

# Drone technology maturity and implications in security surveillance sector

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## ABSTRACT,

*Bachelor thesis research about maturity for application of drone technology in the security surveillance sector. Through the maturity assessment, the implications will be addressed. These implications hold back the development of drone technology within the security surveillance sector for the future. This research is academically relevant, because it determines the maturity for drone application in the security surveillance sector on five different dimensions. These are: technical, business, ethical, legal and social. This research will be practically relevant for security surveillance businesses that want to evaluate at what level they are when talking about implementing drones within their company. This research determined the maturity of drone technology in the security surveillance sector through: a literature study, a UAV readiness Quick Scan tool provided by Space 53 and an expert interview. Through this research, it can be determined that the security surveillance sector is not mature enough to use drones within their business operations. Even though security surveillance drones are technically ready, businesses are still scared to use these drones. They are afraid for all the issues that could arise through the ethical, legal and social dimension. To fully determine the maturity of drone development in the security surveillance sector, further research has to be done.*

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## Keywords

Drone, security, surveillance, space53, technology, readiness

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# 1. INTRODUCTION

## 1.1 Situation and Complication

Professional drone technology gives promising new opportunities for organizations. A drone refers to an unpiloted aircraft. Another term for it is an "unmanned aerial vehicle" (Howell, 2018). Drones are increasingly being used in sectors, such as agriculture, construction, real estate, media, and delivery. An example of this is Amazon's Prime Air delivery. They launched their plans to deliver their packages using drones on the 7<sup>th</sup> of December 2016 (Amazon, 2016).

However, the value of these new technologies is, in most cases, still uncertain. This is due to the fact there are still issues with, for example: safety, privacy, data protection and environmental interference (Heldeweg & Du, 2017). When looking at opportunities, usually only the technical feasibility is considered. For an opportunity to work well, also the customer and employee need to see the added value, society has to accept the innovation with its potential ethical issues and the regulations and laws have to support the application of drones in businesses (CompTIA, 2019). The customers, employees, society and regulations are as important as the technological feasibility. That is why Amazon's Prime Air delivery is still not being used. Their plans to launch the unmanned aerial delivery system have been delayed due to FAA regulations (Federal Aviation Administration, 2019).

A promising application area for drones is within the field of safety and security. This application is promising, because the work could be done faster, better and safer (Elistair, 2020). An example is the fire fighter's department. They could use a drone to enter a building that is too dangerous to enter as a human. Using a heat camera, the fire department can find the heat source and prevent the fire from jumping to adjacent buildings (Brandweer, 2019). Another example is a security surveillance company. Currently, these companies scan properties by walking around themselves, using a dog or surveillance camera systems (Nimo Security, 2020). They could scan properties faster by using a drone. Surveillance drones have operational heights from 50 to 100 meters and are able to fly for hours, allowing long endurance surveillance operations by day and night (Elistair, 2020).

## 1.2 Research Objective

The research objective is to assess the maturity of drone application for the security surveillance sector, which is part of the safety and security sector. Also, the implications that hold back drone development from further developing will be addressed. Several companies operate in the safety and security sector, such as security surveillance companies, firefighters, crowd control companies, search and rescue teams.

Similar research is happening simultaneously in other sectors. These other sectors are: precision agriculture, renewable energy and medical goods. These researches together with this research have similar objectives. Therefore, there may be an overlap between these reports.

This research focusses on security surveillance companies. Security surveillance companies are hired to prevent crime in private and public locations. These companies send security officers who patrol the parking lots of hotels, hospitals and retail locations, protect corporate assets and their customers. They are assisted by dogs and security surveillance cameras. (Sciencedirect, 2020).

There are already companies selling drones that can operate in the security surveillance sector. An example of such a company is Aartos. This company sells drones for airport security, the

police, security at large events and border protection. Currently, Aartos only has 100 installed systems worldwide (Aartos, 2020). The maturity for drone application of the security surveillance sector will be assessed through five different dimensions. This will be done using the UAV readiness Quick Scan tool made by the client, Space 53. Through this assessment of the maturity, the most common implications and points of attention that hold back drone development, will be addressed. A sub-objective is to find possible improvements for the UAV readiness Quick Scan tool, made by Space 53. Throughout this report, the UAV readiness Quick Scan tool will be mentioned as Space 53 tool.

## 1.3 Research Question

What is the maturity for drone application in the security surveillance sector and what are the implications for development of drone technology in the security surveillance sector?

## 1.4 Theoretical Framework

"Technological transitions do not only involve technological changes, but also changes in elements such as user practices, regulation, industrial networks, infrastructure, and symbolic meaning (Geels, 2001)."

As already stated by Geels, there is more to an innovation than only the technical feasibility. Also, the business itself has to be taken into account. Not to forget all the ethical, legal and social issues and factors that have to be dealt with. Next, all five perspectives will be introduced.

Firstly, the technical feasibility can be explained by the TRL model. TRL stands for technical readiness level. Technical readiness level gives a measure for the development of the technology (Innovencio, 2017).

Secondly, the importance of a well-functioning business when an innovation is coming, can be explained by the business readiness. Business readiness is the process of managing change within the company. A change could be a new system, technology or process that can affect the company (Tekfive, 2020).

