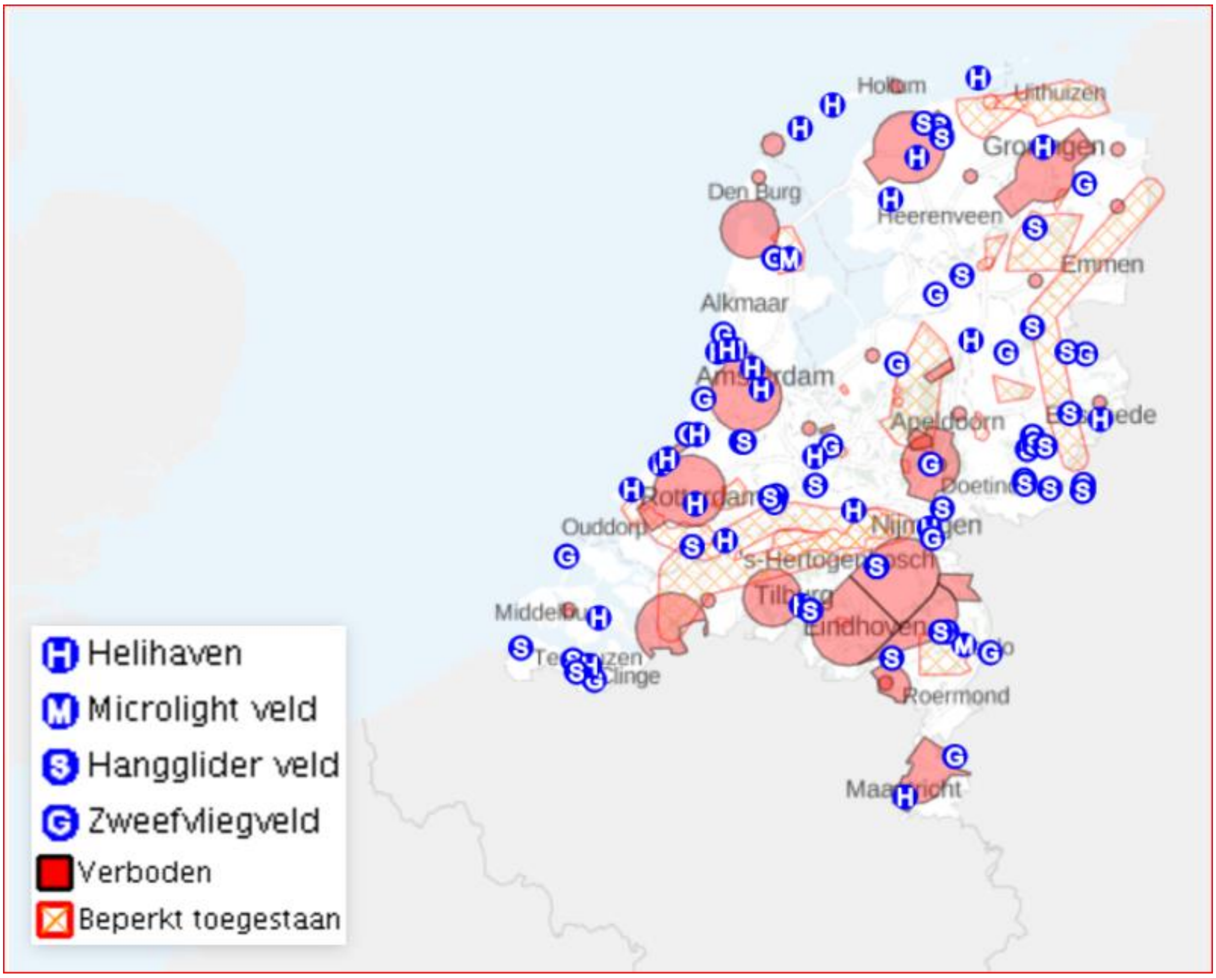

Figure 2 No-fly zones, the Netherlands (source: Ministry of Infrastructure and Environment)

2.3 Regulation

Regulation, as mentioned in the introduction, is about any instrument that is made to channel behaviour. An instrument may have a legal or non-legal character, a governmental or non-governmental source, and may operate directly or indirectly. Regulation, together with law and governance make up the regulatory environment (Brownsword & Somsen, 2009). There are four types of regulatory strategies, each building upon a distinct type of behavioural incentive: hierarchy-based regulation, community-based regulation, competition-based regulation, and technology-based regulation (also design-regulation) (Heldeweg, 2013). Hierarchy-based regulation uses the force of the law by presenting unilateral binding rules ('shall (not)'). Within this type of regulation, the dependence is on command and control. Competition-based regulation relies more on exchange and regulatory competition ('want (not)'). Public rights are tradable, i.e. paying taxes means having rights on subsidies. The community-based regulation is about cooperation ('ought (not)'). It relies on social values and debates, networking and contracts. And last, techno/design-based regulation. This is a type of regulation that takes physical measures by design ('can (not)') and is also called regulation by architecture. An example is a road that is intentionally made bumpy to lower car speeds. A more technological example is, for instance, a drone with a sensor that refuses to fly into a wall to avoid collision (Heldeweg, 2013).

Regulating behaviour occurs via three types of normative or regulatory channelling; negative, neutral, or positive channelling. Negative channelling, with a duty approach nature, is about prohibition ('shall not do'); e.g. "drones, as an emerging technology, are not allowed to be deployed". On the other hand, a more utilitarian approach is positive channelling which is about command ('shall do'); e.g. "the deployment of the new drone technology is compulsory". Last but not least the neutral type of channelling, which is permissive. This is more of a rights approach; e.g. "drones, as a new technology, are permitted to be used, but it is also allowed to restrain". The more exemptions within the negative and positive types of regulatory channelling, the more 'neutral' they become (Brownsword & Somsen, 2009).

