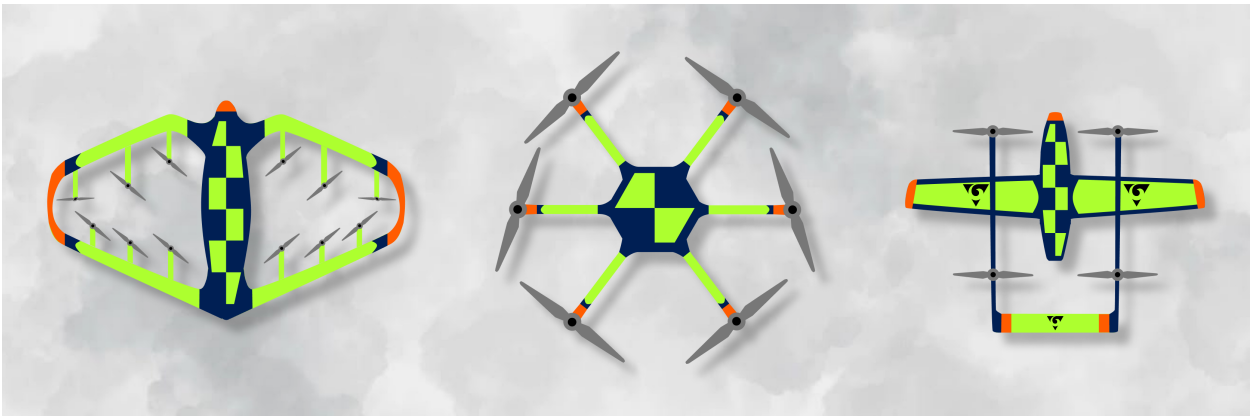

Designing a Standardized Marking System for Public Service Drones

MarkeD: A Framework for Trust and Transparency

Master's thesis in Interaction Design

David Hagberg

Filippa Petterzon

Department of Computer Science and Engineering
CHALMERS UNIVERSITY OF TECHNOLOGY
UNIVERSITY OF GOTHENBURG
Gothenburg, Sweden 2025

Master's thesis 2025

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David Hagberg Filippa Petterzon

Supervisor: Sara Ljungblad, Computer Science and Engineering
Advisor: Anna-Lena Alvekrans and Ann Forsman Sjöberg, Region Västra Götaland
Examiner: Morten Fjeld, Computer Science and Engineering

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Department of Computer Science and Engineering
Chalmers University of Technology and University of Gothenburg
SE-412 96 Gothenburg
Telephone +46 31 772 1000

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DAVID HAGBERG FILIPPA PETTERZON
Department of Computer Science and Engineering
Chalmers University of Technology and University of Gothenburg

Abstract

The increasing interest in drone innovation for public services, such as emergency medical deliveries and early situational awareness, raises new challenges around public trust and transparency. This thesis, conducted in collaboration with Region Västra Götaland (VGR), investigates how a standardised marking system can help communicate the purpose and origin of public service drones to the general public. By aligning the needs of diverse stakeholders, including VGR, drone companies, and citizens, the study aims to reduce ambiguity and increase acceptance of drones into shared public spaces. Using methods including interviews, questionnaires, and iterative prototyping, the project identifies key concerns around surveillance, recognition, and ethical concerns. The resulting design framework, MarkeD, including visual markings such as colour schemes, patterns, and placements of logos, is intended to signal trustworthiness and to differentiate drones from private or military use, as well as support visibility. The findings offer both a practical framework for drone marking and broader insights into designing for societal acceptance in emerging technologies as well as academic discourse on new and controversial technologies.

Keywords: Drones, UAV, Human-Drone Interaction, Healthcare, Innovation, Interaction Design, Public Perception, Visual Markings, Explicability and Trust.

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David Hagberg & Filippa Petterzon, Gothenburg, 2025-06-16

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1

Introduction

The potential of drones could be transforming public services by enabling efficient medical deliveries, situational imaging during emergencies and quick transportation of critical supplies, among other applications. Despite their potential, the lack of standardised markings to communicate a drones purpose and origin, as well as complex airspace legislation and public trust pose challenges to the expansion of drones use cases. Transparency, public trust, and operational efficiency are key, particularly when multiple authorities collaborate on drone operations, since different use cases demand specific regulatory compliance and public acceptance [1]

To address these challenges and fully tap into the potential of drones in public services, a generalisable marking system should be designed, allowing different authorities to use drones for various purposes without the need for case-specific drone marking designs. The markings should clearly communicate that a drone belongs to governmental authorities and its intended use without being tied to a single entity, such as medical services. Developing these markings in collaboration with the public and Region Västra Götaland (VGR) could enhance societal trust, understanding, and operational efficiency for public service drones. Research highlights that transparency is a key factor in fostering acceptance of drones for emergency and societal applications [2].

While developing a generalizable marking system for public service drones would be beneficial for VGRs operations, it comes with some obstacles. Research, further discussed in the background section 2, has identified that medical emergency drones are viewed in a positive light. However, expanding the drones use cases to be able to film or take early situational pictures would mean that, for whatever reason the drone is operational, it would be equipped with working cameras. VGR only share their data with relevant parties, excluding the police or military. Equipping drones with cameras could affect public opinion of public service drones.

1.1 Stakeholders

The two primary stakeholders in this project are the general public, whose acceptance is crucial to its success, and VGR, the collaborating partner responsible for implementing the project. Understanding and addressing key stakeholders' interests is central to this project's success. Our work intersects with public service, emerging technologies, and public acceptance, making stakeholder alignment crucial through-

out this project. Additionally, three drone companies currently working with VGR are considered stakeholders, Everdrone, Aviant and Katla Aero, as they provide the technological information and drone know-how.

This master thesis is conducted at the Interaction Design and Technologies master at Chalmers university. Their interests as stakeholders is for the students to succeed and the paper to contribute to related research.

1.2 Aim and Objectives

The aim of this study is to investigate design challenges in developing a standardised marking system for VGRs public service drones that emerge from balancing regulatory constraints, public trust, and operational efficiency. If a general marking system for drones emerge as a potential solution to the aims of this research, the aim is to develop low to high fidelity prototypes as well as a related design framework.

To achieve this, the study will: Identify regulatory and stakeholder requirements through a literature review, questionnaires and semi-structured interviews. It will develop marking system concepts iteratively based on research insight, evaluate the effectiveness of markings through low to high fidelity testing to assess usability, visibility, and public perception and examine design trade-off's and conflicts arising from regulatory changes, technological advancements, and stakeholder priorities.

1.2.1 Expected Contribution

With a delineation to its context of public service drones in VGR, this research contributes with:

- An interaction design framework, which is a structured approach to designing user-technology interactions, aligning user goals, context and system behaviour to create clear, usable, and meaningful experiences, and a prototype for standardized drone markings in public service applications. The prototype will demonstrate how visual markings, such as colour schemes, patterns, and lighting, can enhance visibility, recognizability, and symbolic clarity. The framework will provide design results that can inform implementation across other drone use cases, with considerations for regulatory compliance, public acceptance, and operational visibility.
- Insights into a wicked problem design space of societal acceptance, regulatory challenges, and perceptual barriers connected to a general marking system for public service drones. By incorporating findings from literature reviews, public questionnaires, stakeholder interviews and iterative prototyping, the project contributes to a deeper understanding of how markings influence public trust and interaction in both urban and rural environments.
- Policy-relevant knowledge that informs VGR and regulators, such as Transportstyrelsen (the Swedish transport agency) [1], on effective design strategies

for integrating drones into emergency and medical services. This includes contributions toward recommendations from Transportstyrelsen by providing a systematically tested, research-driven approach to drone marking standards that reduce uncertainty and build societal trust in drone operations.

1.3 Research Question

Recognising that no solution fits all scenarios, the study acknowledged that laws change, technology advances and public perception changes. Furthermore, stakeholder priorities may conflict, making standardisation unpredictable requiring iterative refinements over time. Therefore, the research question posed by this study follows:

What design challenges and emerging opportunities must be addressed when developing a standardised marking system for VGRs public service drones, considering evolving regulations, stakeholder perspectives, and the need for iterative refinement amid different priorities for developing technologies?

1.4 Benefits to academia, industry, or society

The evolution of drone technology presents benefits for industry and society, particularly in public services, emergency response, and sustainable transportation. Quicker medical aid could save lives and lower-emission transport could have a positive environmental impact. However, for these benefits to be realised, continuous public trust and regulatory adaptation are crucial.

A well-designed generalizable marking system could therefore: Facilitate smoother integration of drones into public service applications by improving transparency and recognition, provide a foundation for future regulatory discussions on drone standardisation, and offer an interaction design framework that ensures markings are intuitive, adaptable, and effective across multiple use cases.

In addition to its practical applications, this study also contributes to the academic discourse on interaction design, human-drone interaction (HDI), explicability in new and controversial technologies and semiotics to meaning for public trust in public service. By examining how visual communication and regulatory constraints intersect with public trust, this research expands existing design theories on transparency and usability in autonomous, technological systems that are rapidly developing. It also provides a case study on the complexities of designing for wicked problems in this context, showcasing how iterative methods and stakeholder-driven processes can inform real-world policy and design.

1.5 Ethical Considerations

Today, drone technology is a divisive subject due to its differing areas of use. Although it has potential to be used in socially beneficial areas such as health care

and logistics, it has strong associations to military use, and is used for surveillance and warfare. Therefore, it is important to elaborate on the technologies ethical implications, as well as the positionality of this papers researchers.

1.5.1 Participants Consent

All participants will need to consent before taking part in any part of the questionnaires, interviews, workshops or observations. They will be informed about the purpose of the project, what data that will be collected and what the data collected will be used for as well as their right to stop at any time without any consequences. In the questionnaires, the participants will be informed of this through text and give consent by checking a box. In the other methods, the information will be provided verbally. Written or verbal consent will be required to proceed. Throughout the project, we will aim to adhere to key ethical principles, including transparency, obtaining informed consent, protecting privacy, confidentiality and data, avoiding harm to any participants, maintaining neutrality throughout the process and providing an honest and accurate interpretation of the results [3].

1.5.2 Positionality

One of the researchers identifies as a woman and one as a man. Both were born in Sweden and still live there. Our perspective on the ethical implications of drone use in healthcare is influenced by the Swedish importance of universal healthcare, patient rights, and data privacy. As well as Swedens strict data protection laws, influenced by EU regulations such as GDPR. Our project is conducted in collaboration with the Region of Västra Götaland, a region neither researcher is originally from but moved to in 2020 and currently live in. Both researchers have a bachelor's in Cognitive Science from Gothenburg University and are now pursuing a master's in Interaction Design at Chalmers University of Technology. Neither researcher has worked with drones before and did not have a prior stance or knowledge on the technology or its implementations.

When it comes to new technology, we think it is important to take part in its development, especially if it is a controversial subject. We believe that not taking part in a controversial discourse just because it is controversial could be equated to aiding the side of a controversy that you do not agree with. However, we also value the perspective that when you take part in the development of new technology, you risk that your contribution could be taken advantage of by opposing viewpoints. With this in mind we still believe that it is a risk we are willing to take since we are open to being proven wrong and believe that new technology needs to be worked with in order to decide when, where and if it should be used.

2

Background

There is a rich discourse concerning drones and their implementations in related sciences. Much like most modern technologies the subject is divisive and in the midst of it there is the question of, who it is beneficial for, its potential consequences and if money should be spent to expand its use. One of these current technologies are drones.

Privacy concerns continue to shape public discourse on drones, with perceived surveillance often generating more concern than actual data collection. However, public trust is highly context-dependent, influenced by transparency, regulation, and the drones intended purpose [4]. Research suggests that identification markings and public awareness tools can improve trust, but concerns about noise pollution and visual clutter remain [5]. These issues are particularly relevant in urban areas, where drones operate alongside existing infrastructure and interact with the public.

2.1 Stakeholder Background

This project involves two main stakeholder groups: the general public, whose acceptance is vital, and Region Västra Götaland (VGR), who initiated the project. Additionally, three drone companies contribute with expertise in drone systems. Stakeholder alignment remains a key factor in the project's progression.

2.1.1 General Public

The general public is a key stakeholder in this project, especially in Västra Götaland, but also across Sweden more broadly. Their acceptance is essential for ensuring that drone-based services are not only effective but also accepted in society, a crucial part for further development and innovation of drones as a public service tool. Since these technologies operate in shared public spaces, they inevitably impact peoples daily routines and environments. As such, public trust, transparency, and a clear sense of purpose are crucial.

Even the most advanced solutions risk resistance or rejection if people dont understand how the technology is being used or who it benefits. The success of this project will rely not just on innovation, but on building a sense of legitimacy and confidence among those its meant to benefit.

2.1.2 Region Västra Götaland

Region Västra Götaland (VGR) is a governing body responsible for public healthcare, public transportation, regional development, and cultural initiatives in Västra Götaland County, Sweden. Established in 1999 when the former county councils of Gothenburg and Bohus, Älvsborg and Skaraborg merged. VGR is a democratically governed body and one of Swedens largest employers.

With a population of approximately 1.77 million, Västra Götaland County has 49 municipalities and includes a varied landscape with coastal areas, islands and larger cities. The county's largest city, Gothenburg, is Sweden's second-largest city and centre for industry, education, and culture[6].

VGR handles many services within the region, including managing public healthcare, with hospitals and clinics offering essential care to residents. They also oversee public transportation through Västtrafik, ensuring that people can travel conveniently across the region. On top of that, VGR plays a key role in guiding the regions development, supporting sustainable growth and innovation across Västra Götaland[7].

VGR is also advancing drone technology for public services, particularly in emergency response. Drones equipped with automated external defibrillators (AEDs) can reduce cardiac arrest response times by over three minutes [8], this is further elaborated on in section 2.5.5, while drones equipped with cameras could be used to improve early situational awareness at accident sites [9], further elaborated on in section 2.5.6 . They are actively exploring other public service applications.

Beyond emergencies, VGR is developing airspace management systems to integrate drones safely into regional infrastructure, ensuring regulatory compliance and operational safety[10]. As drone applications expand, VGR remains focused on balancing innovation with public trust, regulation, and effective service integration. One of these initiatives is the development of a standardised marking system to ensure recognition, compliance, and public trust while expanding drone use cases. This is the central aim of this project.

VGR has an overarching vision since 2005 called **Det Goda Livet** (*The Good Life*), expressing future conditions that they wants to create for all inhabitants. Those conditions concern five areas of priority, namely; business, skills, infrastructure and communications, culture and health [11]. Based on this vision, they have a developmental strategy for 2021-2030, and one of four long term priorities within this strategy is to strengthen their power for innovation [12]. One active project within this strategy concerns the development and integration of drone technology into the regional public service infrastructure.

2.1.3 Everdrone

Everdrone is a Swedish drone company that specialises in autonomous drone solutions for emergency responses, deploying drones as first responders (DFR). The company works to be able to deliver emergency medical supplies, such as AED's directly to the emergency site, cutting down on the time it takes from the med-

ical emergency to starting to apply aid. Alongside drones responding to medical emergencies, they also deploy drones for overseeing incident sites, allowing for early situational awareness at accident sites. Their drone is a multicomputer with six arms [13]. The The image 2.1 shows a Everdrone drone delivering a AED above Mölndal.

Figure 2.1: Everdrone Drone delivering an AED

Everdrone's drones are integrated with Swedens emergency dispatch system, SOS Alarm, working like ambulances or helicopters to respond to medical emergencies. All drone operations are managed by Everdrones Mission Control Centre, which handles everything from flight planning to following airspace rules. The drones fly autonomously, providing real-time updates and use secure, encrypted communication.

Everdrone has permission to fly in urban areas and to fly beyond the visual line of sight. They operate in the *Specific* category defined by EU regulations. Everdrone is currently active in six areas in Västra Götaland in collaboration with VGR, Fiskebäck, Torslanda, Kungälv, Trollhättan, Vänersborg, and Mölndal with emergency deliveries of AEDs [13]. Mölndal, unlike the other areas, is not in a controlled airspace, allowing for more flexibility but also requiring heightened security.

2.1.4 Aviant

Aviant is a Norwegian company started in 2020 specialising in autonomous drone logistics, particularly for deliveries. The company had its start delivering COVID-19 tests and has since done different operations concerning healthcare in remote locations and food delivery. Currently, Aviant has a project in collaboration with the food delivery service Foodora, the telecommunications company *Tele2* and the restaurant chain *Bastard Burgers* that aims to optimise food delivery services and provide food delivery by drone to citizens on Värmdö, Stockholm, Sweden[14].

They have permission to fly beyond the visual line of sight and even though not stated on their website, they presumably fall into the specific category. Their drone is a wing drone with a wingspan of 2.7 meters. The image 2.2 shows one of Aviant's drones parked in a field.

Figure 2.2: Aviant drone, parked on the ground

2.1.5 Katla Aero

Katla Aero is a Swedish drone company specialising in the development and manufacturing of drones. Founded in 2018, Katla Aero aims to advance sustainable aviation by creating efficient and well-designed electric drones and aircraft[15]. Unlike Everdrone and Aviant, Katla Aero aims to produce and sell drones rather than to sell drone services.

Katla Aeros current drone design, KATLA 3, is an eVTOL (electric vertical take-off and landing) drone with a wingspan of 3 meters, designed to comply with EU regulations regarding flying beyond the visual line of sight[15]. seen in flying in 2.3 .

Figure 2.3: Katla drone flying

Katla Aero has also provided drones for reindeer husbandry in collaboration with the indigenous Sámi people and the Swedish University of Agricultural Sciences. In addition, the company have participated in the EDIS project (Electric Drones in Societys Service), which explored how drones and electric aircraft can support remote communities by improving access to essential services and transportation [16].

2.2 Public Trust and Different Stakeholder Perspectives

Public acceptance of drones depends largely on their perceived intent and operational transparency. Emergency drones, such as those used for medical deliveries or search and rescue, tend to receive broad public and expert support, while parcel delivery and surveillance drones remain more controversial [17]. The clarity of a drones function and operator plays a decisive role in public trust, people are more accepting of drones when their purpose is easily recognizable [18].

Stakeholder perspectives vary depending on expertise and familiarity. Industry professionals and academics emphasise operational efficiency and regulatory adaptation, whereas the general public prioritises safety, privacy, and accountability [19]. This divide may stem from differences in exposure considering experts tend to view regulatory barriers as the primary challenge, while the public remains concerned about surveillance and noise. This might be because experts are already more aware of the dimensions to the concerns of the public.

2.2.1 Geographical and Demographic Factors

Public perception of drones varies by geography and demographics. Studies in Nordic countries, particularly Sweden and Finland, suggest that public service drones, such as those used for emergency response, tend to receive higher acceptance than

commercial or private drones [20]. However, concerns about privacy, noise, and environmental impact persist across regions [21], [22].

Demographic trends further influence acceptance. Younger individuals and men are generally more receptive to drone technology, while older populations and women express higher levels of scepticism [21]. These variations suggest that tailored communication strategies, such as public education initiatives and transparent regulatory frameworks can help improve acceptance across different social groups.

2.2.2 Evolving Perception of Drones through Transparency

Drones continue to be associated with their military origins, negatively impacting public trust which influence regulatory decisions [19], [23]. Implementing a clear visual language that accurately reflects the objectives of public service drones can, besides following established regulations, play a key role in reshaping public perception in combination with governmental transparency, enhancing the modern drone technology's legitimacy [24]. This approach is particularly important in urban and emergency contexts, where rapid identification of drones can boost public confidence and improve operational coordination[20], [22].

2.3 Design Considerations

Design choices across visual, auditory, and structural elements also play a role in shaping public perception and trust in drones. Fixed-wing drones are often perceived as more professional and reliable than quadcopters, likely due to their association with aviation rather than recreational or surveillance use. Similarly, colour schemes directly impact recognition, ambulance colours like green and yellow strongly signal emergency services, while darker or camouflaged patterns may raise concerns about surveillance and military applications [5]

Sound is another factor influencing public comfort. Lower-frequency sounds tend to be perceived as less intrusive, whereas high-pitched or unpredictable warning tones can increase anxiety and resistance to drone operations. In addition, clear markings, text, and symbols improve transparency by making a drones function and operator easily identifiable at a glance [5].

These elements, visual identity, lighting, sound, and markings, form the foundation of a standardised drone design approach aimed at improving public trust. In the theory, chapter 3, these elements will expanded upon in greater detail, examining how intentional design can enhance drone acceptance, transparency, and usability.

2.4 Transportstyrelsens Recommendations on Drone Standardization

In 2024 Transportstyrelsen (*Swedish Transport Agency*) published a report about drone usage in Sweden and an analysis of how it can be further developed. The pur-

pose of the report is to strengthen the conditions for a competitive drone industry in Sweden and the EU, and promote a safe, sustainable and efficient use of drones while taking the national conditions and opposing public and private interests in regard. The report *En konkurrenskrafig drönarbranch i Sverige* (A Competitive Drone Industry in Sweden) was commissioned by the Swedish government and carried out in consultation with relevant authorities, mainly the Swedish Civil Aviation Administration (*Luftfartsverket*), the National Board of Housing, and Building and Planning (*Boverket*), along with other input gathered from other relevant stakeholders and interested parties. The report provides a comprehensive overview of drones in Sweden while considering regulatory frameworks, infrastructure needs, societal impacts and financial models for drone operations. The report outlines several proposals to further the Swedish drone industry[1].

2.4.1 Proposal 12

Proposal 12 prompts that operators conducting public service flights should mark their drones in a way that identifies who is operating them. According to the EU Commission Drone strategy 2.0, public acceptance of drone operations is a key factor to success[25]. There is a greater acceptance from the general public of drones if they are public service drones rather than privately operated, therefore Transportstyrelsen suggests that drones used for public service, including healthcare, police and other emergency services should be marked to indicate their function and origin. Another way that Transportstyrelsen suggested to improve public acceptance is to increase the visibility of drone flights. Since January 1 2024 all drones have been required in the EU to have remote ID allowing them to be digitally tracked and displayed [26] therefore one of Transportstyrelsen's suggestions is the implementation of applications similar to existing flight tracking apps [1].

2.5 Drones

A drone is an unmanned aerial vehicle with its belonging systems. Drone is the most common term and is the one that will be used throughout this report, but other terms and abbreviations such as UAS, UAV, RPAS and RPA are also commonly used to reference unmanned aerial vehicles. Drones are flying robots that are produced in varying sizes and weights, they can both have wings or multi-rotors, which leads to drones having a variety of needs when it comes to runways, fuels and flying conditions[1]. Drones can be remotely controlled by a human operator or fly autonomously using software-controlled flight plans integrated with onboard sensors and GPS [27].

Drones were initially developed for military purposes but their use cases have been expanded over time. Drones are now used in public service activities such as logistics, monitoring and emergency services [1]. In the future more use cases may appear more often such as transporting people, packages, groceries, as well as a general more large-scale usage of drones in society.

As of now, there is no standardized framework to mark drones. In some countries

there is requirement to display an identification number visibly on the drone [28], however, there is no such requirement in the EU.

2.5.1 Drone regulations

Transportstyrelsen, the Swedish Transport Agency, is responsible for the rules and regulations when it comes to drone flights in Sweden[1]. In line with the EU legislation, there are three categories based on the risk of different flights of drones, *Open*, *Specific* and *Certified*.

Flights with the lowest risk are in the Open category. In this category drones need to be under 25 kg and fly within visual sight of the operator at a max height of 120 meters above ground. No permission is needed to fly but there is a requirement of registration of the operator, and in many cases, requirement of the operator to have education.

In the Specific category, drones weigh more than 25 kg, fly above 120 meters or fly beyond visual sight of the operator or in a way that causes a greater risk to other people, infrastructure or other aircraft. Flying in the specific category requires permission from Transportstyrelsen and the permission is given or denied based on a risk analysis of the flight.