Thirdly, ethical issues occur when a decision, scenario or activity creates a conflict with a society's moral principles. Businesses and individuals can both be involved in these conflicts, since any of their activities might be put to question from an ethical standpoint (Myaccountingcourse, 2020).

Fourthly, with all innovations legal issues will arise. The consequences of ignoring the legal side of innovation can be catastrophically expensive (Baumgartner, 2020).

Fifthly, social factors that impact innovation should be considered as well. To be aware of potential social issues, social changes have to be carefully looked at. Another point of attention are the cultural changes which take place in business environments (PESTLEanalysis, 2015).

These five dimensions all influence the development of an innovation. Therefore, all five should be included in the evaluation on the maturity of a certain innovation. In this case, the development of drone application within the security surveillance sector. A tool that does include the five dimensions is the UAV readiness Quick Scan tool made by Space 53. In order to perform a well-argued research, the Space 53 tool will be used to cover all five dimensions within the research about the maturity of drone application within the security surveillance sector.

The implementation of drones in the security surveillance sector is a radical innovation. The drone development for the security surveillance sector is still in the niche market of the multi-level perspective (Geels, 2001). The multi-level perspective consists of three levels. These are: sociotechnical landscape, sociotechnical regime and niche. Sociotechnical landscapes involve technical trajectories. These refer to wider technology-external factors. The sociotechnical regimes refer to rules and regulations that disable and enable activities within communities. Both sociotechnical landscapes and regimes change, but regimes change faster than the landscape. The niches create radical innovations. By determining the maturity of drones in the security surveillance sector, it will be determined how far the niche technology has developed. It will also give the implications that keep the niche market from further developing.

## 1.5 Academic Relevance

It is academically relevant to study the maturity for drone application of the security surveillance sector. In most cases only one dimension is taken into account when investigating whether drone application is feasible (CompTIA, 2019). In order to make drones work well, five dimensions have to be covered. Within this research, all five dimensions will be evaluated. The five dimensions are the following: technical, business, ethical, legal and social. These dimensions will be evaluated by the Space 53 tool. This Space 53 tool creates an integral overview of the readiness of a company for drone application.

## 1.6 Practical Relevance

This research will be practically relevant for security surveillance businesses that want to evaluate at what level they are when talking about implementing drones within their company. This research could also be relevant for starting entrepreneurs who want to get a broader insight in what is needed to start a business and become successful.

A sub-objective of this research is to find implications within the Space 53 tool. knowing these implications, improvements can be thought of. These improvements can be implemented by Space 53, in order to improve their tool for their customers.

## 1.7 Research Design

The research question will be answered using primary and secondary data. First, literature study will be done on drones and the security surveillance sector. Secondly, the Space 53 tool will be used by people that have knowledge about security and surveillance, people who would like to start a business in the security surveillance sector or users of the security surveillance sector. Thirdly, the analysis on the experiences by the users of the Space 53 tool will be done. This will be done through an expert interview with someone who has knowledge in the security surveillance sector. An unstructured interview will take place. The results of the scan will be discussed. With the gathered data and knowledge, the maturity of the drone technology in the security surveillance sector will be determined. Also, in this interview the implications of drone development will be discussed. Through this, the obstructing dimensions will become clear. These dimensions will have to be improved to further develop drones for the future.

Finally, through this research also improvements for the Space 53 tool will be addressed. The elaboration on these improvements is the sub-objective of the research.

## 2. LITERATURE RESEARCH AND THEORY

### 2.1 Current State and Implications

This section discusses the current state of the sector and all the implications within drone development for the security surveillance sector. Drones pose safety risks to planes and other manned aircrafts. More than 300 incidents classified as "close encounters" occurred between drones and manned aircrafts in U.S. airspace over a period of less than two years (Booker, 2015). In 28 of these instances, pilots had to change course in order to avoid collision (Ohio University, 2020).

Drones are also causing legal issues. They create issues with insurance companies. Especially when it comes to property damage and liability (Ohio University, 2020). Drones can fly high and record visible parts of private property or inside homes. This causes privacy risks to people, even when the intention of the video footage was not to film their private properties (Rijksoverheid, 2015).

In the European civil airspace regulations, it is stated that drones are required to stay within the line of sight of their operators. This limits their use significantly. By improving the navigation, security and reliability of the drones, it is possible for the regulations to evolve as the technology does (European Commission, 2020).

### 2.2 Five dimensions

This research will determine the maturity of drone application for the security surveillance sector. It will also determine the implications that are holding back the development of drone application within this field. There are multiple ways to determine the maturity. A way to determine the maturity level is through the capability maturity model. The model's aim is to improve existing software development processes, but it can also be applied to other processes. (Rouse, 2007) Since the model is developed to improve the software development process, it focusses mainly on technical elements. Most models that access maturity focus just on technical elements. Since maturity level is more than just the maturity of the technology, a UAV readiness Quick Scan tool made by the client Space 53 will be used. This Space 53 tool covers five dimensions that influence the development of drones. These five dimensions are technical, business, ethical, legal and social. In the Space 53 tool, the user has to answer several questions on each dimension. In this section, all dimensions will be further elaborated on.