2.3.1 Risk mitigation: Technology-based regulation

The fact that drones have several risk issues which need to be mitigated is no longer a surprise. As described in section 1.1 risks can be as dangerous as taking innocent lives. To mitigate risks EASA is working via two approaches: the risk-based approach (RBA) and the performance-based approach (PBA) (EASA, 2017). The RBA mechanism allows hazards to be identified by means of data collection, safety modelling and an analysis of safety data to measure risks that are associated with those hazards to demonstrate and monitor strategies for risks mitigation by the competent authority which helps the authority in focussing on organisations that need higher or extra attention. The PBA, on the other hand, is about reaching a better safety performance by setting up and monitoring relevant goals through measurement of safety performance activities and finding ways to target safety issues of greater demand and concern (EASA, n.d.). The RBA differentiates between the open and the specific drone category. In the open category, the RBA offers subcategories that are based on a risk assessment which mitigates both air and ground risks by a set of limitations, remote pilot abilities, operation rules, and also technical conditions for the drone. In the specific category, the operator is responsible for the risk mitigation by appointing the risk assessment requirements before starting any operation. The PBA is implemented by providing a combination of the requirements mentioned in the draft regulation, and also a set of related Acceptable Means of Compliance (AMC) and Guidance Material (GM). Managing technical requirements is done by their expression into functionalities and supported by industry standards. In the open category, CE marking will ensure that drones are in accordance with the technical requirements, as is set out in the NBR (Regulation 201X/XXX) (EASA, 2017). In other words, the PBA is based on techno-regulation, whereby the drone itself is made to be of a 'low-risk' nature using specific technical characteristics (as pay-load) (EASA, 2017). The above differences between RBA and PBA are listed in table 1 below.

Table 1 European RBA versus PBA (source: EASA, n.d.)

Risk-based approach	**Performance-based approach**
About hazard identification	About better safety performance
Monitoring risk mitigation strategies	Monitoring relevant goals
Implementation by: - Open category: risk mitigation through risk assessment for both air and ground risks - Specific category: risk mitigation by appointing a risk assessment before the operation	Implementation by: - Providing a combination of requirements according to the draft regulation - Providing a set of AMC/GM

Increasing the automation in the field of robotics, in this case, drones will lower risks by lowering (if not eliminating) the chance of human mistakes – i.e. by the drone pilot (which might be a child)). However, robust technology is still required. Drone technologies based on traffic management solutions as geo-fencing, detect and avoid, and datalink will enhance safety (EASA, 2017). Using algorithms drones are capable of handling situations 'on their own', via detecting situations and responding to them (two parts of an algorithm). For example, an algorithm tracks the movement of the drone and detects a violation of the borderline, and thus 'commands' the drone to find its way back. This technique falls under two concepts, namely; 'virtual space boxes' (a 3 dimensional (3D) analogue to geo-fencing), and 'drone-as-reference-station localisation' ("return-home" functions). The virtual space box is, as the name suggests, a 3D space area with boundaries (a box), wherein the drone is programmed to fly. The drone-as-reference-station localisation is a technique whereby the drone is flown to three reference points (triangular) to obtain signal measurements, which the drone will use to triangulate within (Alwateer, Don & Loke, 2016).

Other risk mitigation measures can be pyrotechnics for decreasing masses of impacting objects, and parachutes that reduce the kinetic energy in cases of impact. Also, different types of sensors can play a role in risk mitigation but might be heavy pay-load which is a disadvantage (Dalamagkidis, Valavanis & Piegl, 2012).

2.3.1.1 U-space

European steps towards a drone traffic management system with an automation-based construct have been taken. The EC is advancing Urban-space (U-space) to manage drone traffic up to 150 m (Carey, 2017). In June 2017 SESAR Joint undertaking presented the U-space blueprint (U-space Blueprint, n.d.). All EU research and development (R&D) activities regarding air traffic management (ATM) is coordinated and concentrated by SESAR (Discover SESAR, n.d.).

U-space is a set of services which are set up to aid efficient, safe, and secure airspace access for drones by designed procedures. Techno-regulation based, U-space relies on high levels of functions automation and digitalisation which can be part of the ground-based milieu or on board of the drone. According to the U-space framework, the provided services will be based on agreed upon EU standards. Three “U-space foundation services” (U1) are already identified namely; Electronic identification (e-identification), electronic registration (e-registration), and geo-fencing. Drones below a weight of 250 g are excluded from e-registration. As seen in figure 3, except for U1 services, U-space will ultimately be providing three more services: “U-space initial services”(U2), “U-space advanced services”(U3), and “U-space full services”(U4). U2 provides management support of the drone operations, U3 supports complex drone operations carried out in dense areas, and U4 offers services for operations that are integrated with manned aviation. By 2019 it is expected that the U1 services will be established and will provide great numbers of drone operations while enabling new ones, which will be a cornerstone for the roll-out of U2-U4 (SESAR, 2017).

To conclude, it is clear that the EU and related organisations are working towards a technology-based regulation for drone operations to mitigate risk issues. However, techno-regulation does not remove the uncertainty of the innovation process on its own. Also, testing the technology is required. Therefore the next section elaborates on a necessary legal instrument: experimentation.

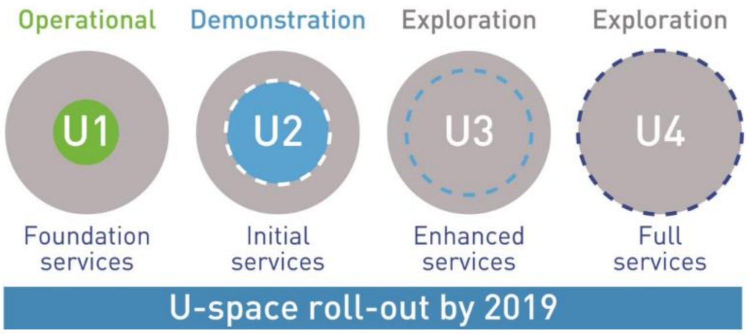

Figure 3 U-space roll-out by 2019 (source: SESAR, 2017)