The Certified category is for the flights posing the highest risk for third parties. The certified category requires both permission and registration of the drone, and permission from Transportstyrelsens[1] Drones flying above populated areas often fall into the certified category.

The Swedish airspace is divided into two categories, *controlled* and *uncontrolled*, which is based on meters above ground and proximity to an airport. Within a controlled airspace, there is an air traffic controller (ATC) that directs the air traffic to manage a safe, effective and environmentally friendly traffic flow. To fly within a controlled airspace one needs to get permission from the air traffic controller. Airspaces around airports are in most cases controlled. In uncontrolled airspace, there is a flight information service (FIS) instead and there is no need for permission to fly, as long as the flight safety rules are followed. In Sweden the airspace is shared by the military and civil aviation, therefore they share the same air traffic leader. Drones only fly in the bottom layer of the airspace [1].

There are also restricted areas, *R-areas*, and danger areas, *D-areas*. R-areas are often areas with limited air-traffic, due to surrounding factors such like military activities, public safety, or environmental protection. To fly in these areas special permission is needed from the relevant authority. D-areas are airspaces where dangerous activity occur. There is no permission needed to fly in a D-area but the operator is flying on their own risk[1].

Drones can fly in both controlled and uncontrolled airspace, but the majority of flights takes place in the airspace called *Very Low-Level* Airspace (VLL), which is from ground level up to 120 meters. This means that drones rarely interact with manned aircraft, which are not allowed to fly lower than 150 meters. The VLL

airspace is historically unused both in city environments and in the countryside.

There are certain sites that are prohibited to fly drones over due to the Protective Security Act (*Skyddslagen*). The areas often have both access restrictions as well as imaging restrictions. There is also restricted use of drones in national parks or Natura, 200 areas[29].

2.5.2 Drones with Cameras

Drones are often equipped with cameras both for navigation and other purposes [29]. Drones that are equipped with cameras need to adhere to rules concerning personal integrity and limit sharing of sensitive geographical information or other data that could affect Sweden's total defence capability. Therefore there are rules and permits that are needed.

The act of turning on the camera with intent of streaming or saving is the act that makes the Camera Surveillance Act (*Kamerabevakningslagen*) relevant[29]. The Camera Surveillance Act is a complementary Swedish national law to GDPR. It allows for legitimate camera surveillance while protecting individuals' privacy. An internal documented interest assessment needs to be conducted before starting operations as well as the registration of all surveillance. In line with the interest assessment, the surveillance should only be used if the public interest outweighs privacy concerns [30].

2.5.3 Drone Use Cases

Drones are increasingly used to enhance efficiency and safety in many operations. In Sweden, their integration into society is noteworthy, especially in emergency services, infrastructure inspection, and environmental monitoring.

Drones are used to improve situational awareness, aiding swift decision-making during emergencies. In Jönköping and Stockholm drones are used by the fire department to track the spread of forest fires and to asses the best way to fight the fire[31], as well as to get an early view over accidents [32].

The Police in different cities in Sweden also use drones to facilitate their jobs. They use drones to survey different areas, to pre-empt, prevent and detect crime as well as to enable investigation and presentation of evidence of crimes that already occurred[33]. Based on an interview with an active police drone pilot, they work with drones to provide aerial view of gatherings, high-risk matches or events where it facilitates. They also aid in searching for missing people, locating something dangerous in conjunction with the bomb group and assessing if an area should be cut off from the public momentarily. The interviewee emphasised their focus on public safety and that their drones are equipped with parachutes that automatically activate in case of malfunction. More about this interview in process.

Outside of Sweden, studies show drones offer a safe and efficient means of inspecting infrastructure such as bridges, power lines, and roads. They help identify damage or safety risks, enabling maintenance while reducing the need for dangerous manual

inspections[34]. Additionally, drones assist in tracking environmental data like pollution levels and wildlife populations. They streamline forest inventory processes by reducing reliance on labour-intensive fieldwork [35]. Some studies highlight ethical considerations, emphasising ensuring respectful interactions with local communities during environmental monitoring efforts [36].

Looking ahead, drones are expected to play a role in multiple Swedish industries, highlighted in the documentary *Framtidens Drönare* (Drones Of The Future)[37]. In forestry, drones equipped with AI technologies could analyse tree health, streamlining inventory management. In search and rescue operations, advanced detection systems may enable drones to locate individuals in hazardous conditions more efficiently. This could also reduce risks for human workers. While automation raises concerns about job displacement, it offers potential efficiency, safety and innovation in areas like data processing and environmental management [37].

2.5.4 Drones and Ethics

Ethical design is a cornerstone of implementing drone systems in public services, particularly in sensitive contexts such as filming accident sites and healthcare. The design must prioritise transparency, inclusivity, and societal well-being[38]. It is essential to ensure that markings and design elements are clear and recognisable to avoid public confusion or mistrust, while also respecting privacy concerns during drone operations. Although drones provide significant social benefits, such as supporting rescue operations and healthcare services, their integration into society can still be disruptive. Issues such as noise and visual pollution, privacy concerns, and increased public anxiety highlight the need for a strong ethical approach in their development. More drone traffic could also have an negative effect on the environment, affecting wildlife, and in case of a crash, they could release hazardous substances into the environment [1]. Crashes also pose a risk to the general public since they can harm them as well as their property. As previously mentioned, drones also has strong connections to military use through warfare and surveillance and is therefore carrying a lot of negative associations, which can affect public anxiety greatly, even if they are not used for military operations. Therefore, it is essential to prioritise ethical considerations throughout the project and actively engage the general public as key stakeholders to ensure their concerns are addressed[5] [1].

Any discrepancy between VGR views and public perceptions of what constitutes societal benefit will be explored. For instance, drones equipped with cameras, even when deployed for emergency purposes, can evoke feelings of insecurity and distrust among the public, regardless of whether their purpose or origin is communicated. As designers, it is crucial to assess whether drones genuinely serve as a societal benefit, especially if they simultaneously create unease or resistance within the community.

Ethical considerations should also include minimising harm and ensuring equity through non-intrusive communication of the drone's purpose and intent. By addressing these challenges and aligning design choices with both organizational goals and public concerns, the system can foster trust, acceptance, and positive societal impact.

2.5.5 Region Västra Götaland and AEDs deliveries

VGR currently has a project together with Everdrone where they deliver AEDs to suspected cardiac arrests in emergency situations, across six different areas in Västra Götaland, Fiskebäck, Torslanda, Kungälv, Trollhättan, Vänersborg, and Mölndal. The airspace is uncontrolled in contrast to the other areas. The operation is integrated with Sweden's SOS alarm system, and the project aims to improve the response time during cardiac arrest emergencies. By delivering an AED that can be applied by the SOS-caller before the ambulance arrives, the likelihood of the individual surviving increases. The drone project of delivering drones with AEDs started in 2020 and is projected to run until 2026 [39].

Cardiac arrest affects 8500 people in Sweden every year. A cardiac arrest is when the heart stops beating, leading to a lack of oxygen reaching vital organs. An untreated cardiac arrest will lead to death within a couple of minutes[40]. For every passing minute the arrest goes untreated, the likelihood of survival decreases by 10%. Cardiac arrest outside of hospitals has a survival rate of 10% , but if an AED is applied within 3-5 minutes, the survival rate can increase to 50-70% [41].

When an emergency call is made, the system uses a location-based index to trigger a request through SOS Alarm, which activates Everdrone's operation. The drone is then sent autonomously after contacting and getting confirmation from air traffic control, in a controlled airspace, who ensures that the flight is safe to perform. As the drone departs from its base, it navigates autonomously at 60 meters height to the emergency site. The route is adjusted depending on the environment below, whether its flying over populated areas, highways, or rural zones, adjusting for safety and maintaining a quick response.

When arriving at the emergency site, the drone descends down to 30 meters and the pilot remotely confirms via camera that the delivery is safe to make. The AED is then winched down to the ground, the drone takes a picture of the delivery and sends it alongside the coordinates to the emergency services that can guide the caller to the location of the AED. The drone then returns to its base, optimising the route only for safety, avoiding populated areas and high traffic roads. The AED is collected by the emergency services on site and later returned to or collected by Everdrone.

2.5.6 Region Västra Götaland and Early Situational Awareness

As of April 23, 2025, VGR is performing live testing in Mölndal municipality, using drones for early situational awareness, until 2026. By deploying a drone, equipped with a camera to an accident site, they aim to provide real-time visual information to emergency dispatch centres and responding emergency vehicles. This aims to provide early information about the situation and, therefore, allow for enhanced decision-making, resource allocation and preparedness for emergency personnel by providing live video feeds. The project is a collaboration between VGR's Innovation Platform, the health care emergency dispatch centre, and the Greater Gothenburg

Fire and Rescue Service[42].

The project is currently being tested both in real-life situations as well as simulated environments. The goals of the project are to identify needs and stakeholders, develop workflows and ensure integration into the emergency response chain, test and evaluate workflows and technology for drones streaming video/images from the incident scene to the dispatch centre and incoming units. Alongside the project, research is performed in collaboration with the Karolinska Institute.

Early situational awareness is a part of PreViS, a InterReg project supported by the EU-program Interreg Sverige-Norge and VGR. The PreViS project, *Pre-hospital Video i Samverkan (Prehospital Video in Cooperation)*, aims to develop and implement advanced video technology to aid decision making and to establish a triple-helix environment that can contribute to the development of the pre-hospital chain of care[42].

3

Theory

Theory is a big part of what guides interaction design projects, defining what is important in early phases will have a big effect on end results. To begin with, it was apparent that the design space would be somewhat of a wicked problem requiring iteration and adaptation to match multiple stakeholder needs, identified through User-Centred Design. Furthermore, prototyping and evaluations was a way of exploring the design space, eventually arriving at a final design framework and recommendations, aligning with research through design theory.

Considering the aim of arriving at a design framework that inform drone designs supporting public trust, transparency and safety, the design process was naturally informed by Human-Drone Interaction theory that align closely with Explicability, Transparency and public trust theory as well as Value Sensitive Design.

Since this thesis is conducted within the master of Interaction Design and Technologies, the practical design decisions and results, such as a design framework, were informed by Interaction Design theory incorporating meaningful usability and user experience. Within this specific design space Ambient Interaction and System Integration theory inspired the complexity of designing a drone marking system that appear to be a public service vehicle without looking like police or ambulance while aligning with public opinion. Semiotics theory that lead to meaning making was also part of aligning the design with Ambient Interaction and System Integration theory with the aim of meaningful interaction design.

3.1 Wicked Problems in Design

Many design challenges are inherently complex, requiring iterative and adaptive approaches rather than fixed solutions. Wicked problems are issues that lack clear definitions and singular answers, often involving multiple stakeholders with differing priorities [43].

Wicked problems in interaction design are shaped by **regulatory uncertainty**, where evolving policies influence design constraints, and **conflicting stakeholder needs**, requiring careful negotiation between different perspectives. Additionally, **shifting public perception** affects long-term acceptance and usability. These challenges emerge from the inherently complex and intersectional nature of interaction design, which must account for contextual dynamics, emerging issues, and

evolving user needs. Addressing wicked problems effectively demands **iterative and participatory methods** that integrate stakeholder feedback to refine and adapt solutions [44].

3.2 User-Centred Design

Designing for usability requires engagement with users and stakeholders. User-Centred Design (UCD) focuses on continuous refinement through iterative user testing and feedback [44]. By structuring the design process around user behaviour and expectations, UCD ensures that systems remain adaptable and easy to use.

The approach helps address wicked problems, as it supports ongoing evaluation and refinement based on real-world interactions. By prioritising user input and adaptability, user-centred design methods create systems that remain relevant with evolving requirements.

3.3 Research Through Design (RtD)

Research Through Design (RtD) is a way of conducting research through the design process itself, using prototyping as a means of inquiry [45]. Rather than relying solely on theoretical models, RtD explores how design can shape and inform understanding. It is still paired with theoretical models to guide the process and novel research results often emerge from the combination.

The strengths of RtD lie in its iterative and practice-based nature. Prototyping enables exploration, allowing for hands-on investigation of different design solutions. Real-world evaluation refines understanding, adapting insights based on user interaction. Flexibility supports evolving design challenges, particularly in addressing wicked problems.

RtD aligns with the user-centred approach by integrating user feedback into the research process. By treating design as a means of knowledge production, RtD provides a framework for understanding complex interaction systems.

3.4 Human-Drone Interaction

As autonomous systems technology such as drones become more widely utilised, Human-Drone Interaction (HDI) explores how people interact with them. Unlike traditional digital interfaces, drones rely on spatial movement, visual indicators, and environmental context to communicate intent [46].

Some factors central to HDI are perceived autonomy, where users must be able to distinguish between autonomous and manually controlled drones, explicability and feedback, where clear signals help users interpret drone behaviour, and safety and trust, where interaction design must account for user comfort and perceived risk. These considerations are especially evident in professional contexts, where drone

operators must develop specific interaction skills, balance system autonomy with manual control, and interpret drone behaviour under pressure [47].

The field of HDI is evolving as drones become integrated into various public and professional contexts. Well-designed HDI frameworks enhance usability, ensuring that drone interactions remain intuitive and trustworthy.

3.5 Explicability, Transparency, and Public Trust

Explicability is often important in interaction design, particularly in systems that operate autonomously or require public acceptance. Explicability refers to how well a system conveys its functionality and intent: how well users can interpret its behaviour without ambiguity [5]. When a system lacks explicability, users have to assume its operations, which often lead to distrust. In autonomous technologies, explicability is achieved through clear visual and auditory cues that indicate system status, operational intent, and expected behaviour.

Transparency ensures that users can observe and predict system actions. A transparent system provides visible or otherwise perceptible indicators of its internal processes, enabling users to build accurate mental models of its operation. By designing for transparency, interaction designers can reduce uncertainty, improve usability and trust in a products and the people behind it [48].

Explicability and transparency are necessary design elements if you want public trust, which is often central to the adoption of new technologies. Public trust can be gained when a product is perceived as reliable, transparent, and responsive [49]. A system that is perceived as opaque or unpredictable risks alienating users, whereas a transparent interface fosters confidence in it. Interaction design plays a central role in this process by ensuring that systems communicate their purpose effectively, reducing barriers to user acceptance.

3.6 Value Sensitive Design

Value Sensitive Design (VSD) is an approach that integrates ethical and societal values into interaction design. It ensures that technology aligns with human needs beyond functionality and efficiency [50]. Unlike traditional usability-focused methods, VSD acknowledges that design choices shape user trust, acceptance, and long-term societal impact [51]. By embedding considerations such as fairness, transparency, and accountability, VSD provides a framework for designing interactive systems that are both functional and ethically responsible [52].

VSD consists of three core components. **Conceptual Investigations** identify key values and ethical concerns within a system, ensuring that design decisions consider stakeholder perspectives [50]. **Empirical Investigations** apply qualitative and quantitative methods, such as user studies and stakeholder interviews, to analyse how people interact with and perceive a technology [53]. **Technical Investigations**

explore how values can be embedded in system design through interface features, automation constraints, or regulatory compliance mechanisms [54].

VSD has been widely applied in areas such as human-computer interaction (HCI), artificial intelligence (AI), and autonomous systems, where transparency and accountability are critical [55]. In autonomous drones and public technology infrastructure, VSD supports explicability, privacy protection, and stakeholder-driven design, ensuring that systems remain trustworthy and socially responsible [56].

To implement VSD, designers often combine stakeholder analysis, value scenario modelling, and participatory design to address competing priorities (e.g., privacy vs. security, accessibility vs. efficiency) [54]. However, scalability and transferability of results remains a challenge, particularly when applying VSD to complex, large-scale autonomous technologies [57]. However, that could be due to core VSD principles being followed.

As interaction design increasingly intersects with autonomous and AI-driven systems, VSD provides a structured approach for balancing usability, public trust, and ethical considerations, ensuring that technology aligns with both practical needs and broader societal values [52].

3.7 Interaction Design

Interaction design is a multidisciplinary field that focus on usability and user experience with the aim of designing interactive products that facilitate meaningful interactions in peoples everyday and working lives[58]. To establish clear communication between users and products the field integrates principles from human computer interaction (HCI), cognitive psychology, design theory and more. A central aim of interaction design is to ensure that systems convey their functionality effectively, aligning with user expectations and cognitive processes.

Results of interaction design research can be a design framework, which is a structured approach to designing user-technology interactions, aligning user goals, context and system behaviour to create clear, usable, and meaningful experiences.

3.8 Ambient Interaction and System Integration

Ambient interaction refers to systems that integrate seamlessly into their surroundings, requiring minimal explicit interaction while maintaining usability [48]. This design approach ensures that interactions remain intuitive and non-intrusive, supporting both efficiency and accessibility.

Key principles of ambient interaction include reducing cognitive load by embedding meaningful visual and auditory cues and minimising user effort through passive system engagement.

Ambient Interaction aims to ensure system integration by aligning with existing workflows and expectations. By prioritising low-effort and high-effectiveness design,

it allows for intuitive interactions without requiring active and focused attention.

3.9 Affordances, Feedback, and Semiotics

Interaction design aims to facilitate interactions partly by considering how users perceive and respond to different parts of a system. For example, affordances describe perceived possibilities for action that a product communicates to a user and shapes expectations about how it can be used [59]. When affordances are clear, users can intuitively interact with a system without requiring additional instructions. When affordances are unclear a product can be lacking in what ways it can be used or incorrectly communicate functionalities that are not there.

Feedback ensures that system responses to interactions are immediate and/or understandable, reinforcing correct usage and preventing errors [59]. Without effective feedback, interactions become ambiguous, leading to uncertainty in how a system should be used. Feedback mechanisms include visual, auditory, and haptics, each serving to clarify system state and user input. Some expected feedback can be due to production customs being constant over the years and not based on intuitive design. Therefore, feedback systems can change or be different based on things like culture and evolving societies.

3.9.1 Semiotics

Semiotics, the study of signs and symbols, examines how meaning is made and interpreteda process central to interaction design and how users engage with systems. Through colours, lighting, patterns, and sounds, designers can create intuitive interfaces that communicate meaning efficiently and reduce cognitive load [60]. These elements contribute to recognition, trust, and usability.

3.9.1.1 Colour

Colour serves as a stable and instantly recognisable design attribute, aiding identification and differentiation in various contexts [61]. It is often associated with immediate cognitive responses, enabling users to interpret meaning at a glance [62]. While some colour associations are culturally dependent, many are widely recognised within specific domains, such as red for warnings, green for permission, and yellow for caution [63].

Studies in vehicle design have shown that colour can significantly influence recognition speed and trust, particularly in high-visibility environments [64]. However, contextual constraints must be considered, as certain colours carry associations. For example, in emergency services, red and white are linked to medical transport, while dark or camouflage patterns are often associated with surveillance or military applications [65]. Consequently, effective semiotic design should balance immediate recognizability with contextual appropriateness [66].

3.9.1.2 Lighting

Lighting enhances visibility, usability, and perception in interaction design. It is widely used to guide attention, indicate status, and improve situational awareness in both digital and physical interfaces [67]. In low-light or high-risk environments, strategic lighting placement can increase recognition and improve public confidence in a systems function [68].

Beyond visibility, lighting design influences perceptions of safety and transparency. Studies have shown that well-lit systems are more likely to be trusted, particularly in public spaces where visibility reduces uncertainty about an objects purpose [69]. However, excessive or poorly placed lighting can contribute to visual pollution and reduce effectiveness[70]. Adaptive lighting, based on environmental conditions and user interaction, is increasingly being explored to balance functionality with minimal disruption [22].

3.9.1.3 Patterns

Patterns are used in interaction design to enhance visibility, communicate urgency, and create recognizability. High-contrast, repetitive patterns such as *Battenburg livery* and *Chevron* designs have been widely implemented in emergency vehicle markings to improve detection and differentiation [71]

Battenburg markings, characterised by alternating reflective tiles, are designed to maximise visibility across varying conditions. They have been successfully applied in emergency services, where rapid identification is crucial. In the image 3.1 a Swedish ambulance has the Battenburg markings in green and yellow across its side.

Figure 3.1: Battenburg Markings on the side of a Swedish Ambulance

Chevron patterns, consisting of angled stripes converging into an arrow-like formation, are commonly used in traffic and signage to indicate motion, urgency, or directional guidance [72]. In the image 3.2 , the chevron pattern, in red and yellow, is placed on the backside of an American ambulance.

Figure 3.2: Chevron Pattern on the back of a American Ambulance

Both colour and contrast play key roles in how effectively patterns function in their intended context. Studies suggest that high-contrast, clearly structured markings improve reaction times and reduce ambiguity in high-stakes environments [64].

3.9.1.4 Sound

Sound design in interactive systems serves both functional and psychological purposes, enhancing usability, safety, and recognition [73]. Auditory cues provide essential feedback in contexts where visual indicators alone are insufficient, such as in high-noise environments or when users are not facing an interface directly [74].

There are some key considerations when it comes to sound design. Frequency and tonality, lower-frequency sounds tend to be perceived as less intrusive, whereas high-pitched, tonal sounds can be more attention-grabbing but potentially irritating [73]. Sound integration into existing soundscapes, embedding sounds within familiar environments (e.g., matching ambient urban noise levels) can reduce perceived disruption [75]. Operational optimisation, research suggests that propeller design, altitude, and flight patterns can affect the perceived noise level and acceptability of airborne systems [76].

In addition to minimising disruption, intentional sound design can improve recognition and trust by ensuring that signals are clear, non-intrusive, and contextually appropriate [77]. Regulatory discussions on noise pollution and psychoacoustic considerations are increasingly influencing sound-related design decisions, particularly in public environments [22].

4

Methodology

This section introduces various methods that may be used throughout the project, organized into four categories: research, ideation, prototyping, and evaluation. Additionally, two design process frameworks are presented.

4.1 Design Frameworks

The Double Diamond model is a design framework developed by the British Design Councils in 2005 that is divided into four iterative steps: Discover, Define, Develop and Deliver[78]. **The Design Sprint Methodology** is a design framework developed by Google, divided into six iterative phases, Understand, Define, Sketch, Decide, Prototype and Validate [79].

4.2 Research

In this section, different methods for gathering and analysing data will be presented. All of these may or may not be used as methods for the project. Two types of data can be collected: qualitative and quantitative. Qualitative data is more subjective and often seeks to answer questions about behaviour and experiences,ăthings that cannot be objectively measured or quantified. Quantitative data is numeric-based and aims to quantify different variables and analyse their relation to each other [80]. Gathering both quantitative and qualitative data is called mixed-method.

4.2.1 Literature Review

A literature review of relevant studies and topics can form an approach knowledge base. During the initial phase of the project a literature review can be conducted to serve as a critical reference point for making informed decisions throughout the whole project. A literature review will also ensure that the research hasn't been done before and make sure that the planned project fits into the currently existing body of knowledge. It will also give an overview of a subject [81].

4.2.2 Questionnaire

Questionnaires are good for collecting large amounts of data effectively and systematically, allowing for structured and unstructured responses that provide insights. By using both free-text questions and structured questions such as Likert scales and multiple-choice in a questionnaire one can gain both qualitative and quantitative data. This mixed-method approach ensures that respondents have the opportunity to freely give their opinion while also gathering standardised data that allows for analysis. [81].

The questionnaire should aim to be unbiased. To achieve this, several steps can be taken while crafting the questionnaire. Questions should be reviewed to avoid being leading and using suggestive language. The questions should also be phrased neutrally and there should be variety in response options, to avoid respondent bias. By including both open-ended questions the respondents can freely give their opinion without being limited by pre-selected answers [81]. Given that respondents may not have experience with the topic researched, ensuring neutrality in question design is extra important to avoid the influence of respondents with the researcher's biases.

4.2.3 Interviews

Interviews are a qualitative research method that allows the researchers to gain deeper insight into a topic by gathering information from respondents on their experiences, opinions and perspectives[81]. Conducting semi-structured instead of structured interviews allows the researcher to be more flexible and have a more explorative approach. By having standardised questions, that allow for comparisons between interviews, alongside a semi-structured approach allows the researcher to elaborate and probe the respondent during the interview to gain deeper insight.