#### 2.2.1 Technical

Firstly, the technical feasibility can be explained by the TRL model. TRL stands for Technical Readiness Level. Technical readiness level gives a measure for the development of the technology. The technology readiness level system has been developed by NASA in the 70s. The European commission has further developed it and uses it to stimulate technology development. The TRL model has 9 levels, which are separated in to four stages. The first three (TRL 1, 2, 3) levels are the discovery stage. Followed by the next three levels (TRL 4, 5, 6), which form the development stage. Next is the demonstration stage, which consist of TRL 7 and TRL 8. Finally, there is the deployment stage, which consist of TRL 9 (Innovencio, 2017).

When thinking about technical developments within drones, you may ask questions such as: How far is the development of the power supply for the drone? What is the image quality of the camera on the drone?

### 2.2.2 Business

Secondly, the importance of a well-functioning business when an innovation is coming, can be explained by the business readiness level. The business readiness level (BRL) is a way to benchmark the current status of a venture – from concept to mature business. The BRL helps to identify the level of maturity of a company, or innovation project. They allow a user to: manage the blend of skills in a company, show progress, plan for next steps, manage the risk for investments. The BRL can also be a more formal way to identify when a project needs to pivot, change or be closed down. (*Business Readiness Levels, 2020*) All stakeholders such as: employees, customers and suppliers should be considered. Also, the financial side of the innovation should be managed (*Tekfive, 2020*).

When thinking about business readiness with drone application in the security surveillance sector, you may ask questions such as: What will be the added value for our customers? Can current employees adapt to the change of work operation?

### 2.2.3 Ethical

Thirdly, the ethics of emerging technologies is focused in large part on emerging enabling technologies, which are expected to result in waves of innovations across different sectors in society and therefore raise a myriad of ethical issues in the process (Brey, 2017). Ethical issues occur when a decision, scenario or activity creates a conflict with a society's moral principles. Businesses and individuals can both be involved in these conflicts, since any of their activities might be put to question from an ethical standpoint. These conflicts sometimes cause legal issues, since some of the alternatives to solve the issue might breach a particular law. In other situations, the conflict may not give any legal issues, but it might generate a negative reaction from third parties (Myaccountingcourse, 2020). Ethical issues are difficult to deal with if no guidelines or precedents are known. For this reason, many companies have ethical codes that are discussed and approved by key participants to provide a useful framework for companies and individuals to make adequate decisions whenever they face one of these conflicts (Myaccountingcourse, 2020).

When thinking of ethical issues with drone technology in the security surveillance sector, you may think about the autonomy in control functions. A question that may arise could be: Is it ethically responsible to have a self-flying drone?

### 2.2.4 Legal

Fourthly, with all innovations legal issues will arise. The consequences of ignoring the legal side of innovation can be catastrophically expensive (Baumgartner, 2020). An example is the patent law. Companies in the tech industry often face aggressive patent laws. Companies often sit on patents for years, hoping that another company accidentally violates them, to get easy money through patent and copyright lawsuits (Sun, 2020).

When thinking about legal issues with drone technology in the security surveillance sector, you may think about a lot of potential legal issues. You could, for example, have legal issues regarding public safety, such as the use of certain airspace. Another example could be a privacy issues, regarding people being watch in their own private space through the camera on the drone.

### 2.2.5 Social

Fifthly, social factors that impact innovation should be considered as well. To be aware of potential social issues, social

changes have to be carefully looked at. Another point of attention are the cultural changes which take place in business environments. Market research is a critical part of this step, in order to get to know the stakeholders. It is important to see the trends and patterns of the society. Family, friends, colleagues, neighbors and the media are social factors that can influence attitudes, opinions and interests. The customer needs and market size are also influenced by social factors such as: lifestyles, education level, emphasis on safety and risk aversion (PESTLEanalysis, 2015).

Questions that may arise when thinking about the security surveillance sector are: Who are the stakeholders? What role does trust perceptions play in the development process?

## 3. METHODOLOGY

### 3.1 Research method

In this section the methodology for the research will be discussed. A qualitative research will take place. A qualitative research is a scientific method of observation to gather data, while focusing on meaning-making (Babbie, 2015). This type of research answers questions related to why or how a certain occurrence occurs, rather than how often it occurs (Berg, 2008).

In this research primary and secondary data will be used to answer the research question. The first part of the research consists of a literature study. In chapter 2, a literature study has been performed on secondary data. The knowledge gained through this literature study, will help to notice trends and implications when the primary data will be gathered. It will also help to give the correct guidance and clarification during the usage of the Space 53 tool.

The second part of this research consists of a survey, which is the Space 53 tool. The Space 53 tool will be used by a minimum of three people. These people should have knowledge about security and surveillance, would like to start a business in the security surveillance sector or are users of the security surveillance sector. Since this research is about the whole sector, they will use the Space 53 tool with the security surveillance sector in mind. They do not just focus on their own company. All participants will start the Space 53 tool, with the same knowledge. A protocol has been created for this and can be found in appendix 7.2. This second part of the research should answer the question: What is the maturity for drone application in the security surveillance sector? A protocol has been created for the participants, in order to have them fill in the Space 53 tool with the same knowledge before starting.