2.3.2 Experimentation

Innovation is, as already mentioned, a process which is uncertain. Experimentation is an important instrument to reduce or even remove the uncertainty factor within technological. The purpose of experimentation is acquiring knowledge to overcome uncertainty (Heldeweg, 2017). The ultimate goal of experimenting is learning on a small scale to later apply widely with societal benefit/relevance. The ideal setting would be to do so without any risks, but mainly it will be risk-taking whereby the possibilities for negative effects are limited. The real challenge, however, is covering the gap between the artificial setting of the experiment and the application in the real world (Heldeweg, 2015). Besides being an instrument to reduce uncertainty, and hereby allowing regulation to keep pace with technological change, experimentation is a tool to “glue” the regulatory disconnect that exists between outdated existing regulation and emerging technological development (Brownsword & Somsen, 2009; Heldeweg, 2017). Hence, creating regimes for experimentation is important for two reasons; (1) encourage policy-learning through gathered information and results of the experiment, and (2) provide experiments with the necessary assets to perform. Experimenting without the experimental regime may cause a breach of existing legislation by performing illegitimate acts outside the scope of legal liberties or legal abilities (Heldeweg, 2017), which is also known as ‘legally disruptive experimentation’. Regarding legal regimes for experimentation, two legal disruptions are to be distinguished, namely; first order and second order. First order legal disruption allows for temporary experimentation, whereas second-order legal disruption may end into a permanent change. In permanent legislation, there is a possibility that first order legal disruption leads to a second-order legal disruption or lead to keep the *status quo* (Heldeweg, 2015).

Looking to the case of this research, drones fall under legally disruptive experimentation, since there is no specific experimental regime and as a result drone experimentation requires exceptional legal arrangements. In the Netherlands, the Dutch law encourages self-regulation by providing meta-regulation (guidelines) whereby two types of experimentation exist; factual and legal. Concerning governance and technology, and without the intention to change the law, factual experimentation is basically about doing or not doing something. Legal experimentation, on the other hand, opts to change the law in the form of legal acts (Heldeweg, 2015).

As regards legal frameworks for experimentation two main types exist, namely; experimentation by exceptional derogation and experimentation by devolution. In the case of the first, it is allowed to differ from the actual legal rules, whereas in the case of the latter experimentation is set by decentralising power within a hierarchical structure. Experimentation by derogation may happen within the framework of experimentation by devolution (Du & Heldeweg, 2018; Heldeweg, 2017).

2.3.2.1 Legal space

Legal disruption is addressed in legislative regimes for experimentation. Confining the design-challenge whereby competent experimentation regimes provide ‘legal space’, as a matter of ‘legal liberty’ and ‘legal ability’, seem important. Legal liberty space is associated with factual experimentation and is about rules of conduct. In case of a lack of liberty space, a regime is needed whereby constraints are removed by derogating from existing commands and prohibitions and hereby granting an extraordinary legal permissiveness for experimenting. Also, obligations are to be introduced for third parties to support, allow, and provide experimentation which is legally facilitated. Legal ability space, on the other hand, is about the rules of power. In case of a lack of ability space, a regime is required that provides legal powers to conduct legal experiments. In the case of factual experimentation, legal powers are needed to secure vital resources. Also, this type of regime is crucial to immunize against unexpected law changes in both factual and legal experimentation (Heldeweg, 2015). In other words; legal liberties provide permission to refrain from or perform certain legal acts, whereas legal abilities are about changing liberties by powers (Heldeweg, 2017).

2.4 Concluding remarks

To clarify, some concluding remarks will be given with regard to the first three research sub-questions. As described in section 2.1 and addressed in the first sub-question the forecasted deployment of drones on a large-scale with a wide range of different applications raises risks and concerns with regard to privacy, data collection, safety, and environmental intrusion. The flying robots are able to easily invade human and animal personal space. Therefore a call for a regulatory framework for drones exists on all the different layers of governance (section 2.2). This call being addressed in the second sub-question, it seems that authorities within all layers recognise the need for a regulation. They also clearly realise that cooperation between 'them' is important to produce effective legislation within a short period of time since drones are already on the market. On the supranational level, the EU is about to introduce a regulatory framework, the NPA, which will be further elaborated with the NBR that will follow at the end of 2018. By means of the NPA, it is clear that the EU acknowledges the importance of the creation of experimental zones (Article 12) to test drones, as well as use feedback from these experiments for the further development of legislation (Article 15.6). On the national level, it seems that the Netherlands also wants to move towards the creation of liberty space by allowing for experimental derogation through the Crown Decree *"Besluit Testlocaties Drones",* which connects to NPA Article 12. Another important element is the EU desire to move towards technology-based regulation with regard to drone deployment to mitigate risks and ensure higher levels of safety and therefore SESAR introduced U-space to safely manage drone traffic up to 150 m. To test whether techno-regulation is useful, not only experimental zones are necessary, but experimental regimes as well, which is mentioned in section 2.3 and connects with the third sub-question. Experimentation is an important instrument to channel behaviour and acquire knowledge. It can occur by derogation from actual legal rules, by devolution through decentralising power within hierarchical structures, or by a combination of both regimes whereby experimentation by derogation happens within the framework of experimentation by devolution. Experimentation is also crucial to societal acceptance since it can "prove" to citizens as well as professionals, that the use of drones regulated by technology has high levels of safety. More on this subject is to be discussed in the next chapter, Expert's View, which is directly linked to the fourth sub-question of this study.

3 Expert’s View

In this research, within the aims of research sub-question 4, interviews with six experts have been conducted which fall under three different actor groups: public (state), private (business), and educational (institutions). The first interview was conducted with state actor Mr F. Bouwmeester, project leader ‘experimental zones’ and Senior Policy Advisor at the Enschede municipality in Twente Region. The second with two educational actors (simultaneously): Mr N. Kloek, Accountmanager Facility Management, and Mrs M. J. Winkler, Program Manager Campus and Innovation, both at the University of Twente. The third conducted interview was with Mr M. Sandelowsky, CEO of Space53, as a private actor. The forth conducted interview has been with Mr R. Sanders, Safety and Coordinating Radiation Officer at the University of Twente. Last but not least an interview with educational actor Mr A. Y. Mersha, Associate Professor Unmanned Robotic Systems at Saxion University of Applied Sciences. The expert views in this chapter provide an answer for the fourth sub-question, but it will be discussed in depth in the next chapter. The findings will be presented in the following main sections: experimental zones, techno-regulation, ethical concerns, level of regulatory framework, and the regulatory-disconnect.