Interviews can uncover perspectives that structured surveys and questionnaires may overlook[81]. By incorporating a diverse range of perspectives, this interview phase will allow for a more comprehensive analysis of the data gathered [81].

A stakeholder interview is a way to get the stakeholder's insight on the project. A stakeholder can be anyone interested in the project. Stakeholder interviews are often semi-structured with the goal of gaining insight into their expectations and opinions[82].

4.2.4 Observations

Observations can be useful for gaining insight into how people act and behave in natural situations, instead of having to rely on the participants' self-reports. Observations can be helpful to strengthen data gathered during questionnaires and interviews[81].

4.2.5 Personas

Personas are pretend users that represent a specific user. The persona is based on contextual data and has a developed backstory, name, life and personality. They

are useful for concentrating on defined needs instead of broad assumptions of needs. Personas ensure that design decisions are human-centred and aligned with the target audience's expectations[83].

4.2.6 Thematic Analysis

Thematic analysis is a flexible and theoretically grounded method used for analysing qualitative data. In this approach, one can identify, analyse, and report patterns within data, providing a rich and detailed account of the gathered data[84]. The analysis is conducted in six phases: Familiarising yourself with the data, Generating initial codes, Searching for themes, Reviewing themes, Defining and naming themes and Producing the report[84].

In the first phase, **familiarising yourself with the data**, the data is read through multiple times, to allow the researchers to immerse themself in the data. During this phase notes should be taken to aid during the next phases. The next phase is **generating initial codes**, where the data is coded. Coding is part of the analysis since it organises the data into meaningful groups, codes are elements of the data that seem interesting. In phase three, **searching for themes**, the codes are sorted into potential themes. In this phase mind maps or tables can be useful tools to help the sorting process. The relationship between codes, themes and levels of themes should be explored in this phase. In phase four, **reviewing themes**, the themes are refined. The data extracts in each theme are read through in search of a coherent pattern, if they do not make a pattern, the theme needs to be reworked. If a pattern is found, the validity of themes is considered against the data set if it accurately represents the data. Through this process a thematic map of the data is created. In phase five, **defining and naming themes**, the essence of each theme is identified through defining and refining. The names decided for the themes need to be concise and represent what is interesting about the theme. The last phase, **producing the report**, involves the final analysis and writing of the report. The analysis should provide a concise, clear and interesting narrative that logically presents the data findings. It should avoid redundancy and maintain coherence, highlighting meaningful patterns both within and across themes[84].

4.3 Ideation

This section presents various ideation methods that may be considered for use in the project.

4.3.1 Sketching

Sketching is a visual medium used for rapid exploration and expressing design ideas. Sketching allows for conceptual exploration, focusing on the concept and not the specific details of an idea. Sketching is an important part of ideation since it allows for rapid visualisation and exploration of different ideas without committing to a

final solution[83]. It is an important part of the invention process, aiding in the ideation by allowing iterative thinking and creative development.

4.3.2 Crazy 8

Crazy 8 is a brainstorming and sketching exercise used to quickly produce many ideas. One produces eight distinct ideas through sketching in eight minutes. The exercise is useful to challenge the designers to push past their initial ideas to generate a greater variety and amount of design solutions and ideas. It is a method that produces rapid and diverse ideas[85].

4.3.3 Mood Board

Mood boards is a tool that can be used to create a visual direction through a collection of different design elements such as colours, textures and imagery. A mood board can serve as an inspiration for the look and feel of the design goal [86].

4.3.4 Concept Portraits

Concept portrait is an ideation method used to identify fundamental elements of an artefact through an exercise of assigning different items to the artefact based on prompts. These items are then analysed for themes to understand the fundamental concepts of the artefact [87]. An example is *"If your artifact was a material, what would it be?"*.

4.3.5 Storyboarding

Storyboarding is a method to represent the design with a focus on the flow of the design. It resembles comic books with a simple scene-after-scene structure using simple cartoons to represent the functionality of the design[88].

4.3.6 Co-design Workshops

A co-design workshop is a structured collaborative session with the designers, stakeholders and end-users working together to generate ideas, explore concepts, and develop design solutions. By including stakeholders and end-users in the workshops, the end design will be more human-centred and reflect real-world experiences by having participants with different expertise and needs contribute. Designers still have an important and active role in the workshops by structuring them and translating insights gathered into design directions [89]. Co-design workshops facilitate a more diverse perspective on the design solution, often leading to more innovative solutions by addressing and including multiple viewpoints. The workshops are also, due to their collaborative nature, great for problem-solving since the participants in real-time work together to define challenges, generate ideas and refine solutions[89].

4.4 Prototyping

This section introduces various prototyping approaches that may be considered for use in the project. Prototypes can work as filters to test ideas and as manifestations to explore design possibilities[90]. They play an important part in the design process as they allow for the exploration of design ideas by having a representation of the product in the early stages of the design process. Being a representation, they can work as a filter by gathering feedback, and the design can be iterated and refined before developing the final product. Using early-stage prototypes also allows the designers to explore different ideas without committing to a single solution and communicate the concepts in a visual and tangible way between designers, stakeholders and users[90].

4.4.1 Low-fidelity Prototyping

Low-fidelity prototypes are used at the beginning of the prototyping process to depict concepts and design alternatives[91]. A low-fidelity prototype is limited in functionality and usually very simple, mostly representing the general look and feel of the product. It is used to inform rather than to test. They are usually characterised by being simple, inexpensive and quickly created to represent a design.

A low-fidelity prototype can be useful when evaluating early concepts and can work as a tool in idea generation. With a low-fidelity prototype, one can quickly make iterations based on feedback and evaluations, and low-fidelity prototypes are very useful in participatory design [90]. Low-fidelity prototypes are not useful for usability testing and for more in-depth interactions as they lack functional interactive elements.

4.4.2 High-fidelity Prototyping

High-fidelity prototypes are more complex than low-fidelity prototypes. When a user can not differentiate between a prototype and a final product, it is no longer a low-fidelity prototype but rather a high-fidelity prototype[91]. High-fidelity prototypes therefore highly resemble the final product and are detailed and interactive, with working elements. High-fidelity prototypes are useful when performing realistic usability testing and are a helpful tool for finalising design decisions. High-fidelity prototypes, due to their complexity, are more time-consuming and expensive to develop. Changes and iterations also take longer to implement [90] therefore, they are more suited for later in the design process.

4.5 Evaluation

This section introduces various usability evaluation methods that may be considered for assessing the final project.

4.5.1 Heuristic Evaluation

Heuristic evaluation is an evaluation method where experts in the subject evaluate the product against established usability heuristics. They identify where the design does not follow the heuristic, which can cause usability problems. The established heuristics are principles such as *visibility of system status, the match between the system and the real world, user control and freedom, consistency and standards, error prevention, recognition rather than recall, flexibility and efficiency of use, aesthetic and minimalist design, help users recognize, diagnose, and recover from errors and help documentation*. Heuristic evaluations are very useful at the beginning of the design process and can provide feedback in a cost and time efficient way [92].

4.5.2 Usability Testing

Usability testing is an evaluation method used to measure a product's effectiveness, efficiency and the user's satisfaction with the product. The method focuses on evaluating the product by observing users interacting with it. By allowing real users to interact with the product, insights into the user experience can be gained, and areas of confusion, frustration and or satisfaction can be identified. Usability testing ensures that feedback gathered is real-world compatible since it is based on real users' experiences and expectations. Usability testing can be used iteratively and help to refine the product to enhance user satisfaction[93].

4.5.3 Think-Aloud

The think-aloud method is a method where the user, while interacting with the product, says their thoughts aloud, allowing the designer insight into the user's thought process when interacting with the design [94].

4.5.4 A/B Testing

A/B testing is a quantitative evaluation method. Two versions of the same design are compared against each other to identify which is the better-performing one. A/B testing is an effective approach since it provides rapid and straightforward results [95].

4.5.5 Usability Questionnaires

Usability questionnaires are a data collection method, used to gather data from participants in evaluations of a design[83]. By being structured, questionnaires can in a systematic way gather feedback, opinions and information from a large group of participants, which is easily quantifiable and compared. The data that is collected can be both quantitative and qualitative, but is mainly quantitative and subjective [83], making them a valuable tool for assessing various aspects of the design[96]. Questionnaires are a tool for evaluating user experiences and are valuable for design improvements.

5

Process

The project began with a **Literature Review** focused on different perspectives on drone technology. Special attention was given to the general publics attitudes, as well as the views of professionals working with drones in Swedish municipalities. Particularly interesting topics are: how regional drones could communicate their purpose and affiliation through visual or other design. Insights from the review informed the data collection methods in a Swedish context.

To capture public opinion, a **Questionnaire** was developed consisting of free-text responses, Likert scales, and multiple-choice questions. In parallel, semi-structured **Stakeholder Interviews** with relevant professionals were conducted. Based on the public questionnaire, an adapted questionnaire targeted at individuals working in the drone industry was distributed to deepen the understanding of stakeholder perspectives.

The collected data was analysed primarily through **Thematic Analysis**, a qualitative method, supported by relevant quantitative results. The analysis guided the following ideation, where **Sketching**, **Crazy 8** and **Concept Portraits** were utilised to move forward in the design process. **Prototypes** were developed and iterated on through a through a follow-up **Questionnaire** and an evaluative **Stakeholder Interview**. The second questionnaire focused on assessing the proposed designs, which had been iteratively refined based on previous findings. The final interview was conducted with key stakeholders at VGR to gather feedback on the proposals and discuss broader results from the project. The whole process will be covered in depth in this chapter.

5.1 Research

This section presents the methods used to collect the data that is the base for the design process, as well as a reference base for making decisions throughout the project. Data was collected through an extensive literature review, two questionnaires and five interviews, as well as continuous contact with project supervisors at VGR, who provided valuable information on their drone operations.

5.1.1 Literature Review

The literary review, described in 4.2.1, aimed to find articles and reports covering four key topics: the use of drones for public services, public opinions on drones, Swedish drone laws and regulations and design elements for emergency vehicles. An effort was made to identify similar studies regarding the design of drone markings for public acceptance, as well as standards for drone markings in other countries, but very little literature on these topics exists, strengthening the need for this research. Relevant literature was found through Google Scholar or in the Chalmers library database using the Scopus AI tool.

5.1.2 General Public Questionnaire

The general public is a key stakeholder, since the development of drone solutions for municipalities in a society requires public acceptance. Therefore, an important part of this project is gaining insights into the general populations opinions and perceptions of drones. To do this, a questionnaire was conducted to collect quantitative and qualitative data. The questions were informed by findings from the literature review and the needs of VGR. This ensured that they addressed relevant themes and public concerns identified in existing research, while also covering knowledge gaps not found in previous studies and meeting the aim of the main stakeholders. The insights gained from this questionnaire were a guiding part in the design process. By understanding societal attitudes and preferences, one can create more user-centred, acceptable and effective solutions that align with both regulatory frameworks and societal expectations. The benefits and workings of a questionnaire are described in 4.2.2.

Before sending out the questionnaire to the general public, initial feedback was collected from the university supervisor and VGR. A pilot study was also conducted, described in section 5.1.4. The questionnaire was distributed through different channels, including LinkedIn, a municipal website, private chats and was active for two weeks.

The questionnaire consisted of 32 questions, including free text, Likert scales and multiple choice questions. It was divided into six parts, in the following order: *Demographics, Public Perception of Drones, Security and Privacy, Identification and Visibility of Drones, External Factors Affecting Drone Perception* and *Closing Questions*.

Before beginning the questionnaire, there was a short informational text about the project stating the project's purpose and affiliations. There were also images of three models of drones from companies working with VGR. Before taking part in the questionnaire the participants also gave informed consent. The questionnaire was in Swedish, with an English translation being displayed below the Swedish text. The free-text questions alongside the data collected can be found in the in the appendix A.

Thematic analysis was used to analyse the qualitative data collected from the questionnaire. Thematic analysis is described in 4.2.6. The patterns discovered during

the analysis served as a strong base and informed decisions and actions during the design process. To analyse the qualitative data from the questionnaire, all the data was divided into different documents based on the questions. A total of 15 documents were made, nine of which were colour-combination questions. Each question was analysed individually to maintain context.

The quantitative data collected from the questionnaire was not statistically analysed, as the aim was not to determine the truth of a hypothesis, but rather to explore patterns and perceptions. The quantitative data rather worked to strengthen the result gained from the qualitative data, gathered from the thematic analysis and to give an overview of the data collected.

5.1.2.1 Demographics

There were four demographic questions. Participants were asked about their age, gender, area of residence, as well as the population density of their areaurban, suburban, or rural. This approach was chosen because VGR has active drone projects in various areas, making the opinions of residents in these areas particularly interesting. However, due to the low number of participants from those areas, this data will not be further analysed.

With a total of 48 participants, the gender distribution was: 26 female, 21 male, 1 non-binary. The age distribution can be seen in the table 5.1 . 38 participants lived in an urban area, 5 in a suburb and 5 in rural areas.

18 - 24	25 - 34	35 - 44	45 - 54	55 - 64	65 - 74	75 +
11	18	3	7	7	1	1

Table 5.1: Age Group Frequency

5.1.2.2 Public Perception of Drones

In this section, the participants' perception and opinion of drones in society is explored.

Question 1: ***What are your view on the use of drones in Society***

Participants ranked their view on drone use in society on a Likert scale ranging from 1 to 5. They rated their drone perception with an average score of 3,98 on a 5-point Likert scale where 5 was "very positively" and 1 was "very negatively", the data is further visualised in the graph 5.1.

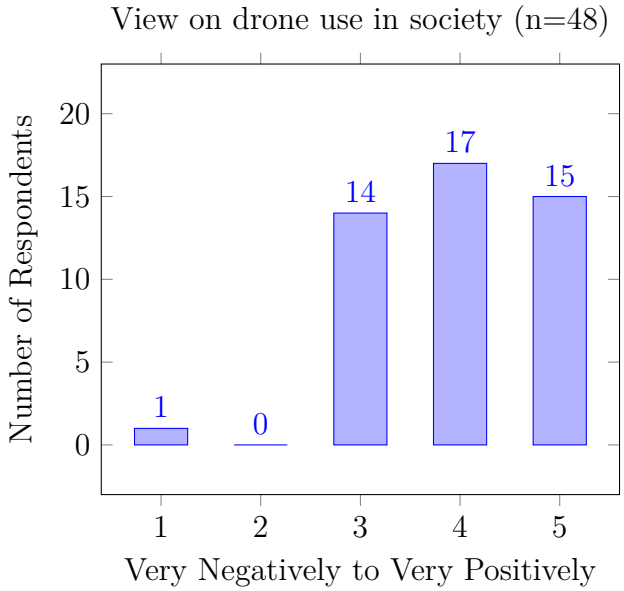

Figure 5.1: Distribution of Responses on a 5-point Likert Scale (1 = Very Negative, 5 = Very Positive)

Question 2: *What influences your opinion?*

Following this, participants were asked to elaborate on their drone perception, answering the question *"What influences your opinion?"*. Collecting both a ranking and their motivation in free text, allows for both quantitative and qualitative data to be collected. Through thematic analysis, prevalent themes were identified. The most frequently occurring theme was **Societal Benefit** with 17 answers that concerned public services such as healthcare, emergency response, transportation, and data collection. Many of these answers also emphasised that they would dislike use cases that did not concern societal benefits. Here are some example excerpts translated to English:

> When you hear/read about drones, it is often in a negative sense, like someone who has flown in an unauthorized area and/or stopped air traffic. Or war. But I know that it is used/researched into being used in healthcare or for medicine or similar, i.e. for positive things.
>
> important to find a use case for drones in "socially beneficial services" to facilitate/simplify/speed up, for example, the transport of items or surveillance.
>
> If it is used for a socially beneficial function - I think it is positive. By socially beneficial I mean police, healthcare, fire brigade, etc. I don't think it is okay with private drone deliveries, drones are noisy + there is already limited airspace so then important functions should be prioritized.

The next theme was **Better Alternative** with a frequency of 12 answers that concerned drones as a faster, more efficient and sustainable option with future potential.

Like the societal benefits theme, participants were positive towards the technology, but their answers were nuanced through the awareness of its current limitations and potential for misuse. Here are some data excerpts:

> It is important that we can find areas of use for drones in "community service" to facilitate/simplify/speed up, for example, the transport of things or surveillance.

> \+ for the freedom of individuals to photograph/film, + if they replace other, noisier vehicles, - what if they come from a foreign power, you never know

> The usefulness of how the technology can be used and the relatively cheap price.

The third, fourth and fifth themes were **Warfare**, **Privacy and Surveillance** and **Area of Use**. They each had a frequency of 8 answers. **Warfare** was identified through concerns about military use, weaponisation, and the potential for malicious practices. This theme also contained the nuance of participants considering positive use cases for drones versus negative:

> The usage of drones for malicious practices, otherwise I think they could be beneficial.

Privacy and Surveillance was identified through respondents mentioning surveillance, data use, and lack of transparency concerns. Most answers here were also nuanced by the awareness of differing use cases:

> Ive only had experience with people flying camera/video drones, which I find a bit uncomfortable as I dont know how that footage is then used or distributed. The noise isnt very loud for those drones which is good, but it can still be a bit annoying in quiet areas. If a drone was to be used by the municipality itself for a good reason, I would view it as more positive though. I think it should be well marked/branded so its clear that its a working drone :)

Area of Use identified that participants' opinions depends on who operates the drone and for what purpose. Much like the other themes participants were both positive and negative depending on the drones' purpose.

> What drones are used for. Healthcare is good, warfare is less good

Other than these five themes, 7 more were identified. Under the theme, **Private Drone Use**, with a frequency of 7 answers, participants expressed discomfort with private drone use, especially when lacking clear purpose or accountability. Under **Sound and Visibility**, 6 Participants noted noise and visual intrusion, particularly in quiet or residential areas where they worried the drones would disturb and/or look bad. Some appreciated that quieter drones could replace louder alternatives. Under the theme, **Ownership and Accountability**, 5 responses were identified relating to concerns about who owns the drone, who is responsible, and how its use is regulated. Other themes found were **Media Influence**(3), media portrayal affected

their view negatively, **Industry Experience**(3), people working with drones expressed positive views. **Rules and Governance** (3), trust towards authorities lead to positive perception of drones. **Negative Perception** (2) had a negative view of technology in general.

Question 3: ***Which of the following words do you associate with drones?***

In the following question, participants were asked to select what words they associate with drones, from a predefined word list based on the literature review of drone associations. The question also included a free-text option, allowing participants to provide additional input if they felt the provided options were insufficient. They were allowed to pick as many words as they wanted. The results of the word associations can be seen in figure 5.2. The graph shows that most participants associated drones to surveillance and military use. The question was however, as mentioned, multiple choice and many also chose social benefit and future.

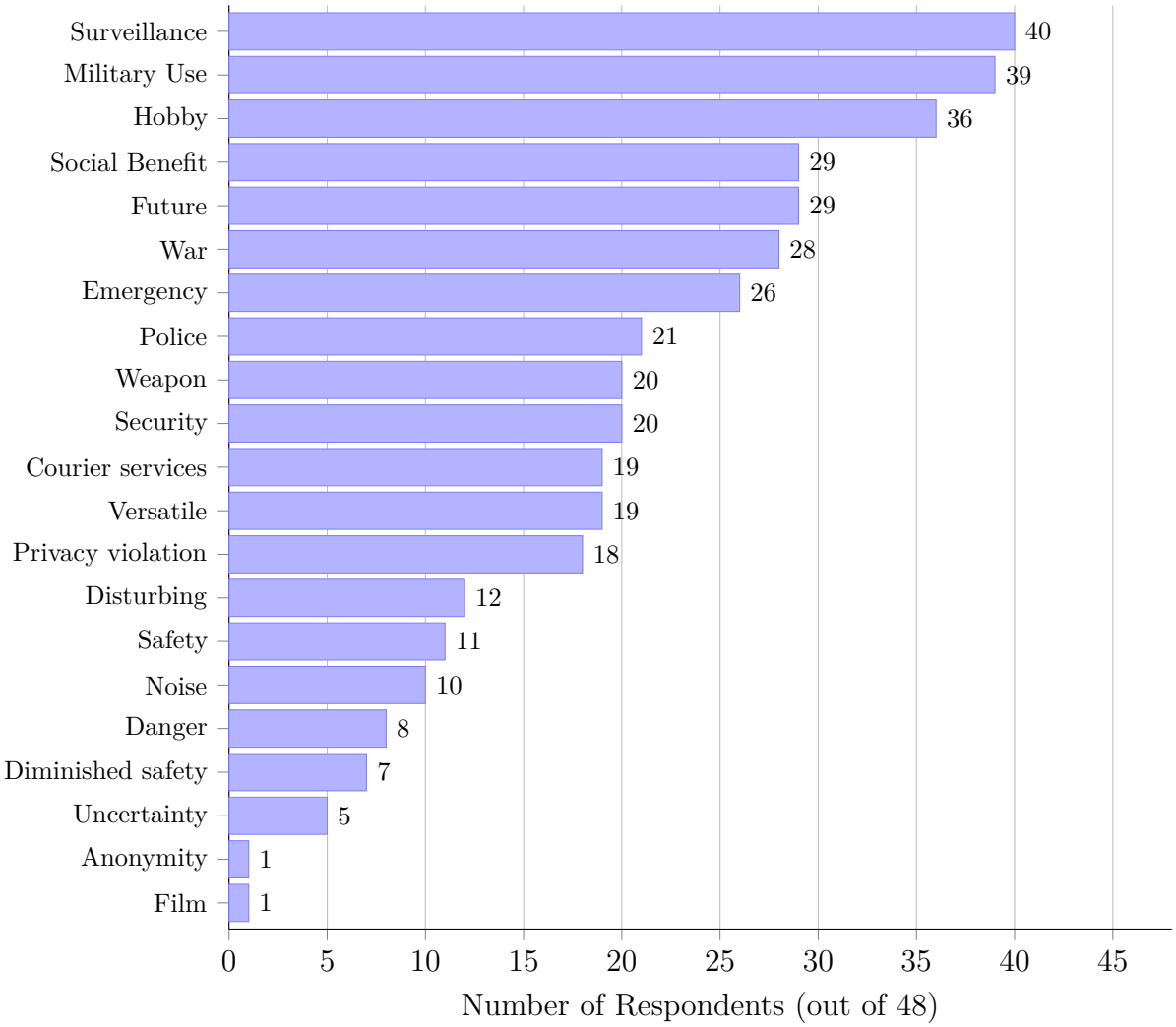

Figure 5.2: Words that public questionnaire participants associate with drones (Ordered by Frequency)

Question 4: ***Which of the following uses are you comfortable with drones being used for in your area?***

The last question in the Public Perception of Drones section of the questionnaire concerned what drone use-cases participants were comfortable with, see 5.3. They were given a predefined list of use cases, where they could pick as many as they wanted, with a free-text option if they found the selection of options lacking.