With the maturity of the drone technology in the security surveillance sector determined, the research can progress to the next part of the research. The third part of the research is the analytics through an expert interview. The results of the Space 53 tool will be discussed in an expert interview with someone that has knowledge in the security surveillance sector. A semi-structured interview will take place. The questions will be divided into five topics due to the five different dimensions. The prepared questions for the interview can be found in Appendix 7.3. This third part of the research focusses on the question: What are the implications for development of drone technology in the security surveillance sector? With the knowledge gained through the literature study and the knowledge gained through the expert interview, the obstructing dimensions will become clear. These dimensions hold back the drone development. With the combination of the knowledge gained through the literature study on implications and the knowledge gained by the expert interviews about implications, all implications will be addressed.

These implications have to be improved to further develop drones for the security surveillance sector.

Finally, through this research also improvements for the Space 53 tool will be addressed. The users of the tool will come across uncertainties about what to do, misunderstandings about what is meant with a certain question or faults and imperfections within the tool. Also, through the expert interview and the literature study on implications for drone technology, improvements for the Space 53 tool could emerge. The elaboration on these improvements is the sub-objective of the research. The main questions for this sub-objective is: What are improvements for the UAV readiness Quick Scan tool made by Space 53?

## 3.2 Space 53 tool

In this section the methodology of the Space 53 tool will be discussed. This tool covers the five dimensions that influence the development of drones. The user has to answer several questions on each dimension. Each answer will be given through a score from 1 to 9. This section elaborates on how the scale from 1 to 9 is integrated within the Space 53 tool.

### 3.2.1 Technical

The European commission has defined the nine levels of technical readiness level as stated in Appendix 7.1.1 (European Commission, 2020). The Space 53 tool has divided the technology readiness section into different topics. The following topics are integrated: total system configuration, drone management components, flight components, application components and systems integration. Each topic has its own points of attention. For example, the topic about flight components asks questions about: the flight control, the flight-related communication, the human machine interface and the flight-related back-end processing.

### 3.2.2 Business

The business readiness levels are defined as stated in the Appendix 7.1.2 (Business Readiness Levels, 2020). The Space 53 tool has divided the business readiness section into different topics. The following topics are integrated: the customer, the value proposition, market forces, alliance partners, the value delivery process and financials. Each topic has its own points of attention. For example, the topic about the customer asks questions about: the customer problems with the new drone technology, the customer advantages with the new drone technology, the customer willingness to participate and whether the company is sensitive to changing customer needs.

### 3.2.3 Ethical

For Technology and Business, there are actual theories about the division of the nine levels of readiness. This is not the case for the ethical dimension of Space 53 tool. Therefore, Space 53 divided the nine levels themselves. The 9 possible points are divided over 5 possible answers to each question. Based on these answers, the user itself has to determine the overall ethical readiness score. The five possible answers are divided as stated in Appendix 7.1.3. The Space 53 Tool has divided the ethical readiness section into different topics. The following topics are integrated: purpose, safety, automation, distance and value shifting. Each topic has its own points of attention. For example, the topic about: automation asks questions about the autonomy in the control functions, the autonomy in the decision support and taking responsibility by incidents.

### 3.2.4 Legal

Similar to the ethical dimension, there are no actual theories about the division of the nine levels of readiness for the legal dimension. Therefore, Space 53 divided the nine levels themselves. The tool itself will calculate the cumulative scoring for the whole category. They are divided as stated in Appendix 7.1.4. The Space 53 tool has divided the legal readiness section into different topics. The following topics are integrated: public safety, environmental burden, privacy, data protection, criminal law liability, administrative law compliance, civil law liability and public security. Each topic has its own points of attention. For example, the topic about environmental burden asks questions about: pollution of air, soil or water; causing nuisance, energy efficiency, exhaustion of scarce materials and disturbance of natural habitats or animal life.

### 3.2.5 Social

Similar to the ethical and legal dimensions, there are no actual theories about the division of the nine levels of readiness for the social dimension. Therefore, Space 53 divided the nine levels themselves. The 9 possible points are divided over 4 possible answers to each question. The tool itself will calculate the cumulative scoring for the whole category. They are divided as stated in Appendix 7.1.5. The Space 53 tool has divided the social readiness section into different topics. The following topics are integrated: stakeholders, design and acceptance. Each topic has its own points of attention. For example, the topic about stakeholders asks questions about: identification of the stakeholders, use-situations, user scenario's, stakeholder requirements and the desired human-machine interactions.

## 4. RESULTS

In the first part of this section the results of the Space 53 tool will be presented to show the maturity for drone development in the security surveillance sector. In the second part of this section, the expert interview will be discussed and used to show all the current implications that hold back drone development in the security surveillance sector.