Experimental zones

In the introduction, the problem of different drone user categories (amateurs, professionals, and manufacturers) is described. The problem is that the second group is legally restricted to ensure that the first group does not endanger citizens’ safety and privacy, and this is also being emphasised by all the expert-interviewees. Amateurs are allowed to buy a drone (max. 4 kg), whether it is from the Netherlands or outside, or tinker their own drone, which is called an experimental drone, and fly it (Sandelowsky & Sanders, 2018). Professional users, on the other hand, need to have a ROC (above 4 kg) with a full risk assessment attached, a certified drone, and an insurance (Sandelowsky and Sanders, 2018). According to Mr Sandelowsky, experimental zones are needed to make an explicit difference between amateurs and professionals. He also mentions the third “forgotten” group of manufacturers, which is also being restricted and only interested in experimenting with their drones as a test for looking at possible improvements of the drones and whether the drones are in compliance with the technological requirements. Mr Bouwmeester sees the importance of experimental zones in their potential of offering possibilities to experiment with certified drones in different situations but in a controlled environment. The ultimate goal is testing in a real-life situation, but this goal is to be reached via sequential testing. However, moving on to the next experimental setting should only be done when the risks are minimalised in the current setting. At this, keeping a drag record of the drone is crucial, as is emphasised by Mr Sandelowsky as well. Notwithstanding for the creation of experimental zones, a structural system of exemptions is needed. The problem here is that it is legally not clear what the conditions of such a zone are. Thus, a definition of “experimental zones” should be included within the law.

Going beyond an experimental zone, Mr Kloek, Mrs Winkler and Mr Sanders are advocating to grant the University campus an “airport” status whereby it is not needed anymore to ask for exemptions with regard to drone operations at the campus. However, this campus is still to be regarded as an experimental zone, since it is dedicated to learning & research.

Technological Regulation

The concept of techno-regulation with regard to drones is to make a drone that operates in risk full areas (i.e. nearby airports and dense areas with citizens or animals), risk-free via technological features attached to the drone as payload. All the experts-interviewees are of the opinion that making drone operations risk free is not possible, but via techno-regulation, it is possible to lower risks to almost nothing because we are not depending on people who are mostly amateurs. However, they do not encourage to fully eliminate the human role in drone operations because humans can adjust (Mersha, 2018). Artificial Intelligence (AI) will only do as is it is programmed to (Sandelowsky, 2018). From a technological point of view, it is possible to make drone autonomous depending on the application the robot is going to be used for. Drones are a tool and by means of the different payloads, they are able to carry out tasks without endangering the pilot. Because drones are able to do tasks humans cannot, we consider robots for applications that were not considered before (Mersha, 2018). However, the same payload that can be used to serve humankind if put to good use, is the creator of societal unacceptance of drones – see section 2.1.3 as well. A camera, for instance, can be used to observe a natural phenomenon for scientific research, as well as film someone in his/her house. Mr Sandelowsky emphasises safety- and privacy-by-design. Geo-fencing, for instance, blocks the drone from flying near airports. Or camera's that do not send a video stream but have sensors that detect abnormal situations (noise and too much light). Making the drone blur those who are not scanned in previously to protect people's privacy (Bouwmeester, 2018). Dr Mersha confirms all of these idea's but emphasizes the fact that drones are a tool, therefore these technologies should be put in/as payload. Blurring people, for instance, depends on the camera technology, not the drone. He also suggests the application of rules that forbid keeping data about others. The problem here exists with the ethics of those who have the data. They might not eliminate it and put it to bad use (Mersha, 2018). Thus it is agreed upon by all expert-interviewees that drones should be put to work for the society and that the society should be aware of this and accept it because people find robotic control very scary (Winkler, 2018). Another problem arises in the case of drone hazards. If techno-regulation is applied on the drone and it is fully autonomous, who is to blame in hazardous situations? The opinion is that in case of a technological failure, the manufacturer is to blame (Bouwmeester, Kloek, Sandelowsky & Winkler, 2018). Mr Sanders, on the other hand, is of the opinion of blaming the pilot because having an autonomous drone does not mean that the pilot does not need to keep an eye on the robot anymore. However, Mr Kloek justly says that this is a problem for later. It is an insurance issue (Sandelowsky, 2018).

Ethical concerns

It is, according to the expert-interviewees, not disputed anymore that societal acceptance should be created, with regard to drone deployment. The greatest concerns exist regarding safety and privacy: no one wants a drone dropping from the sky on his/her head, or suddenly being uploaded to the internet. Coming back to the experimental zones, we do need them to experiment in order to protect peoples interests (Sandelowsky, 2018). The experimental zones could also contribute to the societal acceptance by allowing people to be engaged and showing them results (Sandelowsky, 2018). Guaranteeing safety could be done via crowd control on festivals by means of drones (Bouwmeester & Kloek, 2018). Drones might detect criminal/abnormal activities and send alarming signals to the police (Kloek, Sandelowsky & Winkler, 2018), resulting in fewer burglaries for instance (Bouwmeester, 2018). There are lots of applications drones could be tasked to do that contribute to the well-being of the society, but this needs to be accepted first. We need to create awareness and show citizens how beneficial drones can be (Bouwmeester, Kloek, Mersha, Sandelowsky, Sanders & Winkler, 2018). They might even solve ethical dilemmas, such as if a firefighter should run into a fire to save a citizen even if it would cost his/her own life while drones can do this without costing life (Merhsa, 2018). Even though drones are just another technology that needs time to be accepted, like cars (Bouwmeester, Mersha & Sandelowsky, 2018), the challenge now is bigger because of their mobility (Winkler, 2018). Getting through to the people is the greatest challenge. To do so we need to understand the social concerns of the people and address them. Identifying how they would accept it is crucial. Just enforcing the law will not work (Mersha, 2018).