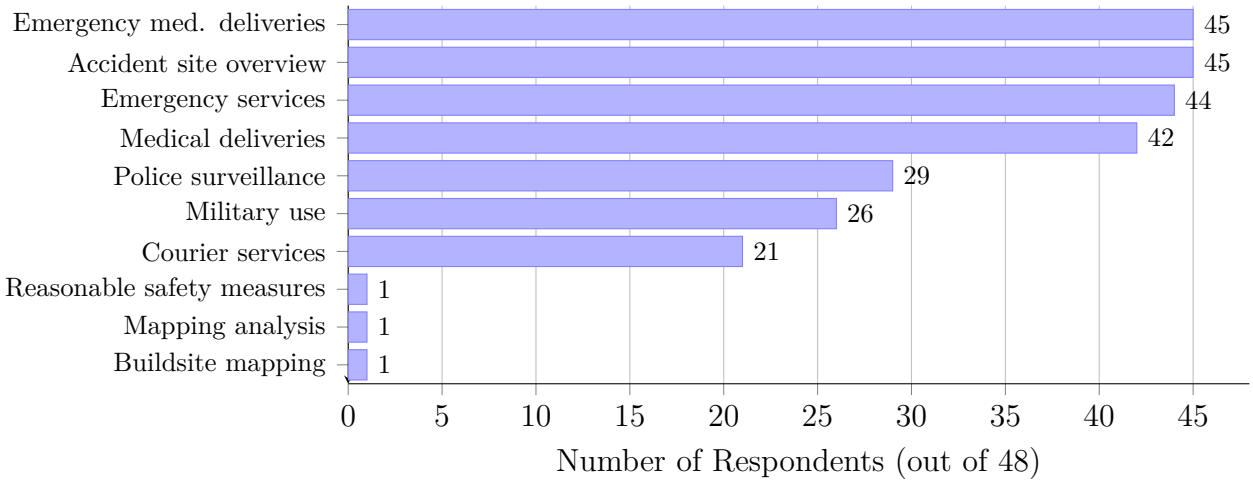

Figure 5.3: Comfort with Drone Use Cases (Ordered by Frequency)

5.1.2.3 Security and Privacy

This section covers questions related to security and privacy.

Question 5: ***How safe do you feel about drones flying in your neighbourhood?***

Starting out, participants were asked to rate *"How safe do you feel about drones flying in your neighbourhood?"* on a 1-5 Likert scale, where 1 was "Very unsafe" and 5 "Very safe". The results showed an average score of 3.375 out of 48 answers, the data can be seen in the graph 5.4.

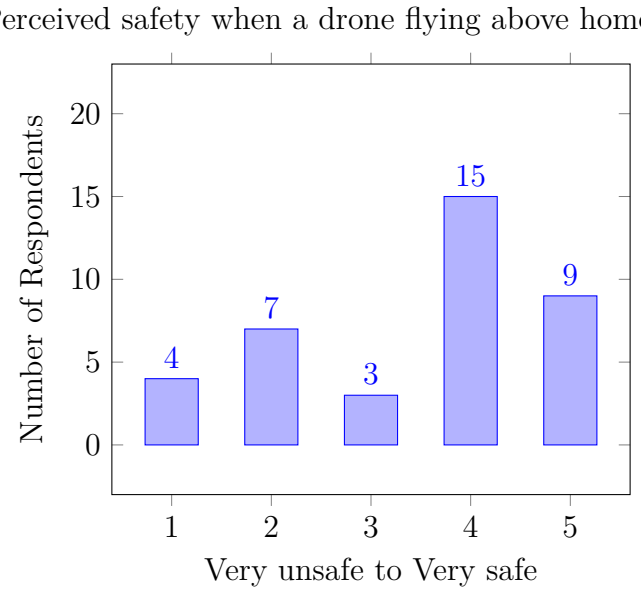

Figure 5.4: Distribution of Responses on a 5-point Likert Scale (1 = Very Unsafe, 5 = Very Safe)

Question 6: *What do you think if you see a drone flying over your home?*

In the second question, "*What do you think if you see a drone flying over your home?*", participants were asked to elaborate in free text form. The most frequently occurring theme was **Privacy and Surveillance**, with 12 responses. They commonly expressed discomfort with the idea of being filmed or monitored in private or residential spaces. Participants emphasized the importance of knowing who operates the drone, as well as its purpose. Below you can read examples, some of which are translated from Swedish to English:

> I generally associate drones with video footage capture. So I would think I was being recorded, which is a bit uncomfortable. I might also jump to the conclusion that something bad has happened and its there to do surveillance. It would be very important to me to know who owns/is operating the drone (it should be clear to the naked eye if possible).
>
> Surveillance. I want to be able to walk around naked in my home without worrying about being watched.
>
> Curiositywhat is it doing here...? So far, Ive only seen small private drones, and I felt it was an invasion of privacy.

The second theme, **Operator Transparency**, appeared in 11 responses and highlighted participants desire to know who is flying the drone and for what reason. The lack of visible operators or markings cause unease. Clear labelling and transparency were commonly requested:

> I wonder whyclear markings are needed so the public understands the purpose.

> I dont reflect much on it, assume its a hobby drone. But if there were more drones, it would be nice with a label to know the sender and purpose.
>
> Doesn't feel good, you don't know who is flying the drone. It could be military but also a private person. I feel the same way about helicopters, I usually check to see if the helicopter is from the police or the health service.

The next theme was **Societal Benefit**, appearing in 10 responses. These concerned the assumption or hope that drones were used for public services such as police work, healthcare, or emergency tasks. Some responses expressed conditional acceptance based on whether the drone served a clear public function, much like in the answers to questions in the previous section.

> *Looking for a rock* No, but I think it's probably a police drone, I don't feel too concerned since this is what is assumed. Of course it could be a private person who wants to spy on me, but I don't have such a big tinfoil hat that I suspect foreign powers, which I assume is what is the root of people's fear of drones.
>
> Over my villa it would feel a bit strange but otherwise nothing special. I prefer that drones during transport fly on specific flight routes so that the flights feel more predictable. Of course, drones for medical transport and other time-critical operations need to fly the straightest route. In that case it is good if they are clearly marked to create better acceptance

The themes **Discomfort and Fear** (9 responses) and **Hobby and Private Use** (7 responses) followed closely. Discomfort was often tied to feelings of being watched, safety concerns, or the assumption of malicious intent.

> I would feel afraid if I saw a drone flying.
>
> Surveillance, uncertainty

In contrast, **Hobby and Private Use** responses often speculated that the drone was flown by an enthusiast or someone filming recreationally, some of them expressed unease.

> Probably a hobbyist or a company working with drones nearby.
>
> Someone filming as a hobby, but Id still feel a bit uncomfortable.

Area of Use (10 responses), where participants considered the drone's purpose as a key factor in their evaluation, Other themes included

> I reflect on what type it is and what its being used for.
>
> I would prefer drones fly on specific routes so their movement is more predictable.

Curiosity and Excitement (6 responses), with some describing drones as "cool" or "fascinating," as well as **Something Bad Happened** (5), **Normality** (4), and

Sound Disturbance (3).

This thematic variety shows that participants interpretations depend greatly on context, perceived purpose, and transparency. See more responses in the appendix.

Question 7: ***Is it important for you to know if a drone has cameras?***

The participants were given a short text followed by the question:

"*Drones have cameras that are used to ensure safety during take-off and landing and can be seen by the drone pilot during control. Some drones have cameras that are used to send information to the emergency centre in the event of an accident. The video material that is filmed in the event of an accident is sent to the healthcare emergency centre and the command centre of the emergency services. The video material is confidential and is used to plan action in the event of an accident.*"

"Is it important for you to know if a drone has cameras?"

There were four different categories to pick as an answer, see the results in figure 5.5

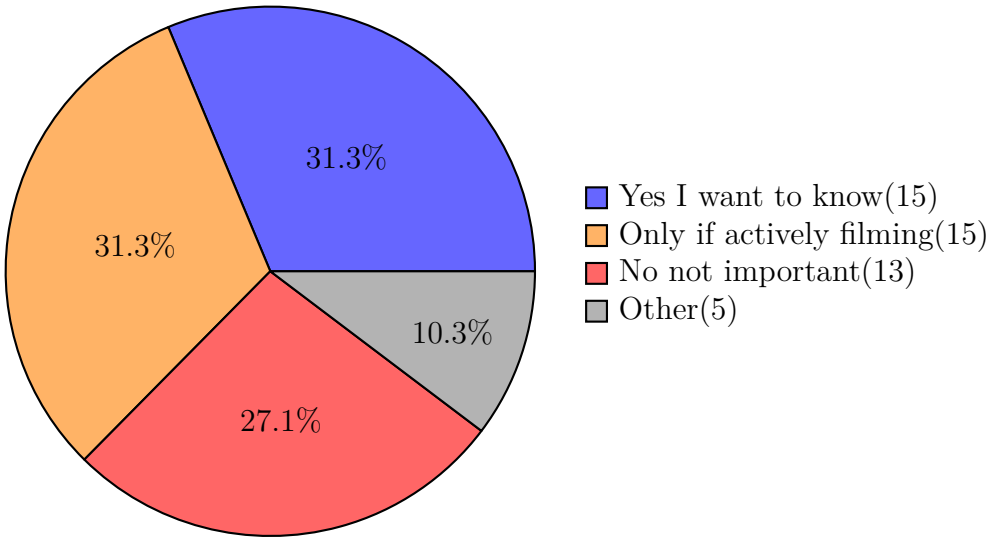

Figure 5.5: Importance of knowing when drones are filming

The majority of the respondents wanted to know that a drone has a camera, especially if it is actively filming. A few participants expressed views that did not fit into the main categories by choosing the category **Other**. These responses assumed that drones already have cameras or sensors and questioned the relevance of knowing.

Question 8: ***How important is it to you to know which organisation flies a drone?***

After this participants were asked to rate *"How important is it to you to know which organization flies a drone?"* on a 1-5 Likert scale, where 1 was "Not important" and 5 "Very important." The results showed an average score of 4 across 48 responses. The data is visualised in the graph 5.6.

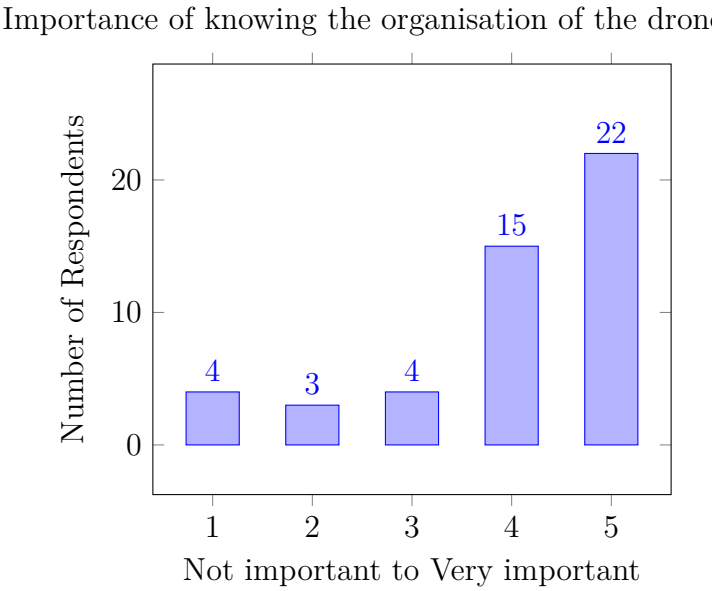

Figure 5.6: Distribution of Responses on a 5-point Likert Scale (1 = Not important, 5 = Very important)

This indicates an interest among participants in knowing who is operating a drone, suggesting that organizational transparency plays a key role in the publics perception of drone legitimacy and trust.

Question 9: ***How important do you think it is that public drones have visible markings?***

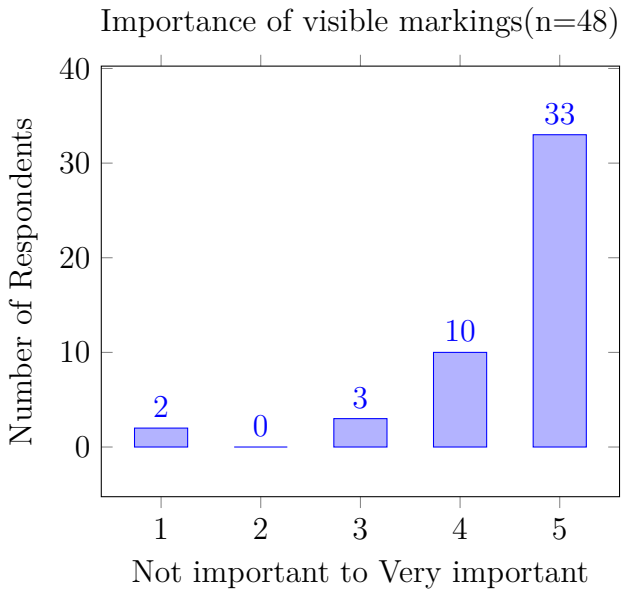

Figure 5.7: Distribution of Responses on a 5-point Likert Scale (1 = Not important, 5 = Very important)

Lastly, participants were asked to rate *"How important do you think it is that public*

drones have visible markings?" on a 1-5 Likert scale, where 1 was "Not important" and 5 "Very important." The results showed an average score of 4.5 across 48 responses. Seen in graph 5.7.

These results suggest a clear preference among participants for transparency and clear identification when it comes to public drone operations.

5.1.2.4 Identification and Visibility

This section began with a short text explaining the potential use cases for VGR drones with the main focus on emergency deliveries of defibrillators and early situational awareness on accident sites, to help emergency response workers. This text was placed here to avoid influencing answers to the drone perception questions at the beginning of the questionnaire and to provide important context to the question regarding drone identification.

Question 10: ***What kind of marking/traceability do you think is important for public drones?***

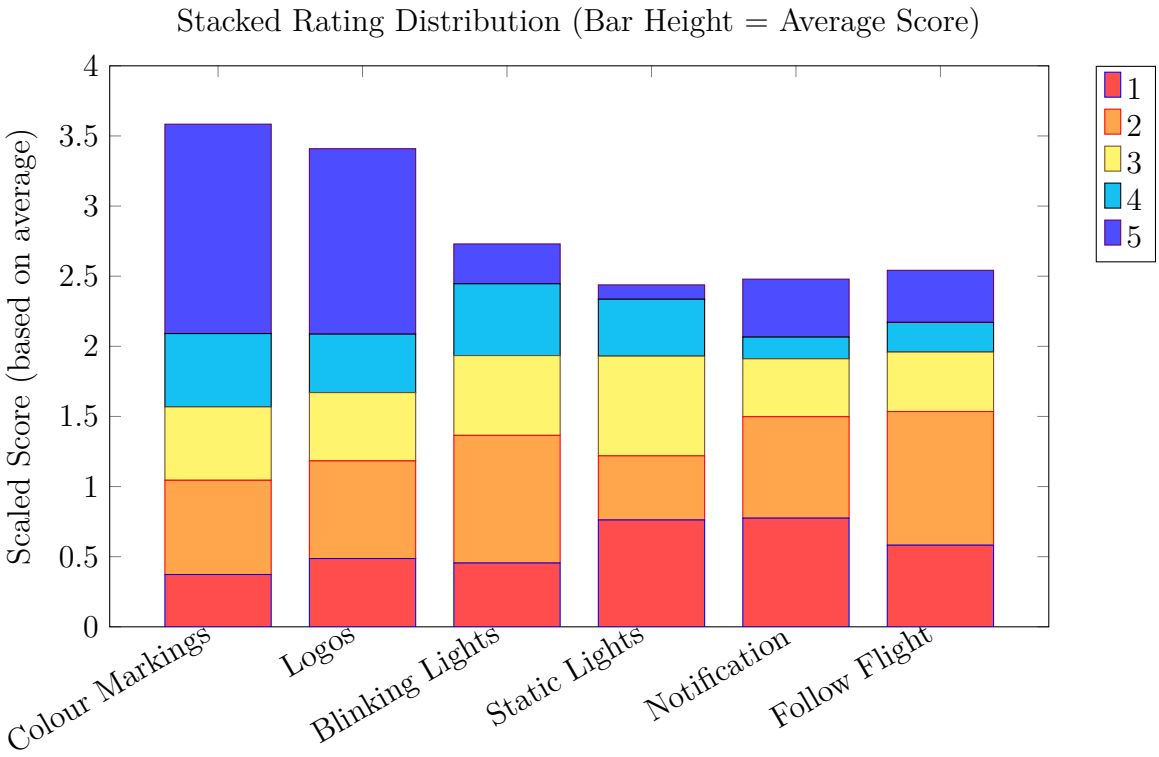

Figure 5.8: Scaled distribution of perceived importance for drone traceability features. Bar height represents average score.

The participants got to rate 6 options on a 1-5 Likert scale, where 1 was not important and 5 was very important, answering the question "What kind of marking/traceability do you think is important for public drones?". Out of 48 responders, 20 participants answered that colour markings are "5/Very Important". For Logos,

19 participants answered "5". For blinking lights, 5 participants answered "5". For static lights, 2 participants answered "5". For App/text notification in case of overflight, 8 participants answered "5". For the possibility to follow flight and operator via website or app, 7 participants answered "5". Furthermore, some options stood out as being not very important according to many participants. For blinking lights, 24 particpants answered "1" or "2". For static lights 25 participants answered "1" or "2". For both noticfication and posibility to follow online, 29 participants answered "1" or "2". See the distrubtion of rankings in graph 5.8.

Question 11: ***Is there any other labelling or traceability that you think is missing from the list above?***

Participants were also asked if any important marking or traceability was missing, from the list in the question before. A few suggested clearer ways to distinguish drone types, such as ID numbers, remote identification, or digital tracking. Others mentioned sound cues, reflective paint, and improved night-time visibility. 27 respondents simply answered No". Full responses are available in the appendix.

Question 12: ***How interested are you in being able to follow drones in your immediate area through an app or notifications?***

After this participants were asked to rate *"How interested are you in being able to follow drones in your immediate area through an app or notifications? "* on a 1-5 Likert scale, where 1 was "Not interested" and 5 "Very interested." The results showed an average score of 3 across 48 responses. The data is visualised in the graph 5.9.

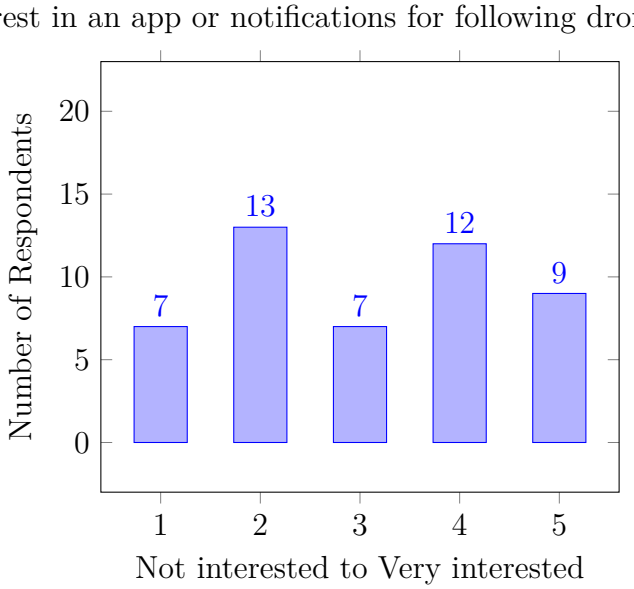

Figure 5.9: Distribution of Responses on a 5-point Likert Scale (1 = Not interested, 5 = Very interested)

Question 13 - 22: ***What associations, thoughts or feelings do the following colour combinations evoke if you saw them on a flying vehicle?***

Participants were asked to elaborate on what associations they had to nine colour combinations in the context of flying vehicles. The colours were chosen for high visibility and association to authority vehicles. Each of these questions consisted of two colours displayed in a two-by-two grid, chosen to emulate Battenburg markings. The participants were asked to explain in free text form what they associated the colour combinations. Based on a thematic analysis of the answers themes were identified and ranked by frequency of response. To gain deeper insight to the data it was visualised as a bubble diagram and plotted on a y-x axis, see 6.2. In the diagram, the size of the bubbles represent the frequency of response within an identified theme. The x and y axis represent the aim of the drones appearance: to appear official and safe without looking like an ambulance or police vehicle.

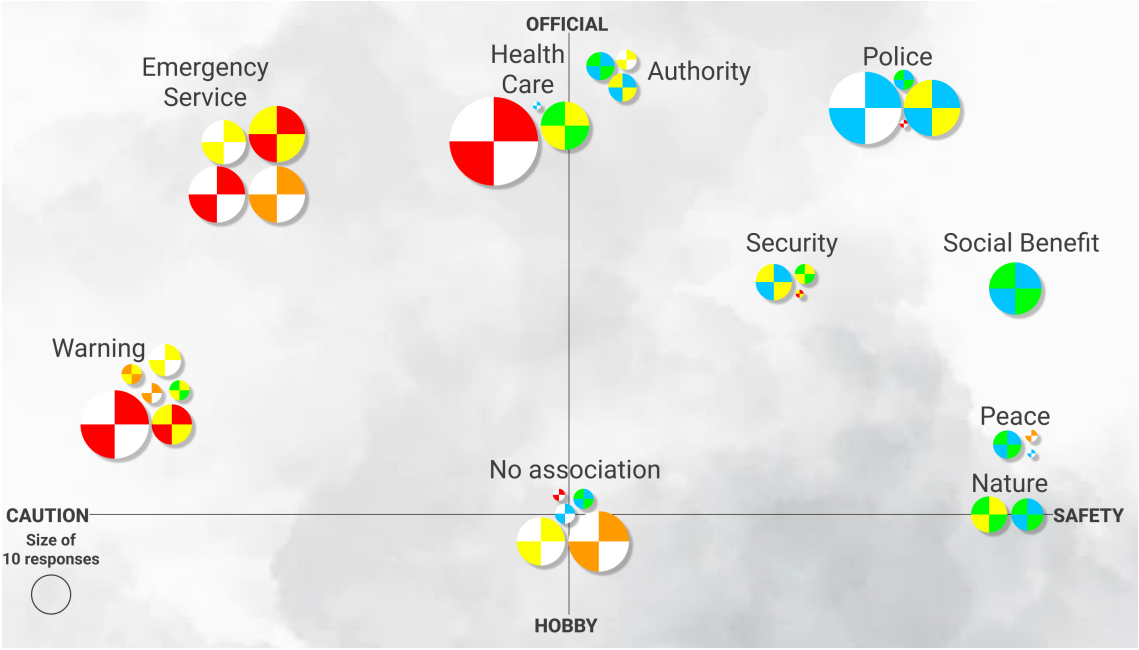

Figure 5.10: Visualisation of associations to colour combinations

5.1.2.5 External Factors Affecting Drone Perception

In this section questions about external factors that can affect the public perception of drones.

Question 23: *How much do you think ongoing conflicts and global security issues affect your perception of drones?*

Participants were asked "*How much do you think ongoing conflicts and global security issues affect your perception of drones? (Positive or negative impact)*". They got to answer through a Likert-scale where 1 was "Does not affect" and 5 was Affects a lot". The average of responses was 3.75, the data can be seen in the graph 5.11.

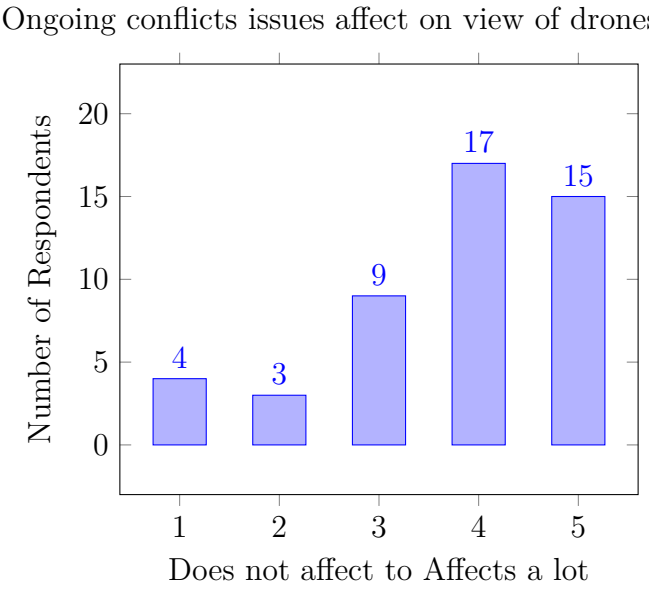

Figure 5.11: Distribution of Responses on a 5-point Likert Scale (1 = Does not affect, 5 = Affects a lot)

Question 24: ***Do you think drones should be regulated in urban areas, if so how?***

The last question of this section was "Do you think drones should be regulated in urban areas, if so how?". 33 of the 34 responses said that drone usage in urban environments should be regulated. Concerns centred on protecting privacy, limiting non-essential use, and ensuring safety. Overall, there was strong support for regulation, even if the exact form it should take remained uncertain.

