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School of Transportation Sciences

Master of Transportation Sciences

Master's thesis

Public Perception of Drones versus Industry Expectation in Hasselt

Francisco Moreno López Pedraza

Thesis presented in fulfillment of the requirements for the degree of Master of Transportation Sciences, specialization Mobility Management

SUPERVISOR :

Prof. dr. ir. Ansar-Ul-Haque YASAR

MENTOR :

dr. ir. Wim ECTORS

2018
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Preface

This manuscript obeys to the completion of my dissertation thesis as part of the Master of Transportation Sciences with specialization in Mobility Management at Hasselt University. It is not so straightforward to translate my previous academic and practical experience into the field of mobility management. However, drones have proven to be an exception. Their accessibility, ease of use and versatility make them an excellent tool for, among many others, mobility-related applications. Its full potential is only now being unveiled so more aviation enthusiasts, including myself, are taking a closer look to this technology.

A great deal of uncertainty surrounds the growing usage of drones for civil applications because legislation, public allowance, commercial expectations and technological developments are not completely aligned with each other. The text clearly defines the problem that this represents for both citizens and industry players in Hasselt. Furthermore, a methodology to reveal and compare industry expectations against public perception is then suggested and implemented. The results of this study have the potential to trigger some organizations and further strengthen the drone industry in the region.

It has been difficult to fully grasp concepts about technological advancements that are not completely available yet and furthermore, ask different stakeholders their opinion about the subject. Nevertheless, it has been the most significant learning experience for myself so far. I consider having a sound knowledge about the value of drones for different civilian applications and I hope I can continue integrating this technology in other aspects of my life upon my graduation at Hasselt University.

I would like to thank the Transportation Research Institute from the university for offering this study program and allowing me to fulfill this truly meaningful milestone in my life. Thanks to my master thesis supervisor Prof. dr. ir. Ansar Yasar for guiding this work and for involving the university and me in such cross-border projects. Thanks to my internship supervisor Prof. dr. Javier Faulin for his additional supervision and his interest to extend the project at the Institute of Smart Cities in Pamplona, Spain. I am particularly grateful with my master thesis mentor, dr. Wim Ectors, for his constant feedback, supervision and genuine interest in this research work. Finally, thanks to my siblings for their motivation and encouragement; and to my parents for putting up additional efforts so that I could pursue this master's degree.

Summary

A drone refers to an aircraft without a human pilot on board. The development of unmanned aircraft has its origins in different military applications, but different civilian lines of work have started making use of this technology. Drones are a cost-effective solution for a wide range of business affairs because of the relatively minor modifications that they must go through to be used for different applications. For example, parcel delivery can be used for same-day-delivery of a good purchased online or to carry urgent medical equipment to a hospital. In Belgium alone, the economic potential of drone solutions was calculated to be worth 408.9 million euros annually (PwC Belgium and Agoria vzw/asbl, 2018).

The size, weight and capabilities of drones can vary tremendously so it is no simple task to categorize drones into a single classification scheme. In the European Union, a proposal to regulate drones based on the risks that they pose to other parties has been recently approved. Open, specific and certified are the three categories for low, medium and higher risk operations respectively. The development of drones is heavily driven by the industry for those that fall in the specific and, specially, the open categories.

As of June 2019, the transitional period to adapt the new drone legislation has begun. The regulation will be completed and fully applicable by 2022. Before this, some Member States of the European Union had specific regulations for drone operations. For instance, Belgium has its own regulatory framework that classifies drones into four categories: private, class 2, class 1B and class 1A. Only the classes 1B and 1A are suitable for commercial operations because of their altitude and weight allowances.

Safety and security concerns have quickly become apparent among the general public although the use of drones for some applications is to some extent supported. It is vital that the public's opinion is taken into consideration and that it becomes a driver for the drone industry, otherwise future legislations would leave substantial gaps between *wants* and *needs* from the industry; and allowances from citizens. Therefore, the goal of this investigation is to reveal and then compare the public perception and industry expectations regarding the use of drones for civil applications.