Level of regulatory framework

All expert-interviewees agree that when it comes down to the choice of level of regulatory framework (supranational vs. national), EU regulation is crucial. An EU regulation is needed as a framework, but for the speed of procedures, there should be local power to decide, while supervision happens nationally. Mr Sandelowsky describes two problems with regard to decentralisation. The first problem is: who owns the skies? Not the municipality. Therefore we need national frameworks, but this creates the second problem which is that there will be too much fragmentation (on EU level) and it will be difficult for manufacturers to consider different national requirements. Hence, professional use frameworks should be rather on the EU level.

Regulatory disconnect

The regulatory disconnect between innovation and regulation is the problem that keeps users of the second and third category from experimenting. Mr Bouwmeester emphasises the fact that the disconnect will always be present because private organisations innovate faster than governments. Nevertheless, the government should be part of the progress instead of standing aside. Allowing experimental zones would contribute to reducing the gap between technology and law because mimicking real-life situations will produce information/data that can be used by regulators (Sandelowsky & Bouwmeester, 2018). Mrs Winkler suggests that within the law there should be more responsibility for the professionals and they do not need to ask exemption for every little detail in their experimentation process. Mr Kloek is of opinion that there should be regulations with regard to conditions of experimental zones. Organisations can show that they do comply with the rules and thus be able to experiment without endangering the environment outside of the zone.

To conclude, we can derive from the expert's view that they do clearly advocate the creation of experimental zones, using certified drones. The experimental zones are not allowed because of ethical concerns, regulatory disconnect, and the insurance whether techno-regulation actually works, but the expert-interviewees view this very differently. The experimental zones are needed to remove the ethical concerns, reduce the regulatory disconnect and actually test whether techno-regulation works or needs to be improved, before largely deploying drones in an uncontrolled environment (the real life). Techno-regulation itself is actually not only to be tested, but it contributes as well to the creation of societal acceptance, reducing the ethical concerns and reducing the regulatory disconnect. Experimental zones in combination with techno-regulation can be used to properly experiment with technology which generates outputs to generate ethical acceptance, and knowledge that is generated locally to be upscaled to the higher levels of governance, i.e. from local, to national, to supranational etc. which as well mitigates the regulatory disconnect. These options will be discussed in the next chapter, four

4 Discussion

The purpose of this research is to identify the problems associated with the emerging drone technology and examine the differences in how this is being experienced by different key-player actors from within and outside the field, i.e. informed and uninformed individuals. Issues include the legal possibilities for the creation of experimental zones, which will be discussed on the basis of sub-question one and two (section 4.2), risks and concerns with regard to large-scale drone deployment as examined in the introductory section of the theoretical framework: 2.1 (section 4.2), the application of regimes for experimentation which stands in connection to sub-question three (section 4.3), and in reference to the fourth and last sub-question: the regulatory disconnect (section 4.1). In this chapter, these topics will be discussed on the hand of the proposed theory, findings, and the expert's views.

4.1 Regulatory Disconnect

The regulatory disconnect is a problem that emerges between innovation and regulation whenever a new technology appears. Hereby law always seems to lag behind innovation. This appears to be the case because of the different natures and principals of public and private actors. Innovators are more driven by enthusiasm and a longing for change. Even if the change from what is 'old' to what is 'new' demands taking risks, as they appear to be tenacious to Socrates' secret of change: "The secret of change is to focus all of our energy not on fighting the old, but on building the new". Regulators, on the other hand, are driven by stability and want to predict future events that may be caused by a certain innovation first, even at the cost of a delayed innovation process. It seems that regulators still abide by the Aristotelian principle: "Law is reason, free from passion". Nevertheless, it should be admitted that this attitude of regulators has tacitly constrained undesirable innovations, while many desirable innovations can still occur within flexible rules that exist. Moreover, without a stable legal context supplying certainty about going back to investment, many desirable innovations would not be set in motion. However, being stuck between team Socrates and team Aristotle, Twente Region still has no *de facto* experimentation zone, which is highly desired by the expert-interviewees as they made clear. On the bright side, (newly) proposed prospective regulations on European and Dutch levels show that there is political willingness towards the creation of liberty space as a means of a legal experimentation regime, instead of the current legal disruptiveness with regard to drone experimentation. Experimentation is a process whereby information is obtained, which allows, through stakeholder participation, for creating acceptance or setting new boundaries of acceptance, and whereby legal and epistemic values are taken into account. This makes experimentation an instrument to base legal framework on. Hence, governments/regulators should encourage experimentation instead of limiting it. Currently, because of a delay in regulation sunrise clauses have emerged whether this was intended by regulators or not. However, this should be seen as an opportunity to base new legal solutions upon and it should show the effectiveness of an experimental approach, even though experimenting is only possible after granted exemptions.