### 4.1 Maturity

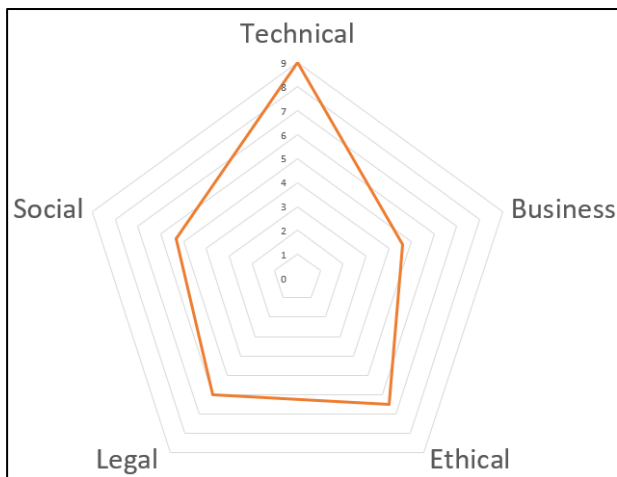
First, participants for the Space 53 tool had to be found. Companies working in different parts of the security surveillance sector were contacted. These different companies include surveillance camera companies and security surveillance companies. Each participant started with the Space 53 tool, having the same knowledge about the tool and research. A protocol was created to provide the participants with this information. The protocol can be found in appendix 7.2.

In total, the Space 53 tool had 6 participants. Some participants only filled in specific parts, of which they had knowledge. Information about each participant can be found in table 1 and appendix 7.4.7.

Participant	Company Type	Function
Participant 1	Security service	Manager Sales & Business development
Participant 2	Electronic Security and fire prevention	Engineer
Participant 3	Security service	CTO (Chief Technology Officer)
Participant 4	Electronic Security and fire prevention	Engineer
Participant 5	Drone flight company	CEO (Chief Executive officer)
Participant 6	Security service	Branch Manager

**Table 1**

The results of the tool can be found in appendix 7.4.1 till 7.4.5. The overall readiness is shown in figure 1 and appendix 7.4.6. In this figure the scores of all five dimensions are shown.



**Figure 1**

This part of the research should answer the question: What is the maturity for drone application in the security surveillance sector? All scores used in this section are on a scale of 1 to 9. As seen in figure 1 and appendix 7.4.6, the technical readiness level is 9.0. This means there is already a drone available on the market that suits the needs for the security surveillance sector. The business readiness level is scored with a 4.6. This shows that the security surveillance businesses are not yet ready for drone usages within their companies. Further steps have to be made to prepare the businesses themselves to use drones within the business operations. The legal and ethical dimensions are scored respectively with a 6 and 6.5. This is a sufficient grade, but to make the drone usage a success, improvement still has to be made. Finally, the social readiness level has been scored with a 4.3. This is an insufficient grade and therefore large improvements have to be made to make drone usage a success within the security surveillance sector.

## 4.2 Implications

The results of the Space 53 tool were discussed in an expert interview with the owner of a company operating in the security surveillance sector. The results of this expert interview will be presented in this section. A semi-structured interview took place. The questions were divided into five topics due to the five different dimensions. The prepared questions for the interview can be found in Appendix 7.3. This third part of the research focusses on the question: What are the implications for development of drone technology in the security surveillance sector?

### 4.2.1 Technical

The results of the Space 53 tool showed that drones are technically ready for the security surveillance sector. The expert agreed with this, because the drones are already for sale. There is no doubt that these drones can capture video in high quality and fly for many kilometers. However, these drones are expensive. Security surveillance drones sell for around €100.000, -. Since these drones are a relatively new product, questions arise whether this new technology is worth the money. This is due to the fact that this is a new technology and there is no actual prove of its performance. Therefore, questions arise such as: how many flying hours does it make before breaking down? How is the quality of the drone after 3 years? For these technical questions, there is still no answer. Even though these drones are already for sale.

### 4.2.2 Business

First of all, businesses are concerned for issues that could arise through the legal, ethical and social aspects of privacy. The expert expects that first these three dimensions have to be sorted out, in order for business start investing in drones on a large scale. Also, many security surveillance businesses do not yet have a clear vision on what a drone could mean to their company, since it is such a new product. On top of that, the expert agreed with the fact that the financial part of business scored a 3,7. As stated before, drones in the security surveillance sector sell for around €100.000, -. For the same amount of money, four security guards could be employed for one year. Even if security surveillance companies had the drone, they would still need staff to fly the drones. Currently, security surveillance companies do not employ staff that has the skills to fly such an expensive drone. Therefore, drone pilots should be educated or employed by the security surveillance companies.

### 4.2.3 Ethical

People have an aversion against drones. Drones were first introduced in the private sector. They were not introduced as a small aircraft with four propellers. They were introduced as an aircraft which could be used to capture video of a wide area. This is what people automatically think of when thinking about drones. They find it ethically incorrect to capture video of other people's property. They do not think of all the business opportunities there are. A solution against this aversion could be colored drones. These colors should be determined by law. For example: the security surveillance drones could be a light blue drone with green stripes. All companies working within the security surveillance sector should use these colors. When people notice a drone nearby, they will see the light blue with green striping. In this case, they will know, this drone is not there to film private property, but is on its way to an alarm notification on a company premises nearby.