The investigation seeks to unveil elements that are essential to understand regarding developments that are likely to happen soon and concerns that are later reflected in public policies. For this, the first part of the investigation consists of exploratory research by means of in-depth interviews to the industry players in Hasselt and its neighboring cities. The second research tool is an online survey addressed to the general population of Hasselt in which their concerns and interests are polled. Furthermore, a preliminary

stated preference survey is conducted to analyze underlying reasons that drive their preferences.

Only three out of thirteen industry players were willing to participate. Results from the interviews show that the present regulatory framework in Belgium represents, to some extent, an obstacle for several drone users. Nevertheless, this was an exemplary approach given the youth of the drone market and the uncertainty that surrounds it. The adoption of drone-enhanced business solutions is an imminent reality so it should be in the best interest of the local government and of some companies to actively examine this alternative before their competitivity is at risk.

The online survey inquires for the citizens' perception regarding two drone services in high demand: parcel delivery and monitoring activities. However, their acceptance level is contrasted for two specific scenarios each i.e. between personal and medical deliveries; and between police surveillance and professional photography. Results show that citizens are not particularly in favor of either application, but they are willing to tolerate activities that directly foster the well-being of society. Sections of this survey were simultaneously carried out in Pamplona, Spain, where citizens had the same tendency to favor one application more than the other but at lower approval rates than in Hasselt.

The investigation has confirmed that the true capabilities of drones are not faithfully perceived by the general population. Given the polled drone-related cases, the most promising applications for drones are the transport of high-value goods between well-defined locations like business-to-business operations or between medical centers. Thus, there should be a gradual deployment of proven safe business cases as these will gradually shift perception from skepticism to approval. However, doing so would directly interfere with the anticipated growth for this market. The future of this research lies on using this investigation as input for polling a truly potential business case.

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1 Introduction

Drones are one of the most impactful and multi-dimensional emerging technologies of the modern era for they are a great technological tool to overcome multiple challenges for equipment manufacturers, investors and business service providers. The increasing demand for drones has not only led to cheaper and higher quality single drones, but also for a desire to develop a diversified portfolio of civil applications. Due to their global spreading trend, different regions are calling for thorough drone regulations.

The transportation research institute at Hasselt University (IMOB) will actively participate in the Urban Air Mobility Initiative which addresses the MAHHL (Maastricht, Aachen, Heerlen, Hasselt and Liège) cities' mobility needs, particularly in the flying vehicles sector. There are several industry and research stakeholders in Hasselt who make use of drones for the following purposes: security, event management, package delivery, image processing for traffic management, recreation and photography. To achieve optimal drone operation, it is crucial to have a framework that considers the citizens' fears, misunderstandings and willingness to coexist with drones.

Public perception research regarding the use of drones for different civilian applications in Hasselt has not been carried out yet, the *needs* and *wants* of the industry have not been carefully compared to what citizens would allow. Thus, revealing the perception and expectation of the different stakeholders would contribute to the design of a framework for civil applications of drones not only in Hasselt, but in the rest of the MAHHL cities as well. In addition, the obtained outcome could also be used for:

- As an input for possible flight plans in the city.
- Encourage innovative mobility solutions.
- Discover relevant factors for that influence the deployment of drones for civil applications.
- Serve as cornerstone for future research regarding drone applications.
- Reduce the breach of knowledge among citizens of Hasselt regarding this and other emerging technologies.

2 Research Questions

2.1 Central Research Question

- How does the public perception regarding the use of drones for civil applications differ from the expectations from drone industry players in Hasselt?

2.2 Sub-questions

- What is the effect of the public perception in the design of a framework regarding the use of drones for civil applications in Hasselt?
- What are the differences between the expectations of the different industry players in Hasselt?
- What are the key factors that could shape flight paths in the city for civil applications of drones?
- What are the key factors that slow down or speed up the use and deployment of drones in Hasselt for civil applications?