4.2 Experimental zones & technology-regulation

Proposed regulations whereby regulators acknowledged the importance of experimentation zones are the NPA proposed by EASA and the Dutch Crown Decree *"Besluit Testlocaties Drones".* Combining the Crown Decree with NPA Article 12, section 1, under e, seems to be the permission for the creation of test locations in the Netherlands, thus Twente Region. Despite the fact that Article 12 still gives MSs the right to abstain, because the Article clearly states that MSs "may" designate special zones, there is no need to worry in case of the Netherlands because it is already clear that Dutch law is going to be replaced by EU regulations (Dijksma, 2017). The Crown Decree will not be discarded, rather key features may then become part of the Dutch implementation of that EU framework. Article 12 of the NPA also states that the EU is working towards eliminating the chance of human mistakes via techno-regulation, and technological features (as pay-load) are made a must under Article 1 of the NPA. However, the first article also states that the operation responsibility is on the operator, which sounds contradictory. This dilemma of techno-regulation versus human brain has been addressed during the interviews with the experts. The problem here is that we want to make the drone itself of a low-risk nature via techno-regulation, to be able to operate safely in a risk-full area. However, the expert-interviewees believe that AI only works through prior programming of certain situations and actions as a response to that situation. It is not able to adjust like humans, which is the greater advantage of the human brain. On the other hand, drones can carry out missions humans are not able to, which means that an approach is needed whereby drones and humans work "together", instead of one eliminating the other. A Dutch premiere of this type of collaboration between humans and drones is the exceptional permission the fire brigade was able to obtain in the Province of Brabant (Central and West) and the Twente Region in October 2015. Through this permission in the law, the fire brigades were able to experiment and practice with drones, to eventually use drones during firefighting (Haven, 2017). This example does not only show the ability of drones and humans to work together, but it contributes to the creation of societal acceptance since such experimentation, and eventually, drone deployment, demonstrates that drones can also be used to serve humanity. Moreover, as safe as an autonomous drone might actually be it is on the other hand highly dangerous within the amateur user category, as this type of users will fully trust the drone since it is claimed that the technology inside the drone mitigates the risks "itself". This may actually result in lower levels of safety through more hazards instead of fewer hazards as is meant to be. Here, amateur drone regulation has been proposed during the interviews, despite the fact that this study mainly focuses on the professional user's category. The expert-interviewees seem to have interest in the amateur users category as well since this category is directly linked to creating societal awareness. Hence, as discussed during the interviews, along with e-registration, a solution might be to propose some sort of ROC for amateur users as well to mitigate hazard risks. It does not need to be as elaborate as within the professional user category, but a workshop of a couple of hours to a day which afterwards ensures a safe(r) use of the drone reduces a certain amount of risks already. A problem hereby is that this can be done only with drones bought at a store for it is not possible to do so with drones bought via the Internet. However, when the compulsory e-registration of drones comes into force, buyers might receive an appointment for the workshop. Hereby a system of drone owners is created (just like cars) and it will be possible to control drone use. Of course, a possible drone police force is needed to maintain this system through surveillance whereby violation is fined. Another aspect the "amateur ROC" should address is the privacy of fellow citizens while operating the drone because operators might just not be aware that they are violating people's privacy (user ethics). Finn et al. (2014) describe privacy as liberty and citizens have a fundamental right to liberty. Other threats that can thus be mitigated hereby are the chilling-effect and function-creep because pilots will be aware of these threats. Actually, the chilling-effect is more of a feeling because people believe to be constantly watched even when they are not. This brings us to a crucial dilemma: societal acceptance. For the creation of societal acceptance, it is needed to create awareness with regard to drones. Identifying the needs and concerns of citizens helps doing this and experimentation in zones can be a helpful means to develop acceptance or adjust drone-technology development to what is acceptable. Coming back to the "amateurs ROC" it might as well be a tool to create awareness instead of enhancing safety and privacy only. Herewith, there will be an "educated" group regarding drones. This group of educated people will contribute to spreading proper information with regard to drones and especially to more difficult groups to reach, i.e. children to parents or grandparents.

4.3 Multi-level information exchange by means of experimentation

Returning to Article 12 of the NPA and Dutch Crown Decree *"Besluit Testlocaties Drones"*, it seems that there are a political willingness and a possibility to create an open innovation regime combining both experimentations by derogation and devolution. In this case, every MS will be able to legally experiment by derogation since the liberty space for experimentation is created. This will show an important understanding of experimentation, which is that obtaining useful information is of big significance. Hence, every MS will obtain valuable information from studies and/or tests from their experiments and send it to the EU, which is a mentioned condition in NPA Article 15.6 as well (EASA). In other words, there will be a valuable exchange between the national and supranational levels of governance, which will contribute to further research and new straightforward and effective regulatory framework and will be profitable for all the involved key-players. Thus, on the EU level, the information from the MSs will be used for the creation or improvement of regulations which will be provided to the MSs in a top-down approach, which means that experimentation by derogation will occur within the framework of experimentation by devolution. Therefore, with the combination of the bottom-up and top-down approach, team Socrates and team Aristotle will be working together on closing the gap between innovation and regulation called regulatory disconnect. Even though this seems to be the happy end, a new problem will emerge: closing the gap between experimentation in an artificial setting and risk-free implementation in real-life.

4.4 In fine

In conclusion, it is clearly seen that the regulators and expert-interviewees are on the same wavelength, with the exception that the experts want steps to be taken faster as is made clear in the discussion. At this point not only the experts seem to realise that the creation of experimental zones for experimenting with techno-regulated and certified drones is crucial to actually solve problems with regard to large-scale drone deployment, but the regulators as well, as this is made clear by the emerging regulatory framework, within the different layers of governance, which are planned to enter into force soon. The joint motion today is that experimentation is key to yield information to address risks and concerns such as safety, privacy and the creation of societal awareness, which will eventually result in societal acceptance. Experimentation is also very important in the contribution of solving the regulatory disconnect problem since experimentation outputs will help regulators in making fast and straightforward legislation.

The next chapter, five, will answer all the research sub-questions, as well as the research main question and draw conclusions with regard to this study. This will be followed by listing the limitations of this study and eventually give recommendations for further research.

5 Conclusion

This chapter firstly gives an answer to the research questions and other concluding remarks with regard to the emerging problems associated with drone deployment and, secondly, the limitations of this study will be mentioned, as well as recommendations for further research.

5.1 Conclusion

The starting point of this research was to investigate options for the creation of permanent experimental zones in Twente Region to allow for sequential legal experimentation, as is as well the interest of the public-private partnership called *"Werkgroep Lobby en Regelgeving"* which includes public, private and educational actors from the region. The main question of the research was: *"What are the options to, within the Netherlands, develop zones for experimentation with civil drones while safeguarding the safety and privacy of the air traffic and citizens, and how does the development of these zones contribute to the solution for the dilemma of regulatory disconnect?"*

Before continuing to answering the research main question, answers for the four research sub-question will be provided. Starting with the first sub-question, which was: "*What are the risks and concerns associated with large-scale drone deployment?",* we have seen that different risks and concerns with regard to large-scale drone deployment exist, as examined in section 2.1.3. To briefly conclude the first sub-question, it can be said that the different risks that exist are privacy risks, data protection risks, and ethical concerns which exist of safety risks, public dissatisfaction, illegal intrusion in wildlife and discriminatory targeting. To tackle these risks and concerns regulatory framework is needed to set rules with regard to privacy and data protection that will protect citizens from fraud. Another solution, which was provided by the expert-interviewees is to address the drone users ethics, as in making them aware of what is right and wrong in terms of dealing with captured data. This applies to the ethical concerns of intrusion in wildlife and discriminatory targeting as well, as it is very important that the pilots (researchers or police) are aware of the amount of damage they can cause, even though their intentions are good. As for safety, the EU is working towards regulating drones by technology, as will be further explained in the course of this section.