#### 4.2.4 Legal

Out of the six participants of the tool by Space53, only one participant had knowledge about the legal aspects of drones in the security surveillance sector. The expert explained this by the fact that laws are difficult to understand in general. On top of that, there are no clear laws for drones in the legislation, at this moment in time. One of the only laws for drones, at this moment in time, is to stay away from airplanes and airports. Missing parts in law are: how much noise may a drone make, what is allowed to film, after how many days should footage of public space be deleted, who is responsible for possible accidents and what colors should a security surveillance drone have. All these insecurities make it a risk for security surveillance companies to start using drones, because consequences of ignoring the legal aspects of such innovations can be catastrophically expensive. In the Space 53 tool, data protection scored 9 points. The expert disagreed with this. When the storage of the footage happens on the drone itself, the data protection is high. When the storage of the footage happens on a ground control unit, the data protection is low. When storage happens on a ground control unit, a wireless connection has to be made and these connections could be hacked.

#### 4.2.5 Social

Google street view takes pictures of everybody and everybody's homes. We have accepted this and it does not create issues anymore. Drones that (accidentally) capture private property are not accepted. People do not know who is flying the drone when they see it fly over. The pilot could be kilometers away. People do not know the reason for it flying over. People do not know what the actual functions are of the drone. All these reasons make it that people have no trust in drones. As stated before, a possible solution could be to give all security surveillance companies the same color. These colors should be determined by law. When people notice a drone nearby, they will see it is a security surveillance drone. In this case, they will know, this drone is not there to film my private property, but is on its way to an alarm notification on a company premises nearby.

#### 4.2.6 Summary implications

This part about implications focused on the question: What are the implications for development of drone technology in the security surveillance sector? There are several implications that hold back drone development in the security surveillance sector. There are no technical implications. The only potential technical issue is that the technology has not proven itself yet, since it is relatively new. The business implications: companies do not have the correct staff to work with drones, do not yet see all the benefits and find the drones way to expensive. The ethical implication is that people have an aversion against drones. The legal implications that come with drone development are: only few people have knowledge about the legal aspects of drones and there are only a few laws about drones, at this moment. The social implication is that drones are not yet accepted within society, because society has no trust in drones.

## 5. DISCUSSION AND CONCLUSION

### 5.1 Conclusion

The research question for this research is: what is the maturity for drone application in the security surveillance sector and what are the implications for development of drone technology in the security surveillance sector?

The fact that there are already drones for sale that can operate in the security surveillance sector, only shows that the drone development is technically ready for usages within the business operations of security surveillance companies. That makes the technical maturity for drone development for the security surveillance sector high. On a scale of 1-9, technical maturity is at 9.0.

In order to use these drones, also the business, ethical, legal and social dimensions should be considered. Currently, security surveillance businesses are dealing with several implications on the business dimension. They do not have the correct staff to work with drones, do not yet see all the benefits and find the drones way to expensive. Therefore, the business maturity for drone development is low. On a scale of 1-9, business maturity is at 4.6.

Security surveillance companies are also dealing with ethical implications. People have an aversion against drones. This makes it that the ethical maturity for drone development is moderate. On a scale of 1-9, the ethical maturity is at 6.5.

Next, are the legal implications that come with drone development. Currently, only few people have knowledge about the legal aspects of drones. Also, there are only a few laws about drones, at this moment. Therefore, new laws should be created to make clear for security surveillance businesses what is allowed. Currently the legal maturity for drone development in the security surveillance sector is moderate. On a scale of 1-9, legal maturity is at 6.0.

Finally, the security surveillance sector deals with implication in the social dimension. Drones are not yet accepted within society, because society has no trust in drones. This makes it that the social maturity is low. On a scale of 1-9, social maturity is at 4.3.

As stated before, to fully determine the maturity of drone development in the security surveillance sector, further research has to be done. Through this research, it can be determined that the security surveillance sector is not mature enough to use drones within their business operations. Even though security surveillance drones are technically ready, businesses are still scared to use these drones. They are afraid for all the issues that could arise through the ethical, legal and social dimension. Therefore, first all laws for drones should be sorted and society has to accept and trust drones. Then, security surveillance businesses will evolve as well.

### 5.2 Discussion

This research could already help companies working in the security surveillance sector, that are thinking about or working with drones. This research could help them to get an understanding of what needs to be done to progress further with drone development. This research shows the current state of the maturity for drone development in the sector. It also discussed implication of five different dimensions. In some cases, it already gives possible solutions.

Due to the situation caused by the covid-19 virus, it was hard to find participants for the Space 53 tool. Therefore, only 6 people were willing to participate in this research by filling in the Space 53 tool. To fully determine the maturity of drone development, the tool has to be filled in by more participants. These people should all be affiliated with the security surveillance sector and should fill in the tool with the whole sector in mind.

This whole research was done within 10 weeks. To fully determine the maturity of drone development in the security surveillance sector, more research time is needed. In this time the literature research could be further elaborated on. Also, more



expert interviews could take place. This would also give more time to find more participants to fill in the Space 53 tool.

To fully determine the maturity of drone development in the security surveillance sector, more research has to be done on the legal aspect of drone development. In this research only one participant had knowledge about the legal aspect. This is not enough to give a factual determination of the legal readiness.

To fully determine the maturity of drone development in the security surveillance sector, further research has to be done.