5.1.2.6 Closing Questions

In this section, final questions about familiarity with drones and additional opinions were asked.

Question 25: ***Have you ever seen or interacted with a drone?***

The participants were asked if they had ever seen or interacted with drones. 44 had and 4 had not.

Question 26: ***How much interest do you have in drones?***

11 answered "I have no interest in drones", 30 "I have some interest in drones", 5 "I have a great interest in drones", 2 "I own a drone" and 5 "I work with drones".

Question 27: ***Do you have any additional comments or thoughts to share?***

Several respondents emphasised the importance of using drones for public service (e.g., police, emergency response), while also highlighting privacy concerns and the

need for clear identification methods beyond colour, such as flags or structural elements. Some appreciated the research topic and encouraged broader public involvement. A few mentioned that autonomous drones feel less intrusive than human-controlled ones, and there were mixed reflections on noise and associations with drones.

Question 28: *Follow-up questionnaire*

The last question was optional and asked the participants to leave their email if they wanted to partake in the following prototype questionnaires. This questionnaire can be found in section 5.4.1.

5.1.3 Industry Questionnaire

It was theorised that if a discrepancy of opinions between the public and the industry was identified, it could highlight a need to better inform about the specifics of active drone operations, for the sake of transparency and trust. Therefore, being in contact with several active drone companies, the opportunity to make a revised questionnaire for industry-active to gain their perspective, was taken. A description of questionnaires can be found in 4.2.2.

The industry questionnaire was a revised version of the general public questionnaire, described in section 5.1.2 and had 23 questions and started with the same information text as the general public questionnaire as well as asking for informed consent. Answers from 5 people were collected.

The *Demographic* section was removed and replaced with a free-text question about their work with drones. The *Public Perception of Drones* section was kept the same as in the general public questionnaire. The next section *Security and Privacy* was shortened to include only the Likert-scale question "*How safe they feel with a drone flying over your home?*", as well as the free-text question to motivate their answer. The *Identification and Visibility of Drones* section was the same as in the general public questionnaire and in the *External Factors Affecting Drone Perception* section the question about drone regulations was removed. The last section *Closing Questions* was also edited to be more relevant for people working with drones. The Industry questionnaire was only in Swedish and the full questionnaire can be seen in the appendix B

5.1.3.1 Analysis & Results of Industry Questionnaire

The drone industry generally expressed a positive view of drones, emphasising their unique capabilities compared to other vehicles. Their responses emphasized drones potential societal benefits, particularly in emergency response and logistics including its ability to improve accessibility and efficiency in the transport of goods, including medical supplies, especially in hard-to-reach areas. However, some also acknowledged challenges, such as noise.

Respondents generally reported a high or neutral level of comfort with drones operating nearby. Most indicated curiosity rather than concern, particularly regarding

the drones purpose or destination. Overall, the presence of drones was interpreted as routine or assumed to be under regulated control.

Their opinions varied regarding the relevance of drone colours. Some emphasized established emergency colour codes, such as red, green, yellow, or flashing blue lights in acute situations, as appropriate for signalling public service use. One respondent questioned the effectiveness of colour markings if the drone would be far away, another questioned its effectiveness during nights. As for the statistical questions, respondents answered very similarly to the public questionnaire.

5.1.4 Pilot study

A pilot study was conducted to improve the clarity, relevance and neutrality of the questionnaire. The answers collected was analysed for relevance to the research topic, to not waste the participants' time with questions and answers that would not be relevant for the project moving forward. The answers to the colour combinations were mainly analysed for relevance. The questionnaire was designed to be as unbiased and neutral as possible. To ensure this, patterns were examined to identify whether the order of questions or the way information was presented may have influenced participants' responses. The last question in the pilot study prompted the participants to leave feedback on the questionnaire, which was valuable for improving the questionnaire.

The pilot study had ten participants collected through convenience sampling, in the age range of 18-64, with the majority in the age range 25-34 (N=6), and the majority were women (N=6) and the rest men (N=4). No one lived in an area of an ongoing VGR drone project.

Based on the feedback gathered the questionnaire was revised. How some questions were posed was changed. The question *What kind of marking/traceability do you think is important for public drones?* was changed from multiple choice to ranking each choice on a Likert scale. This question was moved up, before asking the participants about their associations with different colours, to avoid priming the participants. In the question *Which of the following words do you associate with drones?* the order of the words were changed to be more neutral and balanced.

The intro section was changed to include more information about the project to provide participants with an informed perspective. Information about the purpose of the drones was moved down in the questionnaire as not to influence the participants in the questions concerning their opinions. Images of drones that VGR use were also included in the intro part as well as information about approximately how long it will take to do the questionnaire.

The amount of colour combinations was edited. Some colour combinations were edited for clarity: where the white colours were too similar to the background of the questionnaire, a small border was added. A yellow/green combination was added and seven colours were removed. The decision to remove the colours was based on a brief analysis of the responses gathered. Four of the colours were removed due to their irrelevant associations(pink/orange, black/white, dark blue/ dark green and

dark yellow/ dark blue). Three colours were removed due to their already strong associations with existing actors such as the military, the police and ambulance (grey/ dark green, white/dark blue and dark yellow/dark green).

5.1.5 Stakeholder Interviews

In addition to the data collected through questionnaires, data was also collected through conducting interviews. Interviews and stakeholder interviews are described in the section 4.2.3. The interviews were held with people who have experience with drones and could, therefore, provide a deeper and richer insight into the topic by gathering more stakeholders' perspectives[81]. The interviews were semi-structured, and the questions were developed based on the literature review.

Five people were interviewed, three of whom represented different drone companies with current, past and/or future work in collaboration with VGR. The companies were Aviant, Everdrone and Katla Aero. By interviewing people working directly with drones, valuable insights into drone operations could be gained. A police operative drone pilot and an ambulance nurse who was responsible for vehicles and technology innovation were also interviewed

By including a wide range of people to interview, the aim was to gain a holistic understanding with more depth [81]. The data gathered from the interviews provide more perspectives in a deeper qualitative fashion.

All the interview questions can be seen in the appendix C.

5.1.5.1 Interview with drone companies

Interviews were conducted with three relevant drone industry actors: Everdrone, Aviant, and Katla Aero. The interview with Everdrone took place at their office in Mölndal, with their Head of Customer Operations and allowing the opportunity to observe their drone first-hand. The interviews with Aviant (Commercial Manager) and Katla Aero (Co-founder and CEO) were held separately and remotely via Microsoft Teams. All interviews were semi-structured and recorded with the consent of the interviewees for transcription purposes, using Microsoft Words transcription tool for Everdrone, and OpenAIs locally downloaded Whisper tool for Aviant and Katla Aero. The interviews lasted between 25 and 60 minutes. Notes were taken during all interviews.

The interview questions were the same across the three interviews with drone companies. They were divided into three categories: *General Questions, Markings on Drones* and *Public Perceptions of Drones*. In the *General Questions* section, focus was on the company, what their work with drones looks like and their relation to VGR. The *Markings on Drones* covers the subject of how they currently mark their drones, limitations and needs of the implementation of a standardised marking system and their opinions on visual elements for identification. In the *Public Perceptions* section, questions are asked about how the public typically reacts to their drones, what factors influence acceptance, and whether any ethical concerns

or resistance have been encountered. Due to the semi-structured nature of the interviews, the questions differed somewhat between interviews due to the flow of the conversation.

The interviews with the three drone companies were analysed together using a manual thematic analysis approach. Thematic analysis is described in 4.2.6. The overarching categories and their themes found when analysing the drone industry interviews were:

Camera

In this category, all the themes related to the use of cameras, surveillance and privacy were collected. The biggest theme in this category is **Privacy:** which focuses on protecting the personal space of both people and animals by avoiding identifiable footage and deleting material after a short period. The second largest theme was **Who Sees What?:** it contains data about how different camera feeds are handled, with access based on professional role and ethical considerations. Other themes are **Ethics:** which addresses how live footage can be emotionally distressing for staff and is therefore restricted to certain professional roles, **Early Situational Awareness:** is data about giving the emergency dispatch centre a quick visual overview via live camera from the drone at accident scenes and **Precision:** which focuses on how the camera is used to ensure accurate positioning during defibrillator deliveries.

General Information

In this category, themes focusing on drone operations and uses are collected. The themes are **Other and Future Use Cases:** drones are tested for medical, industrial, and regional transport across varied environments, **Permissions:** operating beyond visual range involves strict rules, risk assessments, and coordination with authorities, **Functionality:** payload, wrapping, and automation impact drone performance and maintenance, **Defibrillators:** the goal is to deliver AEDs within two minutes to patients, relying on bystanders to use them and **Safe Flying:** routes are planned to minimize risk and ensure secure return paths.

Design

This category gathers themes focusing on different design elements or challenges. The themes are **Bad Visibility:** drones are mostly seen from a distance therefore have poor visibility, **Lights:** including lights are essential for visibility and safety, **Context:** the design should reflect public services use when used for public service, **Emergency Vehicle:** it should be clear that the drone is an emergency vehicle, **Colour:** the colour should signal its function.

Public's opinion

This category gathers themes focusing on the public perception and reaction to drone usage. The themes are **Difficulties with communications:** the public is generally positive towards the operation, but most people are unaware and therefore have a more negative opinion, **Is it privately owned?:** there should be clear signalling that it is an official drone, **Noise:** noise is a concern for some, **Positive:** people are generally positive towards public services drones.

5.1.5.2 Interview with a drone pilot at the Police

The interview took place at the police office in Gothenburg and was conducted with an operative police drone pilot. The interview took around 25 minutes and was recorded with the consent of the interviewee, it was later transcribed using OpenAI's locally downloaded Whisper tool. The interview questions followed the same overall structure as those used in interviews with the drone companies but were slightly adapted to better suit the perspective of a drone operator working within public service. Since the interviewee is a police pilot, the questions were modified to capture aspects more relevant to law enforcement operations rather than commercially driven companies.

The police are allowed to fly over groups of people. They are required to have continuous contact with the person responsible for airspace and to be ready to descend at any time if needed. None of their drones are autonomous and always fly within the visual line of sight. They use quadcopters of differing sizes and the pilot operates them through a screen connected to an HD camera on the drones.

Markings and lights

Their drones do not have a marking except for a text that can help identify the drone if it lands. Strobe lights are placed both under and on top of the drone and the interviewee describes them as having a very strong, white, pulsating light. According to the interviewee, the lights are visible both day and night, however, depending on the time of day and the weather, you may need to know where to look to spot the drone. Furthermore, it has green and red lights on its sides that facilitate navigation. The interviewee does not know what colours would work best for visibility since it is not part of their aim.

Safety and public worry

The interviewee points out that safety is a priority. That they are drone pilots first and police second. They have not experienced any worry from the public but says that people are more observant due to the state of the world. If there is an alarm to the police concerning drones, they are directly informed if there are any ongoing government agency operations at that location.

5.1.5.3 Interview with an Ambulance Nurse

The interview took place over Microsoft Teams with an ambulance nurse who was also responsible for vehicles and technology innovation. The interview, which took around 25 minutes, was recorded with the consent of the interviewee and later transcribed using OpenAI's locally downloaded Whisper tool. Due to the nurse's limited experience with drones, this interview was different from the others, with the focus being more on the perceived possible use of drones in emergency situations alongside ambulances.

The interviewee thinks drones are an interesting technology for the future, but currently hard to use beneficially due to technical and legal limitations. The interviewee believes that early situational video footage can be very useful for events and traffic

accidents, especially in sparsely populated areas. However, they think these cases happen too seldom and therefore more use cases need to be considered to enhance the validity of the technology. They also noted that the investment in drone technology as of now is questionable because it takes money from other projects that could be more directly beneficial. The interviewee does not believe as much in drone delivery of AEDs and claims many support that it does not make a big difference. Furthermore, their experience is that they usually arrive at an accident site simultaneously as the drones but elaborate that it could be because they work mostly in urban areas.

The interviewee wishes for a national standard both on drone technology, its markings, as well as more cooperation between regional authorities in general. But they think drone-markings are especially important considering the state of the world and what the technology can be used for.

The interviewees' experience is that the public has not been upset about the presence of drones at emergency scenes, and that efforts are made to cover victims, when possible, to prevent filming or photography. However, they emphasised that both the people at accident sites and the emergency service personnel are focused on saving lives, not on privacy.

5.1.6 Supervisor Meetings with Region Västra Götaland

Furthermore, during the start-up of the process, meetings were held with representatives of VGR connected to this project. They presented their expectations, wants and needs for this project, and gave the opportunity to ask questions to gain a deeper understanding of the project and expected contribution and outcome. These meetings gave information about important stakeholders, recommended literature and provided contact information of people that was later interviewed. Although the meetings were held in an informal manner, they offered valuable insights into the needs and challenges of one of the key stakeholders. As such, they served as an important foundation for subsequent work, fulfilling a similar function to that of formal stakeholder interviews.

5.2 Ideation

During the ideation phase, the collected data was used to generate ideas and explore potential design solutions. Brainstorming methods such as Crazy 8s were applied, and sketching served as a tool to translate insights into actionable concepts. Crazy 8 and sketching are described in section 4.3.2 and 4.3.1. To maintain alignment with the design direction, mood boards and concept portraits were created to establish a clear vision of the intended goals, described in 4.3.3 and 4.3.4.

5.2.1 Sketching & the Crazy 8 Method

To generate and refine the design concepts, a variety of ideation methods, including sketching and Crazy 8, were used. Using the knowledge gained from the interviews

and questionnaires, sketching sessions that incorporated the Crazy 8 method, using drone stencils as an aid, allowed for further development in the design process.

5.2.2 Mood boards & Concept Portraits

Throughout the ideation process, the visual impact, what the drone's appearance should achieve as well as specific aesthetics to avoid, were discussed. To further develop a design direction, two mood boards were created, one with the desired visual elements and another with elements to avoid. In addition, concept portraits to explore and communicate the design intentions, see 5.12 were created. These portraits imagined the drone as various symbolic representations, such as a historical event, a public building, a garment, a fictional character, a material, and an animal, both for the preferred aesthetic and the one to avoid. Gaining a clearer image of the design direction allowed for more accurate sketches and an informed perspective moving on to the next stages of the design process. The aim of the drone impression was, as seen in the left of 5.12, Innovation, protective, guiding, kind, cooperative, peaceful, visible. The impressions that was aimed to avoid, seen in the right of 5.12, was military, surveillance, war, predatory, fast, secret.

Figure 5.12: Concept portraits of the aimed drone impression

5.3 Prototyping

After deciding which sketches and elements of sketches were relevant to the project, the process moved forward to creating the prototypes. The prototypes were created in Figma using the same stencils that were used to guide ideation during some of the sketching process. Based on ideation, answers from the questionnaire, and literature review, five different designs were created and applied to three different drone designs. After evaluation 5.4.1, three of these were chosen as most appropriate for the goals of this research, to further develop. The resulting three new designs, see 5.4.2 were evaluated through a final stakeholder interview 5.4.3. Each drone stencil was based on one of the companies interviewed.

5.3.1 Design elements

The results from the data collection played a key role in guiding the design of the prototypes. The Battenburg pattern, featuring alternating coloured squares,

was selected in several designs due to its strong association with official use and high visibility. Rounded shapes were also used to creates a nicer and trustworthy appearance. However, these were balanced with sharper lines to prevent the designs from feeling too commercial or hobby-like. In one prototype, horizontal stripes were used, as these can suggest slower movement and a less intimidating presence. The chevron pattern, commonly seen on emergency vehicles, was considered. However, the pattern was ultimately excluded as it is often linked to reducing speed rather than drawing attention. The VGR logo was included on all design proposals, as public feedback indicated this was an important element for trust and recognition.

5.3.2 Design 1

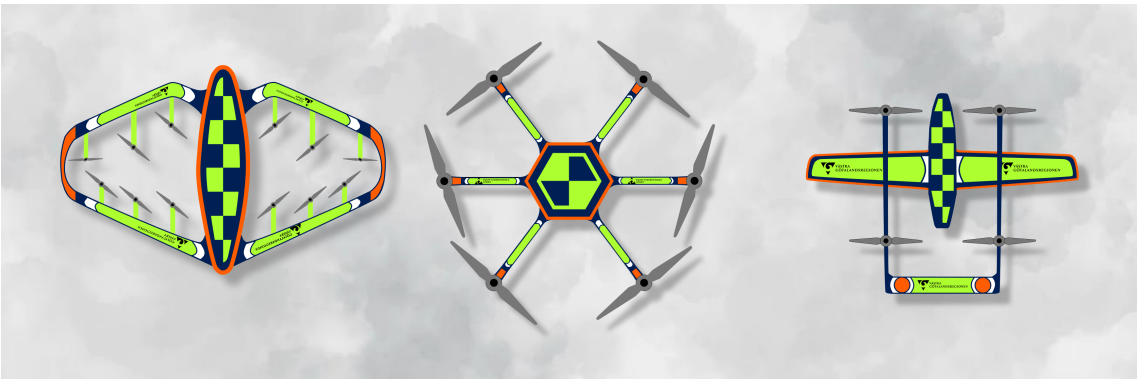

Figure 5.13: Design 1

Design 1 features central Battenburg markings in blue and green. It has many rounded details and curves, as well as white and orange accents. A distinctive element of this design is its thick outlining in blue and orange. The design doesn't have any larger logos only smaller ones paired with text, see figure 5.13.

5.3.3 Design 2

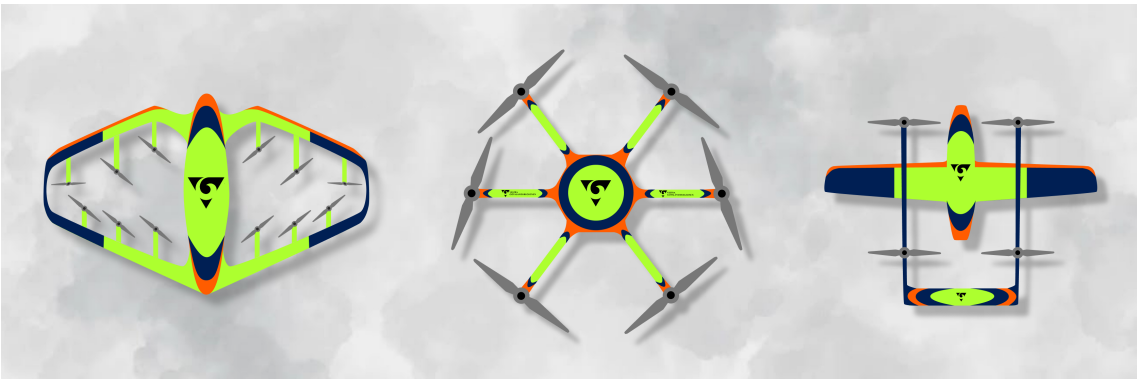

Figure 5.14: Design 2

Design 2 does not use Battenburg markings. Instead, it features a simple design with a large central logo displayed prominently on the drones body. The overall aesthetic includes many curved elements, each with a steep arc, in blue and orange. The design is mainly green, with the curved details being blue and orange and no white details. On the wing drones, horizontal orange lines run across the top of the wings, adding contrast and visual interest, see figure 5.14.

5.3.4 Design 3

Figure 5.15: Design 3

Design 3 has central Battenburg markings in blue and green. The design only has straight edges and few details. The drones wings or arms are primarily green and blue, with smaller white sections separating the colours. The design only has smaller logos combined with text, and no orange details. See figure 5.15.

5.3.5 Design 4

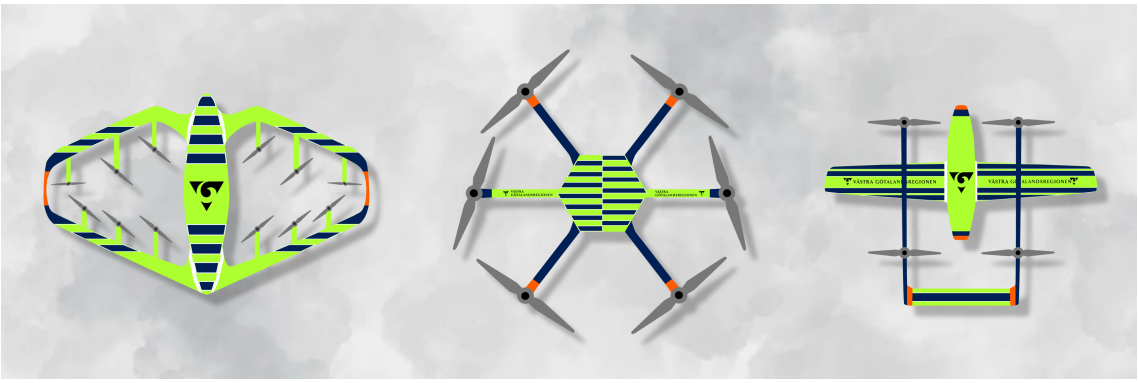

Figure 5.16: Design 4

Design 4 does not include Battenburg markings. Instead, it features horizontal blue lines across a green background with white outlines. The design uses straight edges and includes a few smaller details in orange and white. On the wing drones, a large

central logo is prominently placed on the body. It also has smaller logos combined with text. See figure 5.16.

5.3.6 Design 5

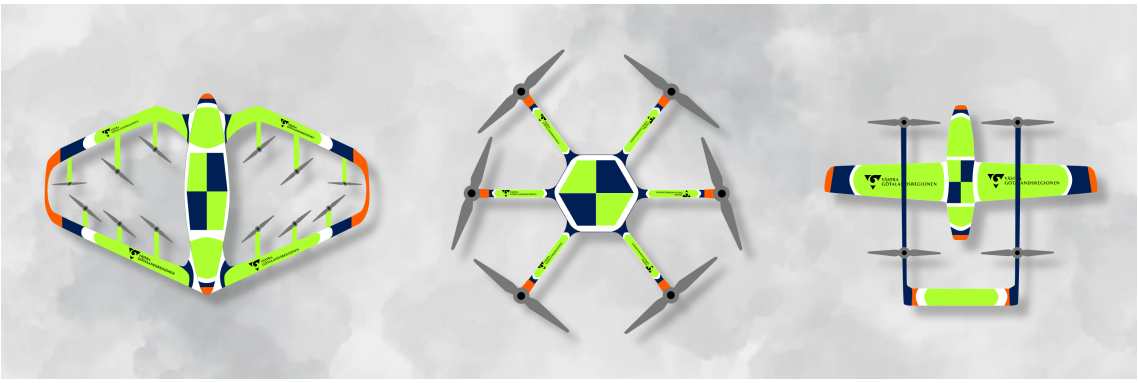

Figure 5.17: Design 5

Design 5 includes a smaller central Battenburg marking (2x2) in blue and green, framed by a white curved border. It employs many curved details, with a few straight lines. This design features both white and orange accents, along with smaller logos accompanied by text. See figure 5.17.

5.4 Evaluation

This section presents the methods used to evaluate the design solutions. Two methods were used: an evaluation questionnaire to reach a bigger scope of participants and after an iteration of the designs, a stakeholder interview/review to get deeper insight into the opinions of our presented design solutions.

5.4.1 Evaluation Questionnaire

To gather feedback on the initial prototypes, a questionnaire was conducted, aiming to gather feedback, opinions and information from a larger group of participants than would have been possible with only individual evaluation sessions. The questionnaire was mainly sent out to people working with drones, both within VGR and also the people who took part in the initial interviews during the data collection phase, as well as people who expressed interest in participating during the general public questionnaire during the initial data collection phase. This questionnaire was in Swedish and collected answers from 16 participants. The only demographic data collected was about their involvement with the drone industry. Why the questionnaire was primarily distributed to people connected to the drone project or to VGR, and not to the general public, was due to practical reasons, since there were some time limitations and by distributing partially internally within VGR, we could get responses quicker than through a public questionnaire.