Coming to the second sub-question which was: "*What is the current state of regulations concerning drones within the different layers of governance, with an emphasis on the creation of experimental zones, and how do Dutch and European regulations contribute to the creation of this legal space for the Twente Region?"* and examined in the second chapter, theoretical framework, section 2.2, there is a high demand for a regulatory framework with regard to large-scale drone deployment. Therefore, organisations on the international (ICAO), transnational (JARUS), supranational (EASA), and national levels of governance are working towards regulated drone traffic, with the National level being the Netherlands in this case. EASA takes works and developments made by ICAO and JARUS into account, and cooperation between these organisations exist. With regard to experimentation and the creation of experimental zones, there is currently no European experimental regulation that allows for such zones. As for the Netherlands, the only options to experiment now are by meeting several conditions set out in the Dutch regulations *"ROABL"* en *"Regeling Minidrones"* (under 4 kg) to be granted exemptions. However by the end of 2018, as EASA states, the European NPA will go into force, which allows for the creation of 'test zones' (Article 12). Despite the fact that Dutch law will be replaced by the NPA, the Dutch Crown Decree *"Besluit Testlocaties Drones"* will not be discarded which also allows for the creation of experimental zones.

Continuing to the third sub-question which was: *"What are the different types of regulatory regimes that can be applied to experimental zones?"* and was examined in the theoretical framework, chapter two, under section 2.3, it can be said that the best types of regimes to be applied to experimental zones are experimental regimes, which might sound obvious. Since the process of innovation is highly uncertain, experimentation is an important instrument to reduce or even remove this uncertainty, which can be done by acquiring knowledge, which is the purpose of experimentation as well. Moreover, reducing uncertainty experimentation allows regulation to keep pace with innovation, which allows the regulatory disconnect to be "glued". However, to be able to experiment, regulatory framework that provides liberty space to do so is needed. For experimentation within legal frameworks, two main types exist which are experimentation by exceptional derogation and experimentation by devolution, whereby the first experimentation regime may happen within the framework of the latter regime. In the case of experimental zones present in the Twente Region, this combination creates a highly profitable open innovation regime for the different key-players, as is discussed in chapter 4, section 4.3.

Last but not least, the fourth sub-question, which was: *"How does the creation of experimental zones contribute to solving the problem whereby law lags behind technological innovation of drones, according to actors and key stakeholders in the field?"* is to be answered. According to the expert-interviewees, the creation of experimental zones will, obviously, allow for experimentation, and experimentation will result in closing the gap between innovation and regulation by mimicking real-life situations and producing information/data that can be used by regulators to create regulatory framework. Moreover, the expert-interviewees seem to see experimentation as the solution for all the risks and concerns with regard to drone deployment, because that is the only way to actually know how high these risks are and mitigate them by experimentation as well.

Coming back to the main question of this research it can be said that the options for experimental zones developing, lie in the fact of new coming regulations on EU and Dutch level, which were the combination of EU NPA Article 12 and the Dutch Crown decree *"Besluit Testlocaties Drones"*. As for the second part of the research question, safeguarding the safety and privacy of air traffic and citizens, two conditions need to be met. First, optimizing techno-regulation programs and services, such as U-space, and second, creating societal awareness. As for the safety of air traffic techno-regulation as a solution provides the GPS technology called geo-fencing, which will not allow the pilot to fly a drone in no-fly zones. However, in the case of human failure techno-regulation does not protect citizens' safety nor privacy. Here comes the role of societal awareness, which does not only advocate for the acceptance of drone deployment by citizens but also on making them aware of drone operations and involved risks. Experimentation is key to the creation of this awareness as well as awareness raising campaigns run by governments and involved organisations, which is confirmed by the expert-interviewees as well. The technology will mitigate safety risks by "making" sure that a drone does not fall off the sky on someone, but societal awareness is the tool to make people aware of rules and ethics while using such a flying robot, which will contribute to their fellow citizen's privacy. As for the regulatory disconnect, theory (section 2.3), as well as the expert-interviewees (third chapter), showed that experimentation is crucial to result in a closed gap between innovation and regulation. Experts made clear that the combination techno-regulation, creating societal acceptance via societal awareness, and legal experimentation in controlled permanent experimental zones, combined with gradual/sequential upscaling, create the ultimate formula for a low risk and successful large-scale drone deployment. They advocate for this to be done under the wings of regulations at the EU level to prevent segmentation, not realising that with this demand they end on the side of team Aristotle: *"The whole is more than the sum of its parts".*

5.2 Limitations and Recommendations

Before ending the thesis limitations of this study as well as recommendations for future research will be given in this section. This study has been conducted while being restricted to Twente Region to be able to only focus on the developments of this region only and *"Werkgroep Lobby en Regelgeving*". However, this may have limited the research, since it is turning a blind eye to another possible partnership in the Netherlands. Also, because of this restriction, only experts from Twente Region were interviewed. For further research, I highly recommend to take at least two Dutch regions into account, or, depending on the magnitude of the research, even the whole country to also be able to compare between developments within different Dutch regions and find options for cooperation. As for the interviews, it would be interesting as well to try and contact regulators from the political city of The Hague themselves, instead of only examining their views via actors from the Twente Region. In this study, semi-structured interviews were conducted to give the researcher more freedom during the conversations. Yet this may have resulted in a researcher bias and therefore structured interviews, which are also recommended for future research, might have been a better solution to avoid this bias. Another limitation is that despite the fact that drones are robots and a regulatory disconnect exists for all robotics, the proposed solutions with regard to closing this gap are not generalizable. This is because drones, *inter alia* being robots and need to be tested, have a flying nature which makes them "reach places", which were out of reach in the 'on the ground' dominant type of world, where fences, gates and doors, would suffice to keep others out. This extended 'reach' makes drones seem 'scary' to people and raise lots of issues as we have examined.