3 Literature Review

3.1 Drones

3.1.1 Definition

Drone shall mean an aircraft without a human pilot on board, whose flight is controlled either autonomously or under the remote control of a pilot on the ground or in another vehicle (EASA, 2015). Other terms used to describe unmanned aircrafts can be found in specific literature e.g. RPASs (remotely piloted aircraft systems), UCAV (unmanned combat aerial vehicle), UASs (unmanned aircraft systems) and UAVs (unmanned aerial vehicles). For consistency reasons, the term drone will cover all type of unmanned flying vehicles except for recreational model aircraft.

Most of the earlier technical development of drones derived into military applications such as surveillance and exploration; going all the way to airstrikes on targeted enemy areas. Over the last years, a great deal of military technical knowledge has been adapted for applications with civilian purposes. As a result, several types of drones were created to satisfy these needs e.g. for scientific, leisure or commercial purposes. Drones can be as small as an insect or as big as manned aircraft. They can hover or reach a speed of more than 1,000 km/h, be controlled e.g. via smart phone, tablet software or satellite communication, launched e.g. through a rocket, catapult or by hand and carry all kinds of materials (Juul, 2015). Due to technical innovations and lower production costs, the number of possible civilian applications for all types of drones is continuously on the rise.

3.1.2 Classification

A basic classification first distinguishes the mission of the drone: civilian or military (De Miguel Molina & Santamarina Campos, 2018). This paper focusses solely on civil applications where drones can be generally categorized by their performance characteristics. Features including weight, wingspan, wing loading, range, maximum altitude, speed, endurance and production costs, are important design parameters that distinguish different types of drones and provide beneficial classification systems (Hassanalian & Abdelkefi, 2017). Unfortunately, most drone classification schemes are not uniform between one another.

The most common threshold to assign a drone to one specific category is its weight range because it will be a good indicator of how big it is. Its size, on the other hand, will be useful to categorize drones according to their operational capabilities i.e. its applications. Hassanalian & Abdelkefi (2017) proposed a new classification for drones based on both its applications and the previously mentioned performance characteristics:

- Drones (UAVs) vary significantly in size and operational purposes. Therefore, they should be classified according to their capabilities. UAVs can be considered as horizontal take-off/landing, vertical take-off /landing, hybrid model (tilt-wing, tilt-rotor, tilt-body, and ducted fan), helicopter, heliwing and unconventional types (Hassanalian & Abdelkefi, 2017).
- A small drone (μUAV) is sufficiently big to be carried without difficulty by individuals. They are of particular interest for civil applications since they can be launched by hand and no additional take-off infrastructure is required.
- Micro drones (MAVs) have thrived in the last decade due to improvements in the field of microthechnology. They can fly at low speeds and altitudes for various applications, such as monitoring of dangerous locations, tracking specific targets or mapping (Hassanalian & Abdelkefi, 2017).
- Nano drones (NAVs) are especially small and light. Their flight range does not usually exceed more than 1 km at a maximum flight altitude of around 100 m.
- For Pico Aerial Vehicles (PAVs) and Smart Dust (SD) there are only a few types available. They are intended to work on a limited area for specific tasks like weather monitoring, air quality control and other sensing technologies.

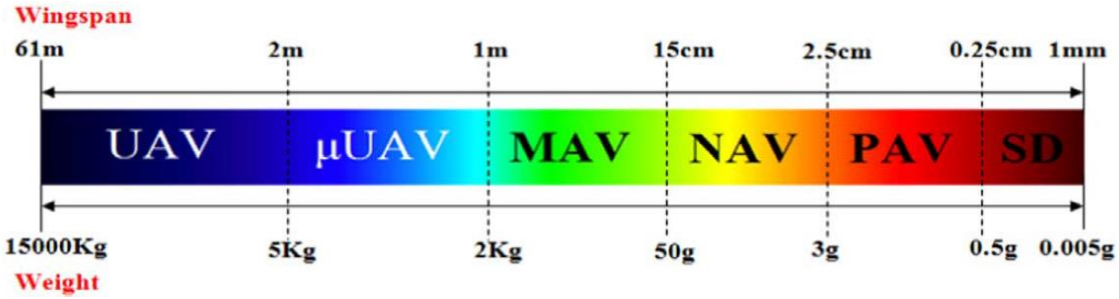


FIGURE 1 Weight and wingspan spectrum for drones (Hassanalian & Abdelkefi, 2017)