The questionnaire started with information about the results gathered from the data collection phase and how they have influenced the design decisions. This covered topics such as colour, patterns and general information about the projects. It was deemed important to give the participants an informed perspective going into the questionnaire to gather relevant feedback.

The questionnaire was divided by design, the designs were presented, one at a time, and then five questions about the design were posed. All the designs had the same questions. After the designs, the questionnaire ended with four concluding questions.

The question about the drone designs was about the participant's reactions to the design, what it signals, whether the drone would be recognized again, what works well or less well, if anything is confusing or creates a sense of insecurity, who the design seems to belong to and how visible it appears. The concluding questions were about whether there were any design or design elements they liked more or less, and a quantitative rating of each design, as well as a space for other comments or opinions. The text and questionnaires can be seen in the appendix.

5.4.1.1 Analysis & Result of the Evaluation Questionnaire

A thematic analysis was performed on some of the qualitative data gathered from the questionnaire. Other data was just gathered and grouped into an actionable list of elements that worked or did not work. Below are the themes and elements of the different designs.

Design 1 Themes found when questioned about their reaction and what the drone signalled were in order of size: **Good visibility**, **Public Authority**, **Warning** and **Emergency Service**. According to participants, the design's confusing elements included a too small logo and text, too many colours, a hard appearance and a lack of consistency between the different drone models.

Design 2 The themes found when asking about their reaction and what the design signalled to them, was **Sport/Hobby**, **Good Visibility**, and **Emergency Service**. The largest amount of data collected was regarding different design choices which were gathered in a group labelled **Design** since a lot of people only commented on different design elements, such as that they liked the bigger logo and the softer design. Confusing design elements identified were the lack of the Battenburg markings, inconsistency between the different drone models, and a too sporty look.

Design 3 The themes found regarding Design 3 were **Emergency Service**, **Public Authority** and **Visibility**. Similar to Design 2, the data regarded **Design** was also the most occurring, with topics such as the lack of orange colour, the size of the text and a calmer appearance. Design elements that were confusing were in line with the reactions found in the **Design** group; it had a too calm appearance, the text was too small, the lack of the orange colour caused less visibility and more associations with the police force, and the design lacked consistency between the drone models.

Design 4 The themes found when looking at the data collected about Design 4, were **Cluttered**, **Harmonic/Serious** and **Hobby**. **Cluttered** was the biggest theme, while the other two themes were very small. Confusing design elements identified

by the participants were that the design appeared cluttered and confusing, it lacked association with an authority and had a too sporty look.

Design 5 The themes found in the data from Design 5 were **Emergency Service**, **Public Authority** and **Good Visibility.** Similar to Design 2 and Design 3, a lot of data gathered was only regarding the design of the drone. The design was considered cluttered, the logo too small, but the bigger Battenburg markings was appreciated. Elements that were identified as confusing were that the drone had too many elements and lacked structure, the larger areas of green were noted as both positive and negative, and the text and logo were too small.

Overall results

	Design 1	**Design 2**	**Design 3**	**Design 4**	**Design 5**
General opinion (% of 16 respondents)					
Positive	81%	56%	88%	19%	69%
Belongs to:					
Authority	94%	56%	81%	31%	94%
Good visibility	75%	63%	56%	44%	63%
Good recognizability	100%	88%	75%	69%	94%
Average fit to context (1–5)	4.2	3.2	3.3	2.3	4.4

Table 5.2: Questionnaire response percentages for Designs 1-5 with even-range colour coding

Based on the results, it was decided to continue working with Designs 1, 3 and 5. The original designs can be seen Prototype section 5.3. and the redesigns in section 5.4.2. As seen in the chart 5.2 , they gained the most positive feedback from the participants and the highest score at looking like drones belonging to an authority, as well as fitting the context compared to each other. The themes found when analysing the data collected also best align with the goals in these three designs compared to the other two designs.

Alongside the individual results for each design, some feedback was recurring across several of the designs presented. The text was too small and being placed on the underside of the drone should be avoided as it's rarely visible in practical scenarios but text can be useful on the top of the drone, either when the drone is on the ground or seen from another flying vehicle above. The larger logos were favoured over the smaller ones as they were effective for both branding and visibility.

The participants preferred a mix of both curved and straight details, but disliked the overly sharp curves, which can feel sporty. The designs using the Battenburg markings better aligned with the goals of this project, as it provided recognition and associations to existing authority/emergency vehicles. The pattern should be large and clear and the overall design should be simple and avoid unnecessary details, so as not to appear cluttered. Including orange in the design was favoured, as it increases contrast and visibility, as well as makes the design less similar to the design of a police vehicle.

Finally, its important to maintain a consistent design language and colour scheme across the different drone models, which should be adapted to each specific drone model to ensure coherence across different units while allowing for necessary customisation.

5.4.2 Redesigns

Based on the feedback from the evaluation questionnaire 5.4.1 as seen in the chart 5.2, design 1, 3 and 5 were as most useful and therefore further developed.

Redesign 1

Based on feedback from the evolution questionnaire 5.4.1 , design 1, see 5.13 was redesigned for further evaluation, see figure 5.18. The logos were enlarged where possible or removed. Fewer curves were used, and the white areas were removed. The Battenburg marking was also made to have fewer repetitions.

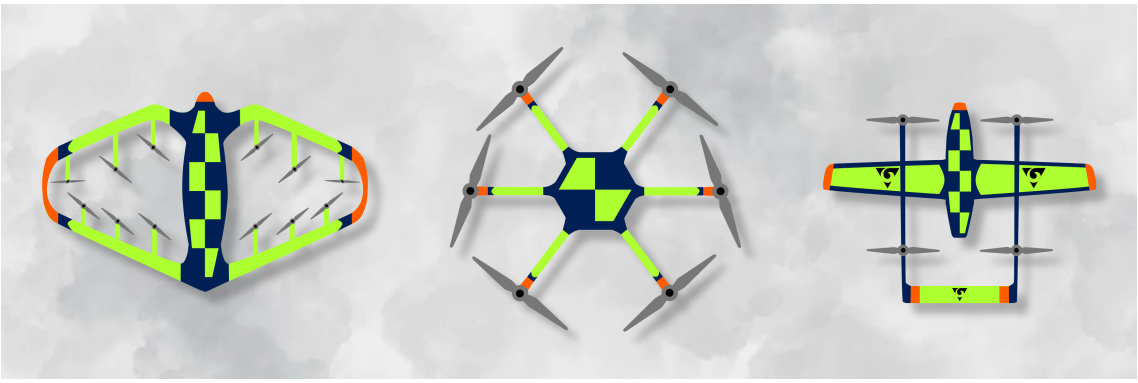

Figure 5.18: Redesign of Design 1

Redesign 3

Based on data gathered and feedback from the evaluation questionnaire, see in section 5.4.1, design 3, see 5.15, was redesigned for further evaluation. The logos were enlarged and removed where they could not become larger alongside all text. Orange details were added in response to participants expressing dissatisfaction with their absence in the initial version, see figure 5.19.

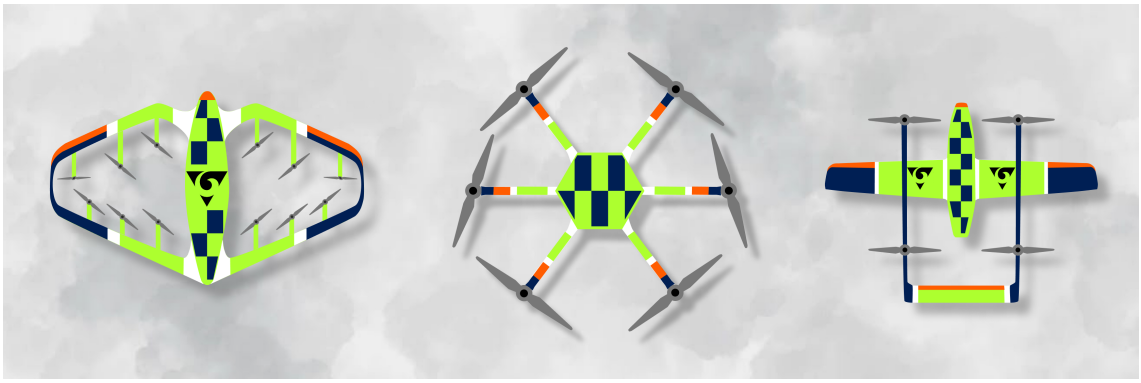

Figure 5.19: Redesign of Design 3

Redesign 5

Based on feedback gained from the evolution questionnaire 5.4.1 , Design 5, see 5.17 was redesigned for further evaluation, see figure 5.20. The logos were enlarged where possible or removed. No curves and very minimal white details were used, instead focusing on larger blue and green areas.

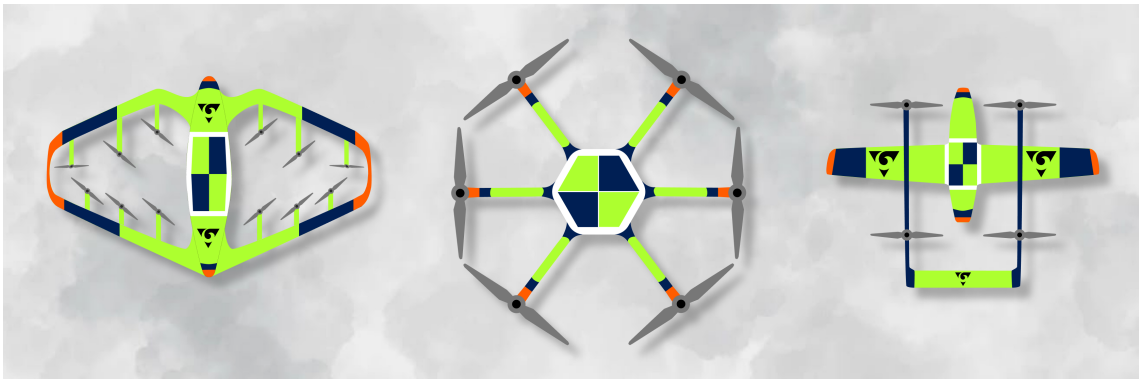

Figure 5.20: Redesign of Design 5

5.4.3 Stakeholder Interview

At this stage of the process, input from the VGR supervisors was sought, along with an opportunity to present the data and results gathered so far. This included presenting key findings from the data collection phase, followed by the initial prototypes and the results from the evaluation questionnaire. Additionally, updated versions of the prototypes were shown, incorporating changes based on the collected feedback. The interview was semi-structured, with a few prepared questions to guide the conversation. The interviewees were also encouraged to ask questions at any point. To help them reflect on the designs, they were encouraged to think-aloud as they viewed the material, allowing for insight into their immediate reactions and thoughts. This approach gave a clearer understanding of how the work was being received and where adjustments might still be needed.

6

Results

The research question posed by this study was: *What design challenges and emerging opportunities must be addressed when developing a standardised marking system for VGRs public service drones, considering evolving regulations, stakeholder perspectives, and the need for iterative refinement amid different priorities for developing technologies?*

As of April 23, 2025, VGR have two drone projects in the municipality of Mölndal, located within the region Västra Götaland, where drones are deployed in live emergency situations. These drones are equipped with cameras to provide early situational awareness and inform emergency personnel about the state of an accident site through live video feeds [42]. These drones are also equipped with AEDs and fly to suspected cardiac arrests. Drones equipped with AEDs have also been used in six different areas across Västra Götaland, since 2020 [39], but the early situational awareness project has only been active in Mölndal municipality since 2025.

As drones are a relatively new technology, their integration into the public sector brings opportunities for innovation. They also presents regulatory challenges and current legislation is not keeping pace with emerging use cases and technological developments. In response, Transportstyrelsen published a government-commissioned report in 2024 aimed at promoting the safe, sustainable, and efficient use of drones while considering national conditions as well as public and private interests. Transportstyrelsens report outlines several proposals, of which proposal 12 recommends that public service drones be clearly marked with operator and function to support public trust, as people are more accepting of public service drones. This proposal align with the EU Commission Drone strategy 2.0, where public acceptance of drone operations is a key factor to success[1].

6.1 Stakeholder Needs

Stakeholder needs have been identified through this research. The stakeholder needs of **VGR** are: Insight into public opinion of drones and public service drones in Sweden. Specifically, public service drones that deliver AEDs[39], medication and film accident sites to aid emergency service personnel[42]. They want to develop a generalized marking system for their drones in line with proposal 12 from Transportstyrelsens report, in line with the EU drone strategy[1]. These needs are part of their developmental strategy that align with VGRs vision **The Good Life**. Part of their

future vision is to place themselves at the forefront of the developing drone industry in Sweden and in the EU to strengthen their image as an innovative, sustainable and socially beneficial region[11].

The stakeholder needs of the **Swedish general public** are: a way to clearly and easily identify the organisational origin of a drone. The stakeholder needs of the drone companies **Everdrone, Aviant and Katla Aero** are: A marking system that suited their drones from a visual and practical point of view. They have drones as their business idea and wants to develop drone services, and therefore have an interest in further innovation and expansion of drone use in society.

6.2 Design Challenges and Emerging Opportunities

This section evaluates how the drone markings of this project align with Transportstyrelsens Proposal 12, mandating clear operator identification, informed by the EU Drone Strategy 2.0's emphasis on public acceptance[1]. Literature reviews, public questionnaires, and expert interviews revealed a mix of design challenges, as well as opportunities, for a generalizable marking system for public service regional drones. The research examined the effects of colour schemes and pattern configurations on drone visibility, recognizability, and public trust. It also examined the need of being able to follow public authorities drones digitally as well as what type of lighting identifications would be appropriate.

Research through Design addressed this wicked problem that came in the shape of design challenges, identified via the aforementioned research as well as the iterative cycles of prototyping and testing with stakeholders in a unique design space. Early sketches highlighted tensions, such as visibility versus unintended associations. Successive feedback refined colour and pattern choices to balance regulatory compliance, public trust and clear authoritative identification, whilst avoiding appearing to much like police, ambulance or any other public authority. A key trade-off surrounded digital monitoring; enhanced transparency versus low public interest and security risks which led to its omission from the resulting design recommendations.

The design challenge, or wicked problem, identified for this research was to make the drones appear as regional public-service assets, distinct from police or medical units, so that VGRs multi-purpose operations remain clearly identifiable without unintended associations, whilst complying to stakeholder values as well as avoiding the use of a drone-monitoring system. Lastly, this is done in parallel with evolving drone regulations that are informed by public opinion research such as this, a complex dynamic common for wicked problems. Following the identified design challenges and the lack of need for digital tracking emerged an opportunity. The need to appear as a public service vehicle aligned with the existing public trust of them. Furthermore, the colours that emerged as most suitable to stakeholder needs were similar to already existing public service vehicle markings, see 6.2.

An identified challenge refers to a concrete tension, conflict, or constraint discovered

through user/stakeholder input, literature, or regulatory ambiguity that complicates the design of visual markings for public service drones. An emerging opportunity is a promising direction or insight uncovered through research that supports design decision-making and aligns with stakeholder values or public expectations.

6.3 Challenge: Public Perception of Drones, Support for Social Benefit but Need for Transparency

The general public questionnaire revealed that the majority of the participants had a positive view of drones in society. This was based on their association with drones being used for social benefit and their belief that drones could be better, faster, quieter, and more sustainable alternatives to already-used methods, see 5.1.2.

Even though the overall view on drones was positive, there were concerns about the use of drones in warfare and for malicious purposes. Many participants expressed unease about privacy infringement and the feeling of being surveilled, highlighting a strong desire for transparency around drone operations. The purpose and operator of the drone were major factors influencing public perception, with opinions shifting depending on how and by whom the drone was used.

Interestingly, even though most people had a generally positive opinion, 83% of the participants associated drones with surveillance, when asked to pick words from a word list they associate with drones, 81% associated it with military, 75% with hobby and 60% with social benefit. Military, surveillance and warfare were themes that occurred throughout the questionnaire, and the majority said that the current ongoing conflicts and global security issues affected their opinion of drones.

94% of the participants said they were comfortable with drones flying in their area if the drones were used for Emergency medical deliveries, such as AEDs and for providing an early situational awareness at accident sites. Yet the participants were slightly less comfortable with drones flying over their home than with drones in general in society. The biggest occurring theme expressed was discomfort with the idea of being filmed or monitored in private or residential spaces. Participants emphasised the importance of knowing who operates the drone, as well as its purpose and some responses expressed conditional acceptance based on whether the drone served a clear public service, such as police work, healthcare or emergency tasks. The lack of visible operators or markings causes unease. The quantitative data supported this, with the majority of the participants believing that it is very important to them to know which organisation is flying a drone and for public drones to have visible markings.

6.4 Opportunity: No Digital Tracking due to High Public Trust

Since drones can be owned and flown privately, it was recommended in proposal 12 [1] that to gather public trust for VGRs developing drone operations, a way for the public to know digitally if there is a drone in their area or if a drone in their area belongs to VGR, would have to be developed. However, participants of the public questionnaire showed little interest in being able to digitally track VGRs drones, see5.1.2. Responses from the questionnaire, interviews and previous research pointed to a high level of trust in drones from a public authority. Many participants were also aware that Swedens airspace is regulated and under observation. While some expressed concern about private drone usage, very few had similar worries about public-sector use.

Inspired by Value Sensitive Design principles [52], the transparency and accountability of VGR, through the design of the marking system, aimed to align with the needs of the public. Value Sensitive design guided the trade-off between privacy and security inherent in having camera equipped drones, ensuring that stakeholder values such as public trust, transparency and regulatory compliance aligned with the resulting design choices. The accessibility of being able to follow the drones digitally was balanced against efficiency. When public trust of public service drones showed to be high and public interest in digital tracking low, it was opted out of in favour of the security of the drones and the data they could have collected. Expert interviews also revealed concerns that if drones could be digitally tracked, they might be more vulnerable to theft or vandalism.

6.5 Emerging Design Elements

Chosen colours and patterns for the design of the drone markings are guided by the theoretical framework, Ambient Interaction and System Integration, and informed by stakeholder needs, the results of the background research and the public questionnaire. Ambient Interaction aims to ensure system integration through alignment with existing workflows and expectations. By prioritising low-effort and high-effectiveness design, it allows for intuitive interactions without requiring active and focused attention[48]. This design framework aided in prototyping drone markings within the aforementioned multi-faceted design space, more about how in discussion.

6.5.1 Opportunity: Colours for Recognition and Reassurance

In terms of colour, **green and blue** stood out as the most relevant for VGR's purpose according to our research, seen in 5.1.2. These colours were associated with social benefit, nature, calmness and authority in the public questionnaire. The combination of **orange and white** also proved useful, both since many people

lacked clear association to the colours as well as offering high visibility and strong contrast, particularly against blue. These associations align well with VGRs goal to stand out clearly, avoid appearing intimidating, and to distinguish themselves from the markings of other authorities.

Figure 6.1: Selected High Contrast Colours

The chosen shades were selected to ensure high contrast with surrounding environments, helping the drones remain visible while also conveying a sense of professionalism and calm, see 6.1. Since both green and blue, and orange and blue, provide strong contrast, these combinations were prioritised for optimal visibility. However, orange was used for smaller areas due to occasional associations with warning signs, construction sites, and traffic. Despite this, its contrast and distinctiveness from other public authority vehicle markings justified its inclusion.

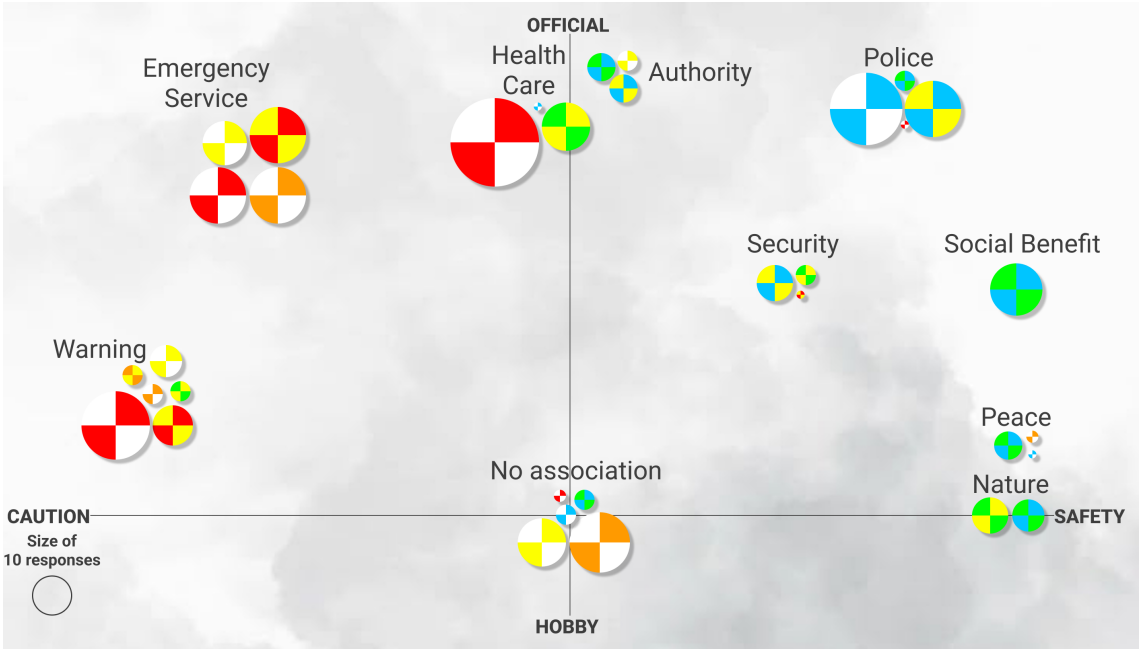

Figure 6.2: Colour Visualisation

6.5.2 Opportunity: Logos and Battenburg pattern for Recognition

Stakeholder feedback from5.4.1 and literature on emergency vehicle markings (3.9.1.3) informed decisions throughout the iterative design process. Semiotic principles guided the evaluation of pattern and logo configurations to support meaning-making

through recognition, trust, and clarity in VGRs drone design; clearer semiotic cues led to faster time-to-meaning and more uniform interpretations[60].

The Battenburg markings 6.5, alternating coloured squares commonly used on emergency vehicles[71], emerged as most effective for conveying public authority affiliations. Prototypes lacking this marking were frequently perceived as private or hobbyist, reducing their credibility. The prototypes featuring Battenburg markings consistently elicited associations with **Public Authorities** and **Emergency Services**. Among the three designs with Battenburg patterns, 81-94% of participants believed the drones appeared to belong to an official authority. In contrast, only 56% and 31% of participants felt the same about the two designs without Battenburg markings5.2. Larger Battenburg segments were especially favoured for their visibility and association with official use. According to Human-Drone Interaction (HDI), the Battenburg markings act as an important and clear visual cue to signal to people what the drone is doing and who it belongs to. With a high association to emergency services and vehicles, the markings elicit trust within the viewer, since it helps bridge the gap between the drone's purpose and public understanding. This aligns with HDI principles such as explicability and transparency. The markings act as a form of non-verbal communication, signalling affiliation with public authorities and enhancing both trust and perceived legitimacy[46].

Participants preferred a combination of rounded and straight elements in the remaining design patterns. Participants viewed rounded shapes as conveying friendliness and trust, while overly sharp curves were linked to sportiness and commercial use. A balanced form was most successful in communicating professionalism without appearing intimidating or playful.

The VGR logo was included based on feedback from the public questionnaire, highlighting its role in recognition, as well as recommendations according to proposal 12[1]. Larger logos were preferred over smaller ones and text markings emerged as ineffective when placed on the underside of the drone due to poor visibility. However, placing the text on the top surface was seen as useful for when the drone is grounded or viewed from above by other vehicles.