Having reached the point of future research recommendations, the first recommendation is to test the interaction of citizens with drones. Involving the people will be a great contribution to identifying their needs and concerns and take them into account as well as a contribution to an easier/faster creation of societal awareness to enhance social acceptance of the flying robots. However, this a research for the next stage when the awaited regulations will get into force allowing for experimentation in the experimentation zones. The second recommendation is about AI. As is mentioned in chapter 4, section 4.2, the expert-interviewees do not believe that AI is very intelligent since everything is already pre-programmed in the concerned robot. It might be the case that AI is already progressed from this stage, which is not examined in this study because it falls outside of its scope and might lead to unknown and unpredictable territory and raise new questions, which may be interesting for further research. Last but not least, the third future research recommendation, which was already mentioned in section 4.3 of chapter four, is that after the experimental zones are created and the experiments are done, a new problem will emerge containing another "gap". This time it is not between innovation and regulation, but between experimentation in an artificial setting and a risk-free implementation in real-life.

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Appendices

Appendix I: Flying a Drone Do's and Dont's Leaflet

Appendix II: Factsheet Regelgeving Drones

Ministerie van Infrastructuur en Milieu

Regelgeving drones - Verschillen in regelgeving recreatief-beroeps (stand van zaken september 2016)

	Recreatief vliegen met drones	**Beroepsmatig (ROC)**	**Beroepsmatig (ROC Light)**
Gebruik van de drone	Hobbymatig, recreatief	Beroepsmatig gebruik en/of vluchten tegen vergoeding	Beroepsmatig gebruik en/of vluchten tegen vergoeding
Gewicht drone (totale startmassa)	Max. 25 kg	Max. 150 kg	Max 4 kg
Voorrang ander luchtverkeer	Verleent voorrang aan alle andere luchtverkeer en landt onmiddellijk wanneer ander verkeer nadert.	Verleent voorrang aan alle andere luchtverkeer en landt onmiddellijk wanneer ander verkeer nadert.	Verleent voorrang aan alle andere luchtverkeer en landt onmiddellijk wanneer ander verkeer nadert.
Drone in zicht van de piloot (VFR = Visual Flight Rules)	Altijd in zicht van de piloot	Altijd in zicht van de piloot	Altijd in zicht van de piloot
Afstand tot de piloot (of waarnemer)	n.v.t.	Max. 500 meter	Max. 100 meter
Daglicht	Alleen bij daglicht	Alleen bij daglicht	Alleen bij daglicht
Vlieghoogte (vanaf grond/water)	Max. 120 meter Uitzondering: leden KNVvL of FLRVC op een modelvliegveld: max. 300m	Max. 120 meter (ontheffing mogelijk in ROC)	Max. 50 meter
Afstandcriteria:		Ontheffing mogelijk	Geen ontheffing mogelijk
Afstand tot **mensenmenigten**	Niet boven	Min. 150 meter	Min. 50 meter
Afstand tot **aaneengesloten bebouwing**	Niet boven	Min. 150 meter	Min 50 meter
Afstand tot **kunstwerken**, **haven-** en **industriegebieden**	Niet boven	Min. 50 meter	Min. 50 meter
Afstand tot **spoorlijnen**	Niet boven	Min. 50 meter	Min. 50 meter
Afstand tot openbare **wegen**, **autowegen** en **autosnelwegen**	Niet boven met uitzondering van wegen in 30 km-zones binnen de bebouwde kom en wegen in 60 km-gebieden buiten de bebouwde kom;	Min. 50 meter	Min. 50 meter
Afstand tot **vaartuigen** en **voertuigen**	n.v.t.	Min. 150 meter	Min. 50 meter

Waar mag je wel/niet vliegen? ***Kijk voor een kaart met no fly zones op rijksoverheid.nl/drones***	Niet in gecontroleerd luchtruim (CTR's)	Niet in gecontroleerd luchtruim (CTR's) *(exacte regels: Regeling Op Afstand Bestuurbare Luchtvaartuigen)*	Niet in gecontroleerd luchtruim (CTR's)
	Niet binnen 3 km van ongecontroleerde vliegvelden, tenzij geen bezwaar van exploitant	n.v.t.	Niet binnen 3 km van ongecontroleerde vliegvelden, tenzij geen bezwaar van exploitant
	Niet in militaire en civiele laagvlieggebieden, tenzij met een waarnemer	n.v.t.	Niet in militaire en civiele laagvlieggebieden, tenzij met een waarnemer
Bewijs van Bevoegdheid voor de piloot/bestuurder ('brevet')	n.v.t.	Bewijs van Bevoegdheid (RPA-L) (medische keuring verplicht, minimaal LAP-L)	Ontheffing Bewijs van Bevoegdheid Wel: piloot kan aantonen over voldoende bekwaamheid te beschikken bv. met een KEI-diploma of een erkend vliegbrevet *(deze eis geldt niet als de drone minder dan 1 kg weegt)* geen medische keuring
Bewijs van Luchtwaardigheid voor de drone	n.v.t.	Bewijs van Luchtwaardigheid (technische keuring verplicht)	Ontheffing Bewijs van Luchtwaardigheid (geen technische keuring)
Inschrijving in luchtvaartuigregister	n.v.t.	Bewijs van Inschrijving	Bewijs van Inschrijving
Minimum leeftijd	n.v.t.	18 jaar	18 jaar
Operationeel handboek	n.v.t.	Handboek noodzakelijk	n.v.t.
Verzekering	Niet verplicht	WA verzekering verplicht	WA verzekering verplicht
Meldingsplicht	n.v.t.	24-uur voor vlucht bij Minister en burgemeester NOTAM	n.v.t.
Kosten	n.v.t.	+/- 10.000 euro	+/- 400 euro

Kijk voor complete en actuele informatie op: rijksoverheid.nl/drones
Kaart met no fly zones: rijksoverheid.nl/drones

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