### **5.3 Sub-objective**

The sub objective of this research was to find improvements for the Space 53 tool. The first problem with the tool is that there are only few people who have knowledge about all the five dimensions. Therefore, it is difficult for one specific person to fill in the complete tool on their own. Currently, it is not easy to fill in the tool with more than one person. Therefore, an improvement could be to make it possible for multiple people to fill in the Space 53 tool in one answer sheet. This way, people with knowledge about different dimensions can fill in the tool together.

The second problem is that the Space 53 tool is written in English academic language and this makes it difficult for non-academics to use the tool. Not all people having knowledge about one of the five dimensions, are academically educated. Currently, these people have difficulties filling in the tool. The second improvement could be to make the Space 53 tool easier to understand by reducing the amount of academic language.

The third problem with the Space 53 tool is that the user has to determine the ethical readiness level themselves. The tool states that the user should base the score on the previously asked questions. In practice, this did not work. All users scored the ethical readiness higher than that all the answers to the questions in the tool were. This makes it that the third improvement is to let the Space 53 tool determine the ethical score.

The fourth problem with the Space 53 tool is that it takes too long to read all the text and explanation within the tool. Even though the tool itself is called the Quick Scan tool, it is not quick to use, due to all the long text sections. The tool takes about an hour to fill in. A fourth improvement for the tool could be to shorten the long text and explanation. Through this, the time it takes to fill in the Space 53 tool will reduce as well.

### **5.4 Acknowledgements**

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## 7. APPENDIX

### 7.1 Readiness Levels per Dimension

#### 7.1.1 Technical readiness levels

##### 1. Basic principles observed:

In this stage fundamental research takes place. The basic principles of the technology are observed and assumptions about the operations are made. At this point in time, there is still no experimental evidence about the functionality of the new technology.

##### 2. Technology concept formulated:

The technological concept and the possible application area are formulated.

##### 3. Experimental proof of concept:

The first laboratory tests are finished with a proof of concept as result.

##### 4. Technology validated in lab:

The proof of concept has been validated in a laboratory environment. This is done with low-fidelity prototypes on a small scale.

##### 5. Technology validated in relevant environment:

The technology has been tested and validated in a relevant environment. At this level of development, functional and high-fidelity prototypes should be used.

##### 6. Technology demonstrated in relevant environment:

The technology is demonstrated in a relevant environment. The performance of the prototypes is not optimal for its operational environment. With this demonstration, the technical working principle is proven.

##### 7. System prototype demonstration in operational environment:

The technology is integrated within the final operating environment. At this level, the focus is on tasks such as production and certificating.

##### 8. System complete and qualified:

The technology performs as it should and the final production issues have been solved.

##### 9. Actual system proven in operational environment:

The technology is technically ready.

#### 7.1.2 Business readiness levels

##### 1. Concept:

The first idea of a venture or an innovation.

##### 2. Problem-Solution fit:

The problem has been identified and the proposed solution will address it.

##### 3. Build team and Plan:

The skills required are known and a team is formed.

##### 4. Customer Definition:

Customer segment is known and well defined, including customer characteristics.

##### 5. Hypothesis testing:

Having a list of hypotheses which can be tested.

##### 6. Minimum Viable Product:

At this level, the company should have released an MVP.

##### 7. Feedback:

The feedback loop of features which are developed alongside early adopters and customers.

##### 8. Scale:

A product or service has been developed beyond an MVP stage.

#### 9. Fully Embedded business:

A business model or venture that is fully embedded in a market or many markets.

#### 7.1.3 Ethical readiness levels

##### 1. This question is not at all applicable.

##### 2. This question is not applicable.

##### 3. This question is indifferent.

##### 4. This question is applicable.

##### 5. This question is completely applicable.

Within the Ethical tool, the user decides the score for the overall ethical score.

#### 7.1.4 Legal readiness levels

##### 1. Completely unaware:

In this case, this particular question should be scored with 0 points.

##### 2. Somewhat aware:

In this case, this particular question should be scored with 1 point.

##### 3. Inconclusively considered relevance:

In this case, this particular question should be scored with 2 points.

##### 4. Conclusively considered relevance:

In this case, this particular question should be scored with 3 points.

##### 5. Action prepared.

In this case, this particular question should be scored with 4 points.

##### 6. Action decided.

In this case, this particular question should be scored with 5 points.

##### 7. Action in progress.

In this case, this particular question should be scored with 6 points.

##### 8. Significant compliance.

In this case, this particular question should be scored with 7 points.

##### 9. Full compliance.

In this case, this particular question should be scored with 8 points.

##### 10. Authoritatively assured full compliance.

In this case, this particular question should be scored with 9 points.

### 7.1.5 Social readiness levels

#### 1. Lab environment:

The UAV technology is developed in a closed laboratory setting, with only developers and researchers involved. In this case, this particular question will be scored with 1 point.

#### 2. Field lab:

The UAV technology is developed and tested in a spatially restricted field lab with a restricted number of experts and/or end-users during a restricted amount of time. In this case, this particular question will be scored with 4 points.

#### 3. Living lab:

The UAV technology is developed and tested in a living lab setting that is open to an undefined number of end-users within their own environment during a restricted amount of time; geographical or legal restrictions may apply. In this case, this particular question will be scored with 6 points.