Overall, the findings support high-contrast Battenburg patterns, minimal visual clutter, and institutional logos, mainly on the top, to ensure recognition and alignment with public expectations for public authority drone operations. Through evaluative and iterative design aimed at achieving recognition, trust and clarity, through colours, patterns and logos, semiotics informed the aim for a faster time-to-meaning, and more uniform interpretations of the drone design.

6.5.3 Challenge: Noise and Visual Clutter, Balancing Benefit and Disruption

Sound can act as useful user feedback[74], but in the case of drones the background research highlighted the issue of noise pollution: noise in the environment that affects people negatively. It was suggested that the noise drones make could be matched to local noise levels by propeller design, altitude and flight patterns to minimise

it. Similarly, concerns about visual pollution can be tackled through altitude, flight patterns and regulations that de-prioritise private drone use[76].

In the public questionnaire, seen in5.1.2, a few participants mentioned noise and visual clutter as a concern while also mentioning that they might replace larger and louder alternative vehicles. Furthermore, some mentioned that they would not mind if the drones flew for a public service cause, as long as they fly in less crowded areas when the situation is not acute. From the question about word associations, 10 participants picked noise. Furthermore, industry interviews (5.1.5), showed awareness of this concern. All operational drone pilots fly in a way where they are seen and heard least by the public when possible.

Considering the relatively low amount of noise and visual clutter concerns encountered in the Swedish context, seen in 5.1.2, the recommendation is to continue to avoid noise and visual clutter when possible. Furthermore, drone production companies should be encouraged to design for less noisy or more suitable sound scapes. Lastly, regulations for private drone use should reflect a balance between the public's privacy, noise pollution and visual clutter concerns, towards the freedom to operate a drone with a camera.

6.5.4 Challenge: Lights, Unclear Standard

Lighting can work as an important design element for increasing drone visibility and supporting public trust, especially in low-light environments or acute contexts[68]. Literature emphasized that strategic lighting can enhance recognition, safety, and perceptions of transparency, while poorly implemented lighting risks contributing to visual pollution[70]. The questionnaire results showed mixed public opinions, most participants rated both static and blinking lights as somewhat important and a minority valued blinking lights for signalling urgency. One drone operator said that their current lighting systems use strong, pulsating white strobe lights visible in various conditions, along with green and red navigation lights, and that this is a sort of industry standard for flying vehicles. However, the other drone experts did not know of any standard.

It was expected that this research would contribute to lighting guidelines, but the results have been unclear in this area, see 5.1.5. It is unclear if a lighting standard exists that all drone operators follow since most did not know about it, and an explicit standard could not be found. However, based on stakeholder needs of promoting public trust, as well as results showing that recognizing drones as belonging to a public authority, diverging from an industry standard seemed counterproductive. This is also informed by the aforementioned design framework of ambient interaction and system integration through alignment with existing workflows and expectations.

6.5.5 Challenge: Visibility from Above or Below

The design framework primarily focus on the underside of the drone, as this is the view most often seen by the public: from below and at a distance. Since public acceptance is one of the main aims of the project, visibility from below against

the sky was prioritised. However, based on feedback received during the design process, separate recommendations for the drone's top and bottom were developed. The visual requirements differ significantly between these perspectives, for example, viewing the drone from the ground versus from above, such as from a helicopter. The top of the drone is also the only part that will be visible if the drone were to land, and can therefore allow for smaller details since they can be seen close up. While the top-view design is less thoroughly researched, as it falls slightly outside the projects main scope, it is informed by feedback and data gathered through interviews, seen in5.1.5, and a questionnaire, seen in5.4.1, with professionals in the drone industry.

The design of the top of the drone should be mostly white with minimal orange details. Text should be in black, and company logos should be in their respective colours. White does not generate heat to the same extent as darker colours do, and is therefore gentler to the drone mechanics. The drone top should have minimal details, which should be a combination of curves and straight edges.

Logos should be included in large sizes to have good visibility from a distance5.4.1. There could also be an inclusion of smaller logos that would only be visible if the drone were to land. Text should also be included since it would be readable if the drone lands. The inclusion of both logos and text allows for recognition and identification both if the drone is found on the ground or, from above, based on the size of the drone and distance.

6.6 Design Framework: MarkeD - A Standard for Drone Visibility and Public Trust

The following framework, MarkeD (*Marked Drones*) was developed using one multicopter and two different fixed-wing drone models. Since there is currently no standard drone model for public service tasks, the guidelines are kept broad to allow for use across a variety of drone types, while still keeping a consistent visual style and clear connection to public service. The following prototype 6.3, made by following the MarkeD framework, was the preferred design in evaluations, as seen in 5.3.2. While the elements from framework MarkeD are reflected in the design, it is not field tested and does not need to be designed exactly like in the picture, if, for whatever reason, it benefits from alteration.

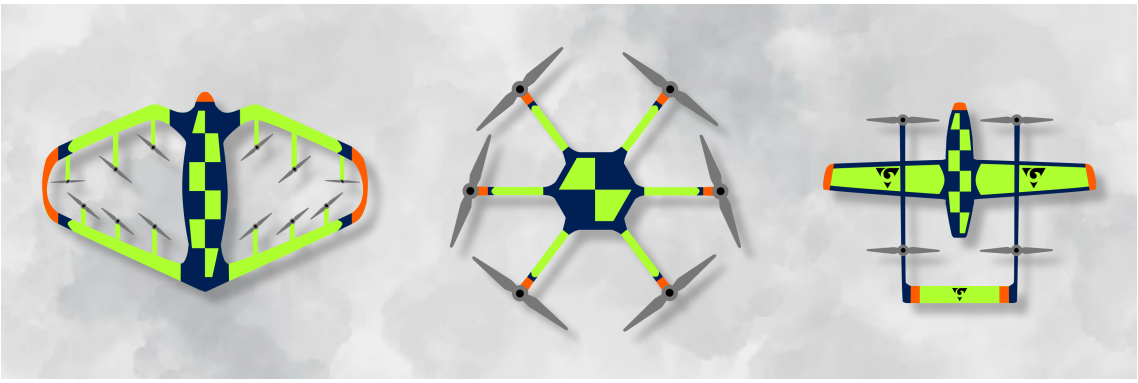

Figure 6.3: Final Design Using MarkeD

6.6.1 Colours

Top design: The top of the drone should be mostly white, with a few orange details.

Bottom design: The colour palette best suited to VGRs purpose includes dark blue, neon green, neon orange, and white. Blue and green serve as the primary colours, with green covering most of the body and all larger details being blue. Orange is used as an accent, while white is applied sparingly and only when necessary, for example, to create contrast or separate design elements. Maintaining this colour hierarchy is important to avoid a design with a cluttered appearance, with too many competing elements, see figure 6.4. The colours should all be in a reflective material for higher visibility.

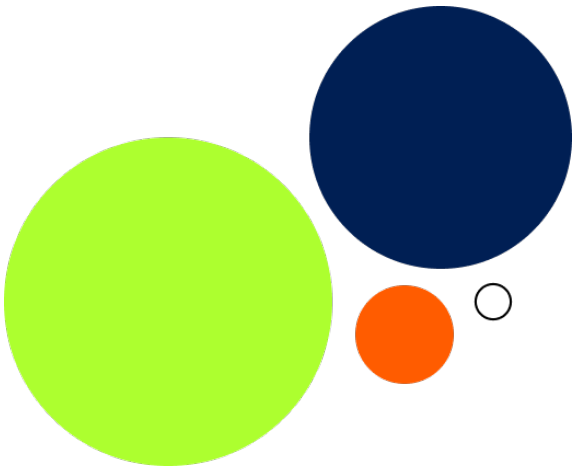

Figure 6.4: Colours

6.6.2 Pattern

Top design: The top of the drone should not use any patterns.

Bottom design: The largest element on the drone body's underside should be the Battenburg markings, see figure 6.5 . The amount of repetitions of the pattern

should be balanced between visibility and recognisability, where a pattern with more squares has greater visibility but less recognisability and vice versa. Therefore, the number of repetitions should be based on the size of the drone and the size of the area the pattern is placed.

Figure 6.5: Battenburg pattern

6.6.3 Logo placement

Top design: Logos should be placed in a large size. If there is a need for multiple logos, the placement and size should be prioritised based on importance. Smaller logos can also be included on the design on top of the drone.

Bottom design: Logo should be placed as large as possible without obscuring the Battenburg markings. If the logos cannot be placed in a way that allows for sufficient size, they should be excluded, as they would not be recognisable and would only add to visual clutter.

6.6.4 Text placement

Top design: Text identifying the drone's affiliations should be included on the top of the drone

Bottom design: Text should be excluded, as it is only readable in rare and impractical situations, and would therefore only contribute to visual clutter.

6.6.5 Details

Top design: The design should have very few details.

Bottom design: When it comes to details, the majority of details should be in blue, with smaller details in orange, white details should only be added if necessary for visibility or contrast. The details can have both curved and straight edges, preferably a combination of both. The curved edges should not be too sharp.

6.6.6 Consistency

Finally, maintaining a consistent design language across all drone models is important, with adaptations made to suit each specific model to ensure overall coherence while allowing for necessary customisation.

7

Discussion

The aim of this project has been to develop and design a marking system that can signal to the public that the drone is affiliated with public services and therefore increase the acceptance of drones, leading to the possibility of a strong drone business for VGR. This aligns with their aim to strengthen their image as an innovative and socially beneficial region[12]. Our project is just a small piece of a larger context of drones being introduced as tools for public services. Our research does not touch on topics of the actual need for the implementation of drones into the public services sector or how the implementation will effect the opinions and views on drones but is reflected upon below. The approach and context of the project has been grounded on the future of drones being introduced into more use cases within the social services and healthcare, while the drone projects related to this project are still on a small scale or have recently been implemented.

7.1 Human Drone Interaction and Public Perception

Our research can be explored through a Human-Drone Interaction (HDI) perspective to examine how people perceive, interpret, and feel about drones based on different elements or contexts[46]. A theme found within the data was a desire for transparency and a clear way of understanding the purpose and origin of the drone. This highlights the importance of designing for explicability and trust, meaning that the drones actions make sense, people feel safe around it and believe its being used for the right reason[5]. Participants expressed more acceptance of drones used for purposes that were socially beneficial, such as emergency medical deliveries or supporting first responders at accident scenes, through a live video feed. These use cases offer a more transparent and more meaningful context, allowing participants to understand the drones purpose. This aligns with HDI theory [47], which suggests that when people can easily interpret what a drone is doing and why, they are more likely to feel comfortable and trust the technology.

Throughout our research, we saw that the general public wants to know who operates drones and their purpose. The lack of visible affiliations can cause discomfort whilst markings, colours and other known patterns can reduce the perceived risk of a drone and therefore enhance interpretability. The participants strongly preferred drones to have visible markings, such as colouring and logos, and showed a big need for

visible identification on drones. Including visible elements that can be identified to an affiliation gives people a cue to mentally categorise the drone as trustworthy [46].

Privacy and surveillance concerns were frequent themes throughout the research, with participants expressing discomfort around the thought of drones filming them. These concerns were more frequent in the context of the drones flying over participants' homes. By marking the drones as being clearly connected to social services [47], this research aims to increase transparency, giving the public a context and therefore reduce the tension through increased understanding, trust and perceived legitimacy[48].

Finally, the associations to military, surveillance and warfare were recurring throughout the research, and the majority said that ongoing conflicts and global issues influenced their opinion of drones. To negate these negative associations, our design aims, in line with HDI, to give positive associations with visible cues for public service and non-threatening design choices. However, some participants in the public questionnaire that associated drones to military, surveillance and, or war, elaborated in free text that they had a positive view of drones, highlighting the fact that some do not value these use cases negatively.

The research suggests that a design focusing on transparency, explicability, and visible affiliation has the potential to increase public acceptance of drones used in socially beneficial contexts. Participants clearly expressed a desire to understand who is operating a drone and why it is present. By incorporating visible markers such as colours, logos, or identifiable patterns, drones can more easily be interpreted as part of a legitimate, non-threatening public service. By aligning with what people value and expect from public service technologies, our design proposal can help foster greater understanding and trust, ultimately leading to broader acceptance of drones in socially beneficial roles. While general knowledge about the use of drones in public services may still be limited among the public, our research shows that thoughtful design can help bridge that gap and improve perceptions.

7.2 Ambient Interaction and System Integration

As the research question poses, this project highlights how opportunities can emerge in challenging design spaces. While exploring theory that could inform these challenges, Ambient interaction and system integration was found to be potentially useful. Ambient interaction refers to systems that blend into their environment, enabling intuitive, non-intrusive use with minimal effort while supporting efficiency and accessibility[48]. The framework usually refers to software but inspired the integration and design of the drone marking system into the already existing system of public authority vehicles, that appeared to already have the public trust necessary.

One theme to be explored in the design space was, if a digital drone monitoring system was of interest or not, informed by proposal 12 from Transportstyrelsens report. As unmotivated technical solutions can create more problems, the choice not to have one can also make a solution more clearly interpretable. Following this, the results of the public questionnaire showed that there was almost no interest in

a digital drone monitoring system. Combined with the risk of making the marking system unnecessarily confusing, the security of the drone and its collected data was prioritised. At this point the design framework of Ambient interaction and system integration inspired the design of the colour and pattern elements.

VGR wanted a marking system that would ensure public trust through transparency whilst not appearing to belong to other public authorities such as the police or ambulance. Aligning with the opportunity that emerged of existing public trust towards public authority vehicles along with the lack of interest in a drone monitoring system, colours and patterns were designed to communicate stakeholder needs. This resulted in a marking system that effectively prioritises low-effort and high-effectiveness design, allowing for intuitive interactions without requiring active and focused attention, according to ambient interaction and system integration.

7.2.1 Semiotics to meaning making

To support the ambient interaction framework, semiotics was applied as a method for achieving intuitive recognition and efficient meaning-making in the drones visual design. Evaluative and iterative design aimed to foster recognition, trust, and clarity through colours, patterns, and logos. Semiotic principles helped shorten the time-to-meaning and encourage more uniform interpretation of the drones role[60].

This approach informed the recommendation to use Battenburg markings and a balance of rounded and straight lines in the overall design, meeting stakeholder needs. While the resulting colours, blue, green, orange and white, are often used by other public authority vehicles, they were based on results from the public questionnaire that asked participants what they associated different colour combinations with. The associations were matched to stakeholder needs in order to chose appropriate colours.

The public might associate these colours to VGRs aims because of already existing vehicle designs. Hypothetically, other public authorities have wanted their vehicles to be associated with similar things as VGR. The public might associate colours that are common for public service vehicles to, public authority, calmness, safety, trust, transparency and emergency healthcare, already, which were the aims of VGR. This could be the reason that similar colours where associated to these values in the public questionnaire and why they were used in the resulting design recommendations.

7.3 Are drones actually the future?

The results of the research show a positive attitude towards drones, but a need for transparency of the drones' operations and affiliations, as well as presenting design recommendations for visual marking. Throughout this project, the approach has been grounded in the fact that drones will be a part of the future of social services and healthcare, while the drone projects this research is related to are still on a small scale or recently implemented. This future vision may not necessarily be true, drones may not be the suitable solution to the problems they are supposed to solve.

The opinions of drones may also change if there is greater implementation of drones in society.

While not researched in this project, it might become more relevant if society continues to embrace technological advancement, to be critical towards innovation pursued for its own sake and what innovations actually contribute beneficially to society in a meaningful way. Are resources applied in a meaningful way or only to further technological advancements without social benefit. In this context, its practical value may vary depending on geographical and infrastructural factors. In densely populated urban areas such as Gothenburg, the existing emergency response infrastructure, such as ambulances, may be sufficiently fast and efficient, thereby limiting the added value of drone deployment. In contrast, in smaller or more remote communities where hospitals are farther away, drones could offer significant advantages by reducing response times and improving access to emergency services. The development of more uses cases could elevate the value and need of the drone technology.

As of now, the extent of drone potential for socially beneficial areas are partly speculative, since related drone projects are still in early phases. Its usefulness has to be evaluated continuously as well as after it has been operational for a longer period of time. Before they have been, resources should be invested accordingly. Considering the fact that VGR has a future vision called **The Good Life** for the benefit of the regional population which includes an investment in innovation projects between the years 2021-2030, the motivations for their drone projects are explicitly more than the direct benefits of drone technology [11]. One of the four pillars of this investment is to strengthen their power for innovation - Tillsammans gör vi Västra Götaland till ett föredöme för omställning till ett hållbart och konkurrenskraftigt samhälle. (*Together we are making Västra Götaland an example of transitioning to a sustainable and competitive society.*) [12]. While this can have positive future effects for VGRs population, and motivate it, it is not necessarily connected to the efficiency of drone technology used in, for example health care services. However, exploration of new technologies can be a way of finding out their potential benefits and can lead to innovative progress, even if does not turn out be the optimal solution for its current planned and developing use cases. While this type of exploration can be needed to find new solutions in general, and could lead to an enhanced image for the region for the benefit of its population, it should be balanced against its cost and other solutions that get de-prioritized. Furthermore, it could add to the need to be critical towards innovation pursued for its own sake, to stay transparent with why something is done and if it is sufficiently motivated.

While the public perception of drones in VGR was generally positive, in the results of this research, these results do not necessarily represent the perception of the Swedish population and even if it did it can change over time. Because war in the surrounding world is utilising a lot of drone technology, Sweden could see a rise in the number of immigrants and military personnel directly affected by it in the near future. Furthermore, a lot of people might be experiencing anxiety about imminent war because of the state of the surrounding world and the media coverage of war. This could lead to a future Swedish population where some have trauma responses towards drone noise and sightings. If this is not already the case in Sweden, it

could be argued that having a minority who are very negatively affected by drone infrastructure requires further considerations of noise and visual design, as well as considerations of where it is okay to fly and how low.

7.4 Limitations

7.4.1 Research Improvements - Sample Size and Biases

Limitations and improvements that could have been done to strengthen our project in the research phase include the structure and distribution of the questionnaires. The general public questionnaire was the largest source of data that gave us insight into the general public's views and opinions, 48 responses were gathered. While 48 responses gave us a good sample for the qualitative questions, which were the majority of the questions, it is still quite a small sample size, especially in regard to the quantitative questions. If the questionnaire had reached more participants, the quantitative data could have been further analysed to provide extra strength.

Of the 48 participants, the age of the largest group, 38%, was in the age range 25-34, and the second group, 23%, was in the range 18-24. Only 4% of the participants were above 65. Having an over-representation of younger participants can affect the data, where there could be generational differences in the view of drones in society. Another demographic factor that could have had an influence on the data collected was that 79% of participants lived in urban areas, and only 8% lived in areas that currently have active VGR drone projects, with 40% living outside the region of Västra Götland.

Another limiting factor that affected the data collection was that the industry questionnaire only had 5 participants, although not a large number of participants was expected, there could be value to having gathered more data for a deeper insight into the drone industry. It should also be mentioned that these industry participants could have a bias benefiting drone technology.

While precautions were taken in the making of the questionnaires to avoid creating bias and influencing the participants' answers, there still could exist inherent biases within the participants based on the knowledge that the project was done in collaboration with VGR, creating associations to healthcare and regional innovation. The inclusion of the collaboration with VGR was done with the aim of transparency and informed participants, but could have affected the data. For the questionnaire that evaluated design recommendation, five designs were proposed and the first one came out as the favourite. This could be due to a bias of primacy where the first thing on a list is valued more highly than others, however, number three and five of the designs were almost equally liked so it seems unlikely.

The colours in the public questionnaire were not the same shades as the ones used in the final design. They were a combination of two resulting colour combinations from the public questionnaire that matched stakeholder needs. While using those colours for the design, their shades were further optimised for contrast and visibility, towards each other and the drones environment, such as a grey or light blue sky.

7.4.2 Practical limitations - Lack of drone access

Due to a combination of a lack of access to drones or drone material combined with the emphasis on public acceptance, the results and research are only theoretically based, with evaluations of low-fidelity prototypes in an unrealistic context. Both due to the lack of access to drones and to the reach of a larger sample size. The prototypes were presented as 2D graphical interpretations using stencils set against an image of a grey sky. This differs greatly from a realistic scenario, where the drones are fast-moving and are seen at a distance. Having greater access to a drone or a CAD model of a drone would have allowed for presenting the design in more realistic settings and therefore aided in getting stronger evaluations and results.

While the general public was the primary user group, design were primarily evaluated with industry stakeholders with drone and/or design experience, due to not being able to place the design in the right context because of a lack of access to drones or drone material. As described in 5.4.1. Therefore, feedback from the general public run the risk of being inaccurate due to lack of context knowledge, while industry people have the right context knowledge to provide useful feedback. If been able to access more drone material in form of CAD models or actual drones, it could strengthen the research by being able to put the designs in the right context and test on the actual primary user group.

7.4.3 Limited Perspective in a Pending Industry

Since the drone projects this research is working towards are still in the early stages of implementation, or are still working on a small scale, the data collected and research done has been partly speculative. There existed some uncertainties around the operations, as it is not yet fully developed and operational. The opinions of people collected have been on the current state of drone interference, and partly on an imagined future with more drone services. These opinions and thoughts may change if the usage of drones becomes more widespread and has a greater impact on the public's life than it currently does.

The fact that the development of drones for these use cases is still in the early stages of implementation also limits the amount of available insights. The general impression gained through the industry questionnaires and interviews was very positive towards drones, which may be due to the fact that it is still a smaller industry and therefore attracts people passionate about the subject. This fact may also lead to a more positive and optimistic portrayal of drones than would be found in a broader, more mature field. As such, the views captured in this research are likely shaped by the early adopter mindset of new technologies. If the industry gets more widespread and implemented into more spaces and industries, it may be possible to interview a wider range of stakeholders, including professionals who interact with the technology but are not directly part of the drone industry. This would enable a more diverse and potentially less biased understanding of how drones are perceived and experienced across different roles and sectors. For now, the early-stage nature of the field limits this breadth of perspective.

7.5 Future Work

The findings in this project are mainly theoretical, with no real-life practical testing. This is because the main approach of the research was conducted within a public opinion context, combined with a lack of access to drones. Because of this, the design recommendations found are theoretically based, with no real-life testing for visibility and recognizability. Performing further practical tests with drones or realistic materials could have strengthened the results for practical use. Performing more true-to-life tests can also strengthen the design, since the design has currently only been presented as low-fidelity prototypes, therefore, further research that puts the design in the correct context would be valuable to further explore the design. Tests using actual drones would further strengthen the design.

The colour we have found, had a high association with socially beneficial use and theoretically should be highly contrasting. However, the recognisability and visibility in itself was not tested, but only inferred by data collected and related research. Performing recognizability and visibility experiments in a more realistic context would strengthen the results. This can be said for all our visual design recommendations.

The design framework describing recommendations for the drone visuals are partly aimed at contrast and visibility towards the sky. Even though there are some recommendations based on this research, how the top of the drone should look like and why, it is not equally researched and not evaluated. If it would be evaluated in the future, the recommendation would be to visualise prototypes with a backdrop of the ground and evaluate them through the perspective of people operating other flying vehicles.

As previously mentioned, the drone industry in Sweden is developing and this could affect how the public view the technology. Therefore, new research on public opinion is recommended within the near future. Since other stakeholders could also be affected by this potential change, their views should also be re-evaluated. Parallel to the developing industry, new stakeholder could emerge whose opinions should also be evaluated.

Public opinion of public service drones are hypothetically based on the public opinion of public service and public service vehicles, since many do not have any direct personal experience with drones. Furthermore, as the results of this research shows, many opinions are effected by the media coverage of drones which usually centres around war and surveillance, but that is also an indirect effect. It cannot be said that the results of this research represent public opinion of drones for many years ahead since public exposure to public service drones is just now on the rise.