According to their propelling system, there are three main types of aerial drones: rotary wing, fixed-wing and lighter-than-air (PwC Belgium and Agoria vzw/asbl, 2018):

- Rotary wing drones are the most common drone configuration. Multirotor drones with four, six or eight propellers are the most cost-effective solution for most needs. They have great control, ease of use and can take off and land vertically. The main drawback is their short flight time (20-30 minutes) which decreases even more as different payloads to be carried are added. Because of the high-precision stabilization needs, rotary wing drones make use of electric motors as power source. The development of longer flight times has reached a

plateau so until a new power source comes along, we can only expect very small gains in flight time (PwC Belgium and Agoria vzw/asbl, 2018).

- Like with normal airplanes, the fixed-wing configuration uses a wing to provide lift and thrust to move forward. They can fly for up to 16 hours, cover longer distances while being exceptionally efficient. Depending on their size, they require a runway or a mechanism for both taking off and landing. Additional downsides are their difficult operation, inability to work over a confined area and higher costs.
- Lighter-than-air refers to blimp-like aircraft which can fly almost indefinitely because there is no need to generate lift. They benefit from silent flights, but they are very weather dependent and have little maneuverability.

3.2 Applications

3.2.1 Economic Potential of Drones in the European Union and Belgium

As most technology-oriented industries, drones have a majorly problem-driven evolution. Military applications set the tone for the research and development of drones. However, the development of small and cost effective drones has led to a variety of uses that businesses and public institutions are starting to leverage to reduce risk, optimize processes and drive new forms of customer and societal value (SESAR Joint Undertaking, 2016). The market segment for drone usage increased to incorporate commercial applications after it was only for military and leisure purposes. The military segment will continue to be the biggest market in terms of value, but it is the commercial market segment that will have the greatest expansion as Figure 2 illustrates.

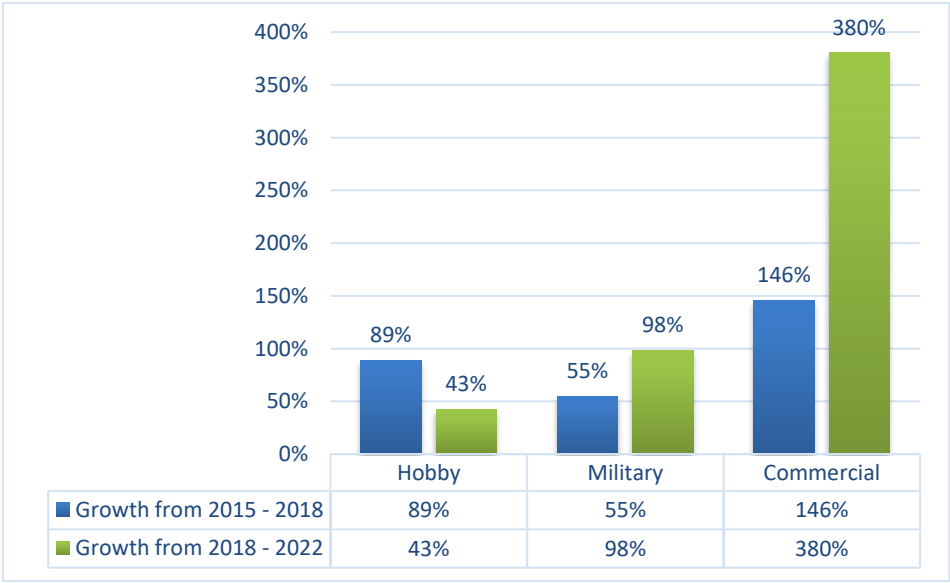


FIGURE 2 Estimated growth per segment 2015-2022 (De Miguel Molina & Santamarina Campos, 2018)