#### 4. Public space:

The UAV technology is market-ready and ready to be exposed in public space. In this case, this particular question will be scored with 9 points.

## 7.2 Protocol for Space 53 tool

Dear Participant,

Professional drone technology gives promising new opportunities for organizations. However, the implementation of these new technologies is, in most cases, still uncertain. This research focusses on the security surveillance sector.

Security surveillance companies are hired to prevent crime in private and public locations. These companies send security officers that patrol the parking lots of hotels, hospitals and retail locations, protect corporate assets and their customers. They are currently helped by, for example, dogs and security surveillance cameras. Drones could potentially help this sector as well.

This research will determine the maturity and implications of drone development in the security surveillance sector. Therefore, the research question of this research is: What is the maturity for drone application in the security surveillance sector and what are the implications for development of drone technology in the security surveillance sector?

In order to determine the maturity, data is needed. This data will be generated through this survey/tool filled in by participants that have knowledge about the security surveillance sector. The objective of the research is to determine the overall maturity. Therefore, it is important to answer the questions with the whole security surveillance sector in mind. Do not just focus on the company you work for. Instead, answer each question with the experience you have about the whole security surveillance sector.

The survey/tool has several questions about five different topics. The following topics will be addressed: technology, business, ethical, legal and social. At the end of the survey/tool some feedback questions are added. I would appreciate if you filled these in as well, since the sub-objective of the research is to improve the tool.

Thanks in advance for filling in the survey/tool. If you have any questions, send me an email or give me a call. Good luck!

Greetings, Willem van Sambeek

Student International Business Administration at the University of Twente.

## 7.3 Expert Interview Questions

### 7.3.1 Technology

- What is your opinion on the technology results?
- How do explain the average score of question 5 being this high/low?
- How could the low score of question 5 be improved?
- What could be a risk for the high score of question 5 to decrease?

### 7.3.2 Business

- What is your opinion on the business results?
- How do explain the average score of question 10 being this high/low?
- How could the low score of question 10 be improved?
- What could be a risk for the high score of question 10 to decrease?

### 7.3.3 Ethical

- What is your opinion on the ethical results?
- How do explain the average score of question 15 being this high/low?
- How could the low score of question 15 be improved?
- What could be a risk for the high score of question 15 to decrease?

### 7.3.4 Legal

- What is your opinion on the legal results?
- How do explain the average score of question 20 being this high/low?
- How could the low score of question 20 be improved?
- What could be a risk for the high score of question 20 to decrease?

### 7.3.5 Social

- What is your opinion on the social results?
- How do explain the average score of question 25 being this high/low?
- How could the low score of question 25 be improved?
- What could be a risk for the high score of question 25 to decrease?

## 7.4 Data by Space53 Tool

### 7.4.1 Technical Readiness Level

<b>Technical Readiness Level</b>	<b>9.0</b>
Total system configuration	9.0
Drone management components	9.0
Flight components	9.0
Application components	9.0
Systems integration	9.0

### 7.4.2 Business Readiness Level

<b>Business Readiness Level</b>	<b>4.6</b>
The customer	5.7
The value proposition	4.3
Market forces	4.1
Alliance partners	5
The value delivery process	4.9
Financials	3.7

### 7.4.3 Ethical Readiness Level

<b>Ethical Readiness Level</b>	<b>6.5</b>
Score by user	6.5

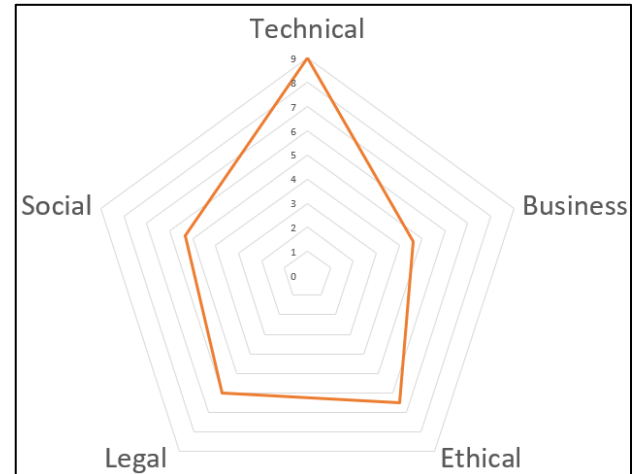
### 7.4.4 Legal Readiness Level

<b>Legal Readiness Level</b>	<b>6</b>
Public safety	5
Environmental burden	6.4
Privacy	6.5
Data protection	9
Liability	5.8

### 7.4.5 Social Readiness Level

<b>Social Readiness Level</b>	<b>4.3</b>
Stakeholders	3
Design	3.6
Acceptation	5.2

### 7.4.6 Overall Score Overview



### 7.4.7 Participants

Participant	Company Type	Function
Participant 1	Electronic Security and fire prevention	Engineer
Participant 2	Drone flight company	CEO (Chief Executive officer)
Participant 3	Electronic Security and fire prevention	Engineer
Participant 4	Security service	Manager Sales & Business development
Participant 5	Security service	Branch Manager
Participant 6	Security service	CTO (Chief Technology Officer)