7.6 Conclusion

Finally, drawing back to the research question:

What design challenges and emerging opportunities must be addressed when developing a standardised marking system for VGRs public service drones, considering

evolving regulations, stakeholder perspectives, and the need for iterative refinement amid different priorities for developing technologies?

Challenges identified were: **Public Perception of Drones:** Support for Social benefit but need for transparency. **Noise and Visual Clutter:** balancing benefit and disruption. **Lights:** unclear standard. **Visibility from Above or Below:** This scope of this research did not evaluate top designs.

Opportunities that emerged were: **No Digital Tracking due to High Public Trust:** It was better to not develop a digital monitoring system, public service alignment ensure trust. **Emerging Design Elements:**Colours for Recognition and Reassurance. Logos and Battenburg pattern for Recognition.

This research has explored the design space of public service drones in Sweden; what the public opinion is, how the drone should look like and what should be considered from related stakeholder perspectives. It presents the framework MarkeD and recommendations on how to promote, or work with public trust, whilst exponentially implementing drone technology in public service infrastructure through the choice of colours and design elements. It takes into account regulatory compliance, visibility, symbolic effectiveness, and public perception. Through iterative prototyping it supports the implementation of markings that enhance trust of public service drones in Sweden through transparency and recognizability.

As of now, public authorities and their vehicles are generally trusted by the Swedish public, according to the results of this research. Therefore, being recognisable as a public authority vehicle, through colours and patterns, seems to be enough for public trust of public service vehicles in Sweden. The majority of participants in this research see the evolution of more effective public service as a good thing that is to be trusted, a recurring theme in questionnaires and interviews. However, as mentioned in conjunction with the research question, this research highlight the fact that, technology and its context change and evolve and should be evaluated continuously, especially whilst balancing privacy and security together with accessibility and efficiency. For example, in the Swedish political climate, a drone monitoring system was not of much interest, this could change. The general perception of drones could also change depending on Sweden's international political climate and the state of the world. Drone technology, its use cases and its potential use cases, as well as how it could be perceived by the public could also change how it can and should be used from an ethical standpoint.

This research recommends continuous evaluation to keep public trust, as drones are a new and divisive technology in an unpredictable political climate. Even though some of the research results are similar to other research from the literature review, it could change over time or look different based on who and how many participants gets to participate in the evaluations as well as when people in general get more acquainted with drone technology. Therefore, the research recommends future projects to do their own evaluations of public trust in their context of time and space.

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A

Public Questionnaire

Vad påverkar din åsikt? *What influences your opinion?*
Tycker det kan vara mycket bra sålänge det inte blir för mycket och man har tydliga regler kring användandet. Till exempel hur det används i närheten av bostadshus, privat mark och sådant. Och så vill man väll såklart att det inte används för mycket så det blir fult i himlen haha.
Drones have an anonymous element to them that makes their chain of accountability unclear. If a drone is talking pictures of you, or your property, what can you do other than to report it and hope someone investigates? Moreover, unless you can see its operator, how can you even begin to touch on the topic of consent if it's a private drone? Or if it's equipped with a weapon of some sort, you can't really tell at a glance or until it would be too late. Even if you try to make distinguishing colors or other parts to denote its purpose, bad actors could still copy that style themselves for their drones. Official resources like apps or websites, etc, should supplement and publicize what their drones are doing (and where) for better transparency.
Vad drönare används till. Sjukvård är bra, till krigsföring mindre bra
När de används i ett övervakande eller inskränkande syfte
Ive only had experience with people flying camera/video drones, which I find a bit uncomfortable as I dont know how that footage is then used or distributed. The noise isnt very loud for those drones which is good, but it can still be a bit annoying in quiet areas.If a drone was to be used by the municipality itself for a good reason, I would view it as more positive though. I think it should be well marked/branded so its clear that its a working drone :)
Kan säkert vara hjälpsamma men lite obehagligt då jag förknippar drönare med att de filmar och blir lite övervakningskänsla över det
När man hör/läser om drönare är det ofta i negativ bemärkning, typ någon som flugit på otillåtet område och/eller stoppat flygtrafik . Eller krig. Men jag vet ju att det används / forskas på att användas i sjukvård o för medicin o liknade , dvs för positiva grejer
Beror på hur de används/av vem, om de används för övervakning
Snabbt få fram hjärtstartare.
Kontroll, vem äger den (privat eller offentlig), i vilket syfte är den där, att det används som övervakning eller som vapen, facial recognition

The usage of drones for malicious practices, otherwise I think they could be beneficial.
Depends on purpose / function.
Splittrad åsikt, effektiva för millitär & polis. Men också högljuda och skräniga. Element av cyberpunk dystopi kring dem, övervakning så som i China osv. Tacksamma redskap i rätt händer dvs!
Tycker det är coolt med drönare
+ för individers frihet att fotografera/filma+ om de ersätter andra, mer bullriga fordon- tänk om de kommer från en främmande makt, det vet man ju inte
.
Jag anser att drönare kan hjälpa oss i vanliga livet men även inom vård och göra vår liv lättare
Om det används till en samhällsnyttig funktion - tycker jag det är positivt. Samhällsnyttig tänker jag på polis, sjukvård, brandkår etc. Tycker inte det är okej med privata drönarleveranser, drönare låter + det är redan begränsat i luftutrymmet så då ska viktiga funktioner prioriteras.
Privacy laws, trust in the swedish government (hence the high score). And the general societal benefits that might come from drone usage (thinking primarily about police use for first responders)
Jag är själv pilot och utbildare. Flyger även drönare inom räddningstjänsten
Kan inte påstå att jag har någon vidare åsikt. Medierapportering av händelser i samhället där drönare är involverade kan påverka min åsikt och isf i negativ riktning. Jag generellt en låg åsikt om teknik så om min åsikt skulle röra sig i någon riktning skulle det vara den negativa.
Ett snabbt och effektivt redskap i allmänhetens tjänst i närliggande alternativt vidsträckta områden eller otillgänglig natur.
Effektivt och smidigt
I understand that they do good however infringement on privacy worries me
Möjligheterna med drönare.
I am writing about drones
How much it invades the natural ambience, with sound and visuals. Also how the recordings deal with personal data.
en bra utveckling av transportsystemet i Sverige
Vilka som får använda dem
Teknikeanvädning är bra men utnyttjas inte alltid optimalt
Finns positiva saker man kan göra med drönare. Kan hjälpa polis, sjukvärd, råddningstjänst tex
Vad de används till
Studerar just nu för "Specifik", samt är verksam i branschen.
På många sätt ett överlägset sätt att frakta saker och samla in data. Som leksak är det också viktigt att få flyga.
Känns som det kan öka övervakningen på folket
Modern teknik, smidigt
Känns som övervakning

effektivt sätt att samla in information
Det man läser i media om drönare
Potentiell nytta
Behovet av att inte drönare missbrukas av privatpersoner eller myndigheter.
Att det finns tydliga regler för användning.
viktigt att man kan hitta användningsområden för drönare inom "samhällstjänst" för att underlätta/förenkla/snabba på tex transporter av saker eller övervakning
Användning av senaste teknik för att effektivisera transport
Miljövänligare alt än helikopter
Vet ej
Magkänslan
Nyttan i hur teknologin kan användas och det relativt biliga priset.

Vad tänker du om du ser en drönare flyga över ditt hem? *What do you think if you see a drone flying over your home?*
Inget super konstigt då jag bor i centrala Gbg. Oftast ser man användaren som styr. Man blir dock nyfiken när man inte ser användaren.
I would feel afraid if I saw a drone flying.
Att det är någon privatperson som testar ny hobby, eller så är det polisen
Coolt, intressant, spännande
I generally associate drones with video footage capture. So I would think I was being recorded, which is a bit uncomfortable. I might also jump to the conclusion that something bad has happened and its there to do surveillance.It would be very important to me to know who owns/is operating the drone (it should be clear to the naked eye if possible).
Övervakning, man vill kunna gå runt naken i sitt hem utan att oroa sig för att man blir iakttagen
Oftast tänker jag nog att det är något bus eller polisövervakning
Någon tar bilder/filmar som en hobby, men skulle ändå känna mig lite obekväm
Säkerhet
Övervakning, osäkerhet
That someone is using it to record scenery videos. If its a bit too much around my home I would be a bit suspicious
Wondering is something happened nearby.
Söker efter en sten Nej men tänker att det förmodligen är en polisdrönare, känner mig inte allt för brydd då detta är vad man förutsätter. Klart det skulle kunna vara en privatperson som vill speja på mig, men har inte en så stor foliehatt att jag misstänker främmande makter, vilket jag antar är det som är rotten till folks drönarrädsla.
Tänker nog att det är en polisdrönare
Hobbyflygare i farten.
Ge dig av
För den mesta dels är väl att någon ska filma i Slottskogen

Reflekterar inte så mkt över det, tänker det är någon hobby drönare. Om det blir en ökning av drönare hade det dock varit nice med en märkning så man vet avsändaren & syftet med drönare
There's probably a hobbyist or a company working with drones nearby
Spännande
Att någon troligen behöver övervaka något i närområdet och att ljudet stör.
Möjligen särskilt ärende Drönaren skall visa tydliga dekaler i form av militär, polis, sjukvård, brandkår, mattransport.
Framtiden
I reflect on what type it is/what its being used for
Ryssland
Welcome!
Filming some sort of movie/commercial or test-flight. I also hope that it does not disturb me or film me in my home.
Över min villa skulle kännas lite märkligt men i övrigt inget speciellt. Jag föredrar att drönare under transport flyger på specifika flygsträckor så att flygningarna känns mer förutsägbara. Självklart behöver drönare för sjuktransport och annan tidskritisk verksamhet flyga rakaste vägen. Då är det bra om de är tydligt utmärkta för att skapa bättre acceptans.
Att det kan va en privatpersons
Hobby
Skulle kanske tänka om det va svenska drönare. Skulle också anta att det händer något läskigt eller jobbigt i området, typ en skjutning.
Otryggt, litar inte på den. Känner mig övervakad
Nyfiken, spännande och skoj!
Jag undrar vem det är. Då jag bor i ett område med luftrums restriktioner funderar jag också ofta på om de har tillbörligt tillstånd.
Känns inte bra, man vet inte vem det är som flyger drönaren. Det kan väl vara militärt men också en privatperson. Jag känner lite samma med helikoptrar, jag brukar kika på om helikoptern är från polisen eller sjukvården.
Att ryssen kommer
Troligtvis att det bara är någon som filmar
inget särskilt
Funderar på varför den flyger där
Oj, vad spännande
Icke nödvändigt bruk av privatperson eller näringsverksamhet
Vad har hänt? Vilken myndighet är kopplad till drönaren?
Nyfikenhet, vad gör den här.... (Har hittills bara sett små privata och då kände jag att det var integritetskränkande)
Jag undrar varför; tydliga markeringar behövs så att publiken förstår syftet
Syfte?
Beror på drönare, svår fråga att svara på fritt
Jobbigt ljud

Eftersom inget hörts om att det används för samhällsnyttan så tänker jag för hobby eller byggarbete eller annan privat verksamhet/företag

Tycker du att drönare bör regleras i stadsområden, i så fall hur? *Do you think drones should be regulated in urban areas, if so how?*
Runt botadsområden, skolor, dagis, kontorsbyggnader, sjukhus, och likande ifall de har kameror för secretes och sånt
A registry of drones and ongoing air traffic log
Lite kanske
Nej, inte för offentlig nytta eller hjälp
Definitely - I dont support the idea that all citizens should be allowed to operate drones in urban areas. Either you should need a special license or drone usage should be restricted to only public services (or potentially businesses can get a license - e.g. PostNord parcel delivery)
Borde inte användas om det inte är superviktigt
Hmmm både ja och nej . Räddningstjänsten borde alltid få använda . Jag tycker det är kul när det används för film och liknande o det är tråkigt att det stoppas helt . Men kanske att man behöver ansöka om tillstånd ? Så kanske det redan fungerar. Å andra sidan hur kontrollerar man vad som filmas ? Och att det inte blir integritetskränkande
Vet inte
Så att det inte stör flyg, helikopter osv.
Vem som får tillstånd, tillsynsmyndighet som har koll på vem, hur och hur länge samt vad syftet är
I think so as they can be used to spy on people or otherwise used with malicious intent.
times of operation, flight paths, areas for landing & takeoff
Inget för massa hippa startups eller privatpersoner i stadsområden, mer ett störningsmoment i form av brus, hade kunnat bli det nya lime/voi som alla stör sig enormt på. Är dock mindre bekymrad över min "trygghet" eller "inskränkande" på mitt privatliv.
Ja, inte flyga över vägar
Vill inte behöva oroa mig för att de är i vägen när jag tar mig fram. Vill inte heller känna mig övervakad
.
Nej, tycker att alla ska kunna flyga drönare om dem har körkort
Ja så det inte blir för många. Som sagt samhällsnyttiga funktioner är bra, rädda liv sjukvården kommer först så kan man räkna på hur många akutfall det är, och sen portionera ut antalet drönare. Har ingen uppskattning på hur många det är men har svårt att se att någon skulle störas om det kommer en drönare 3-4 gånger om dagen, men om man skulle se drönare konstant under dagen som låter skulle man ju tröttna.
dont know
Ja, man bör ha körkort

Ingen aning.
I luften oinskränkt srbetesområde.Avvisade landningsplatser för transporter som sjukvård, hjärtstartare etc..
Ja, med körkort för drönare
I think it should be regulated to some extent, maybe you need a permit
Inte reglering av offentliga drönare
Ja, men tillräckligt med nuvarande regler
Noise regulation, distance regulations (not too close to face or body, both dangerous and invasion of privacy)
Ja, man bör ta hänsyn till buller, personlig integritet osv.
Ja om de inte är livsviktiga
Ja säkerhet och integritet
Vet ej
Ja, borde bara vara tillåtet med offentlig tjänst, inget kommersiellt.
Drönare och drönaranvändning är ju redan hårt regulerad, tyvärr är efterlevnad med drönarkort väldigt dålig, så väl kunskapen hos många drönaranvändare. Det borde därmed bli mer strikt angående drönarkorten, borde vara på samma nivå som för bilkörkort.
De är redan reglerade i stadsområden. Måste ha rätt C-klassning för att få användas där.
Ja, men vet inte.
Ja. Bara nödvändiga drönare i tätbebyggt område.
Ja men vet inte hur
ja, bör vara fokus på samhällsnyttiga drönare
Ja, det borde vara reglerat kring hur och när de kan samla in data av privatpersoner (tex filmning)
Ja, med tillstånd
Anser att nyttjande av drönare ska vara strikt reglerat överallt genom regler och lagar.
Regelverk - antagna av staten
Ja, men kan inte säga hur...
Ja. Offentlig tjänster bör prioriteras
Endast polis och räddningstjänsten
Ja men vet inte hur
Som med vois, zoner med förbud och landningsförbud
Ja, det ska vara en övervägning kring samhällsnyttan och inte användas i onödan. Att använda som bud för paket osv är onödigt medan krisövervakning eller för polis inte är.

B

Industry Questionnaire

I vilken utsträckning jobbar du med drönare?	Hur ser du på användningen av drönare i samhället?	Vad påverkar din åsikt?	Vilka ord förknippar du med drönare? (*Välj alla som passar)*
heltid	5	De kan göra nytta på ett sätt som inget annat fordon kan.	Samhällsnyttigt, Militärt bruk, Trygghet, Polis, Framtiden, Mångsidigt, Räddningstjänst, Säkerhet, Krig
Jag ansvarar för utveckling av tjänster för akutmedicinska drönarleveranser	5	Det är mycket som talar för att drönare är ett effektivt verktyg vid akutinsatser	Samhällsnyttigt, Militärt bruk, Hobby, Polis, Framtiden, Räddningstjänst, Säkerhet, Krig
Pilot/operatør	5	Jeg jobber med droner og har sett mange positive bruksområder for de.	Militärt bruk, Hobby, Budtjänster, Övervakning, Trygghet, Polis, Framtiden, Räddningstjänst, Krig, Vapen
Food delivery	4	They can streamline the transportation of goods, medicine, and packages, especially in inaccessible areas.	Samhällsnyttigt, Militärt bruk, Hobby, Övervakning, Trygghet, Polis, Framtiden, Räddningstjänst, Krig, Vapen

Jag jobbar som ingeniör for Aviant AS	4	Jag vet at det fins mycket drönare kan göra for at effektivisera samhellet, men jag vet också at det er några problem med drönare som ljud som kommer vara svåra at lösa.	Samhällsnyttigt, Militärt bruk, Hobby, Budtjänster, Övervakning, Polis, Framtiden, Mångsidigt, Räddningstjänst, Störande, Oljud

Vilka av följande användningsområden är du bekväm med att drönare används till i ditt område? *(Flera val möjliga)*	Hur trygg känner du dig med att drönare flyger i ditt närområde?	Vad tänker du om du ser en drönare flyga över ditt hem?	Vilken typ av märkning/spårbarhet anser du är viktig för offentliga drönare? [Färgmarkering av drönaren]	Vilken typ av märkning/spårbarhet anser du är viktig för offentliga drönare? [Logotyper på drönaren]
Medicinska leveranser (t.ex. blodprov, medicin), Akuta medicinska leveranser (hjärtstartare), Räddningstjänst (t.ex. förebyggande brandskyddsbevakning), Ge första överblick av olycksplatser	5	Att det är någon som är uppe och nöjesflyger	2	2

Medicinska leveranser (t.ex. blodprov, medicin), Akuta medicinska leveranser (hjärtstartare), Räddningstjänst (t.ex. förebyggande brandskyddsbevakning), Ge första överblick av olycksplatser, Budtjänster till privatpersoner, Polisövervakning, Militärt bruk	5	Nyfiken på vart den ska och vilket uppdrag den har	4	2
Medicinska leveranser (t.ex. blodprov, medicin), Räddningstjänst (t.ex. förebyggande brandskyddsbevakning), Ge första överblick av olycksplatser, Budtjänster till privatpersoner, Polisövervakning, Militärt bruk	5	Kommer an på typen drone, hvis jeg ser det er en hobbydrone så blir jeg skeptisk, men hvis jeg ser at det er en drone som brukes av politi eller lignende er jeg mere komfortabel.	2	2

Medicinska leveranser (t.ex. blodprov, medicin), Akuta medicinska leveranser (hjärtstartare), Räddningstjänst (t.ex. förebyggande brandskyddsbevakning), Ge första överblick av olycksplatser, Budtjänster till privatpersoner, Polisövervakning, Militärt bruk	4	I don't really care if a drone flies over my home	4	3
Medicinska leveranser (t.ex. blodprov, medicin), Akuta medicinska leveranser (hjärtstartare), Räddningstjänst (t.ex. förebyggande brandskyddsbevakning), Ge första överblick av olycksplatser, Budtjänster till privatpersoner	3	Jag tänker inte så mycket. Om det er drönare över mitt hem er det sannolikt polis eller ifbm et evenemang, så jag räknar med at dom har säkerheten og sina rutiner på plats.	1	1

Vilken typ av märkning/spårbarhet anser du är viktig för offentliga drönare? [Ljus - blinkande]	Vilken typ av märkning/spårbarhet anser du är viktig för offentliga drönare? [Ljus - statiskt]	Vilken typ av märkning/spårbarhet anser du är viktig för offentliga drönare? [Notifikation via app/sms vid överflygning]	Vilken typ av märkning/spårbarhet anser du är viktig för offentliga drönare? [Möjlighet att följa flygning och operatör via hemsida/app]	Är det någon annan märkning/spårbarhet som saknas från listan ovan?
5	5	1	2	
2	2	1	2	
5	5	1	3	QR kode med kontakt info på dronen, så pilot kan kontaktes ved en eventuel krasj eller nødlanding
3	1	3	4	
1	1	1	1	nej

Blå och Grön	*Vit och Gul*	*Röd och Vit*	*Vit och Blå*	*Röd och Gul*
skoj. lekfullhet	svårt att se	fara. allvar.	Klart, färdigt.	Akut
Inga associationer	Inga associationer	Polens flagga	Vatten, flod	Skåne
Ambulanse drone	Ambulanse drone	Politi	Politi	Arbeid skjer her
Hobby	Ambulance	Ambulance	Drone for Deliveries	Ambulance
ingen	ambulans	ambulans	ingen	ambulans

Orange och Vit	*Gul och Blå*	*Orange och Gul*	*Grön och Gul*	Vilka färger skulle vara mest lämpliga för att tydligt signalera att en drönare används för offentlig tjänst? Behöver ej vara någon av färgkombinationerna ovan.
inget	Sverige	rörigt	akut, ambulans	Rögg, grönt, gult.
Inga associationer	Sverige	Inga associationer	Inga associationer	Om det är akutsituation skulle blinkande blåljus vara lämpligt. Jag antar att samma färger som andra fordon/utrustning inom samma område vore bra.
Arbeids drone	Ambulanse drone	Kartlegging	Kartlegging	Tror fargen på drone ikke burde ha noe å si, fordi droner ofte opereres på kveldstid hvor det er mørkt å du ikke ser fargen på dronen uansett.
Not sure	Swedish police	Not sure	Not sure	Blue and yellow
ingen	ingen	ingen	ingen	Drönare brukar vara långt nog borta at färgerna inte kommer bli synliga nog, så jag tror inte det spelar stor roll hvilken färg dom har.

Hur mycket tror du att pågående konflikter och globala säkerhetsfrågor påverkar din uppfattning om drönare? (*Positiv eller negativ påverkan*)	Hur stort intresse har du av drönar utanför jobbet?	Har du några ytterligare kommentarer eller tankar att dela?
3	Jag har stort intresse av drönare, Jag äger en drönare	
4	Jag har visst intresse om drönare	
2	Jag har visst intresse om drönare	Nei
4	Jag har stort intresse av drönare	No
3	Jag har visst intresse om drönare, Jag äger en drönare	

C

Interview Questions

Intervju frågor till *Stakeholder Interviews*

- **Allmänna frågor**
  - Hur arbetar ni med drönare inom er verksamhet?
  - Kommersiellt etc
- Vad har ni för projekt för tillfället?
- Hur ser ert arbete med VGR ut?
- Hur ser en typisk drönarflygning ut, vilka tillstånd behöver ni söka, i vilket syfte flyger ni oftast?
  - Vilken höjd och hastighet flyger ni på?
- Hur tror ni drönaranvändning kommer utvecklas i framtiden?
  - Användningsområden?
- Hur mycket jobbar du personligen direkt med drönarna?
- **Märkning av drönare**
- Har ni i dagsläget något sätt att märka era drönare?
  - Standardisering
  - Efter syfte?
- Ser ni något behov för en standardiserad märkning av drönare?
  - Utmaningar?
- Vilka tekniska begränsningar eller utmaningar ser ni för implementeringen av märkning på olika typer av drönare?
- Vilka krav/rekommendationer/aspekter anser ni vara viktiga för märkning av drönare i offentlig verksamhet?
- Hur påverkar dessa operativa och regulatoriska aspekter?
- Vilka visuella element (t.ex. färg, ljus, mönster) anser ni vara effektiva för att öka identifierbarheten och förtroendet för drönare?

- Hur ser ni på möjligheten att införa en nationell eller europeisk standard för märkning av drönare och vilka fördelar eller utmaningar skulle en sådan standard innebära?
- Är det någonting du personligen tycker borde vara med, eller som borde undvikas när det kommer till märkning av Katlas drönare vid flygning för, till exempel, VGR/offentlig sektor?
- Vilka visuella märkningar har ni i nuläget?
- **Allmänhetens uppfattning av drönare**
- Hur upplever ni att allmänheten reagerar på era drönare
  - positivt/negativt
- Vilka faktorer spelar störst roll i acceptansen av denna teknik?
- Har ni stött på motstånd eller etiska frågor när det kommer till flygandet av era drönare?
- Finns det något vi inte har frågat om som ni anser är viktigt inom detta ämne?