Different problems can make use of similar technology with minor alterations instead of a much longer complete development cycle i.e. problems can be solved by connecting the pieces of a puzzle that already exists. For instance, a mounted camera suffices the need of safely inspecting an otherwise inaccessible zone for a human e.g. power lines or a mine field. The computational power is miniaturized and becoming less costly every day. Drone technology becoming accessible is the reason for the rapidly expanding market, and explains the use of drones in media, advertising, police work, firefighting, agriculture, construction, energy, transport and more (PwC Belgium and Agoria vzw/asbl, 2018).

Operations among stakeholders, refinement of legislations and an enhanced collection of data, in comparison of traditional manned aviation, will impact the economic growth on businesses and general population. The drone industry in the European Union (EU) has a clear upper hand with respect to the rest of world greatly because of its regulatory framework. Studies from Sheahan (2013), forecast that worldwide expenditures in the market of drones will double from EUR 5.7 billion to EUR 10.3 billion per year by 2020. Main drivers for further market uptake are advances in payload transport capability, sensing, radars and other geographic location technologies.

In a study by PwC Belgium and Agoria (2018), over 50 select users and stakeholders for commercial applications of the drone industry in Belgium were interviewed to provide an overview of their vision for the drone industry and to assess the economic potential of drone solutions in Belgium. The total addressable was calculated to be worth 408.9 million euros annually. Table 1 breaks down the value for each industry being infrastructure the most significant one with 176.3 million euros which represents 43% of the total value.

Industry	***Value (M€)***
Agriculture	29.0
Energy & Utilities	23.3
Entertainment & Media	45.7
Infrastructure	176.3
Insurance	40.6
Security	30.9
Telecom	19.6
Transport & Logistics	43.6
Total	**408.9**

TABLE 1 Estimated value of drone solutions per industry sector in Belgium (PwC Belgium and Agoria vzw/asbl, 2018)

3.2.2 Potential Commercial Sectors

i. Agriculture

Drones can be used in precision agriculture for obtaining rich frequent data and for light payload transportation. The long-distance surveillance capabilities of drones allow farmers to decide in advance the treatment for their crops e.g. soil analysis, disease detection, harvest estimation and scarecrow duties. On the other hand, payload-related uses include spraying and seeding activities. Thus, drones are a feasible option to meet high productivity demands for the upcoming decades. An estimated 150,000 drones by 2035 and 145,000 by 2050 are to be used across Europe's farms (SESAR Joint Undertaking, 2016).

The deployment of drones for agriculture is experiencing a relatively low maturity speed in comparison to other emerging technologies. Legislation in some Member States of the EU and limited technological capabilities of drones are failing to convince farmers to make use of this technology. For example, the European regulatory environment impedes aerial application of sprays and light payload drones are only cost-effective on small high market sections. This naturally leads to a minimal use of drones in agriculture.

ii. Energy

This industry is dedicating a significant part of its budget to the use of drones mainly for short- and long-range maintenance issues such as leakages and detection of temperature differences. The frequency intensity and quality of inspections are boosted so drones can offer a drastically lower cost in comparison to traditional manned aircraft or driving vehicles that travel along the lines. Additionally, efforts are being made to harvest wind energy from high altitude winds by means of tethered drones. If this more efficient form of producing Europe's renewable energies can capture 10% of the additional capacity needed, the emergence of approximately 5,000 tethered drones flying at 450 meters altitude by 2035 could be seen (SESAR Joint Undertaking, 2016). Social resistance is limited since operations take place on specific facilities or on areas of no concern for regular citizens. The outlook calls for 30,000 drones by 2035 and 35,000 drones by 2050 (SESAR Joint Undertaking, 2016).

iii. Security

Various security and safety needs arise as different threats become more elaborated. Drones can offer proactive security solutions like facial recognition, assist first response teams, site monitoring and in general, address hazards in a more effective way. Their closest counterpart, the helicopter, has huge operation and cost limitations so they are not feasible whatsoever for most of the previously mentioned purposes. Although they

only serve as a tool which always calls for human interaction, it must be ensured that customer requests are met within a legal framework that also responds to the use of drone for malicious intentions.

iv. Parcel delivery

Drones have the potential to be a truly cost-effective solution for parcel delivery. Their accessibility, speed, operation costs and low emissions are translated as an area of opportunity for custom-made dispatch solutions. The demand of high-value goods and services is driving this type of premium delivery service. For example, same-day deliveries or urgent medical supplies have a much higher willingness to pay than other daily goods. On the other hand, the high operation costs can be allotted among a larger fleet of drones that is operated by few pilots in a semiautonomous environment.

The idea of using drones for parcel delivery because of the benefits that they provide is quite straightforward but the current regulations, carrying capabilities and even the most trivial aspects of package delivery are yet to be resolved. The outlook is for 70,000 drones to deliver some 200 million light weight parcels across Europe in 2035. Additionally, larger freight aircraft that currently represent a fleet size of less than 1,000 may also become unmanned by 2050 (SESAR Joint Undertaking, 2016).

v. Construction and infrastructure

Drones are fit for hazardous work, but also for collecting accurate data so their use in civil engineering has been carried out for some time already. Even if some of the applications overlap with the energy sector, the business case for this industry, as noted before, is equivalent to 43% of the total projected market share in Belgium (PwC Belgium and Agoria vzw/asbl, 2018). For construction and infrastructure applications, drones offer real-time monitoring of construction sites i.e. no actual access to the site is required for some tasks. Once drones can operate closer to populated areas, the number of drones estimated to serve over 2 million construction sites in Europe is 35,000 (SESAR Joint Undertaking, 2016).

vi. Telecommunications

U-Space is the term adopted by the EU Commission for a set of services supporting low level drone operations. A fully automated infrastructure will provide drone pilots with all the information needed to conduct a safe operation, including air traffic management, and will ensure that drones do not enter any restricted zones. U-Space will be gradually deployed, starting in 2019 (EASA, 2018). The telecom industry will be able to benefit itself not only from previously mentioned applications, such as maintenance and inspections, but mainly from its kingpin position in the actual development of U-Space.

vii. Media & Entertainment

Drones offer creative new angles in audiovisual production and can have wide usage in the advertising industry (PwC Belgium and Agoria vzw/asbl, 2018). Aerial photography by the film industry has been a major driving force for the development of drones for civilian purposes. They are increasingly popular for their much lower costs and flexibility. Sport channels, film making and news coverage are expected to become the greatest users of this technology in a short-term period.

3.3 Legislation

The technological progress of drones in the last decade has been leading to a large introduction of drones for civilian applications into the market. Consequently, the situation calls for regulatory solutions for the many challenges and legal vacuums that are being generated. Some of these challenges include safe operation of drones, environmental preservation and interaction with infrastructure. Likewise, privacy is a topic often addressed by different stakeholders. Involved parties go beyond drone operators, pilots and the general public i.e. aviation authorities, manufacturers and air navigation service providers play a major role too.

As with any other vehicle of flying nature, drones could be translated as a manifest threat to third parties in both airspace and on the ground. Hence, the number of countries that establish procedures to lessen this threat is continuously increasing. A study by Stöcker et al. (2017) revealed that drone regulations are subject to national legislation and focus upon three key aspects: targeting the regulated use of airspace by drones as they pose a serious danger for manned aircrafts, setting operational limitations in order to assure appropriate flights and tackling administrative procedures of flight permissions, pilot licenses and data collection authorization.

International efforts to standardize regulatory and legislative aspects regarding drone operations do exist. This is the case of regions like the EU where the cross-border cooperation sets the standard for all its Member States although different legislations can be adopted by each country. The global overview of drone regulations, as per October 2016, reveals that nearly one-third of all countries have respective regulatory documents in place. Approximately half of all countries do not provide any information regarding the use of drones for civil applications. However, this does not imply that flights are per se prohibited or allowed. Announcements for pending drone regulations were found in 15 countries. In 13 cases, the information of relevant precompiled lists could not be validated, and no documents were found that prove the existence of particular regulations (Stöcker, Bennett, Nex, & Gerke, 2017).

3.3.1 Drone Regulation in the European Union

The International Civil Aviation Organization (ICAO) serves as the governing body that regulates all civil aviation including the use of drones in the EU. The responsibility for civil drones of over 150 kg is left to the European Aviation Safety Agency (EASA) and this type of drones is regulated in a similar way to manned aircraft (Herrmann & Esq., 2017). However, the current regulatory system for drones is based on fragmented rules, with many Member States having already regulated or planning to regulate some aspects of civil drones with an operating mass of 150 kg or less.

There is a prevailing desire for having harmonized legislations among Member States. The EASA is taking care in submitting such regulations at the request of the European Commission. In a "Technical Opinion" in December 2015, the EASA presented "basic principles" for a "risk-based approach" upon which the regulation of the civilian use of drones will be based. It sets out three categories of operating regulations, increasing progressively in severity and no longer based primarily on the weight of the drones (Nader & Reichert, 2016).

Drones will operate in the same airspace as general aviation (GA), so GA community concerns in terms of air risk or airspace occupation can be understood. Nevertheless, the Opinion prepared by EASA addresses this issue accordingly and includes several provisions to reduce the risk both on ground and in the air (EASA, 2018). The new approach takes into consideration the variety of applications the drones have. For example, a big drone flying above an open field or the sea poses almost no threat in comparison to a small drone on top of a crowded area. The three categories proposed by the EASA for risk-based regulation on the operation of drones are:

i. Open Category for Low Risk

Drones that represent a relatively low risk to third parties are part of this category. Safety is guaranteed by means of the following operational and mass regulatory principles:

- Maximum operating weight of 25 kg.
- Authorities can restrict or completely forbid them on established areas like airports, helipads, power plants or dense cities.
- By design, the maximum height that drones can achieve is set to 150 meters.
- Flights over crowds are not permitted. Is it not allowed to fly within 50 meters of people, property or vehicles.
- The direct visual line of sight must always be kept by pilots.
- Police forces of each Member State are accountable for supervising and executing these regulations.

ii. Specific Category for Medium Risk

Drones that operate outside any limitation of the open category will be subject to the more rigorous regulations of the specific category:

- The authorization and requirements for operating a drone are given by a national aviation authority i.e. by each Member State.
- Operators must perform a risk assessment than contemplates third parties on both ground and air.
- Operators must also propose a manual of operations with measures to mitigate the risk.
- Pilots must have enough qualifications and training for the drone operations.

iii. Certified Category for Higher Risk

The applications of the large drones that are found in this category are related to international freight transport as well as transport of people. National aviation authorities play a major role since the risks and requirements in this category can be compared to those of manned aviation:

- The EASA and the corresponding national aviation authorities must certify each drone as air-worthy.
- National aviation authorities certify the airworthiness of each drone, certify operators, grant licenses for pilots and regulate aspects corresponding to the lifecycle (design, production, maintenance and involved staff) of drones.

In June 2019, these new common European rules on drones were adopted by the European Commission. The new rules will replace existing national rules in EU Member States. While the new EU regulation was adopted almost immediately after its publication, the transitional period will begin one year after its publication i.e. June 2020. By 2022 the transitional period will be completed, and the regulation will be fully applicable (EASA, 2019).

3.3.2 Belgian Drone Legislation

The Belgian Civil Aviation Authority (BCAA) published the Royal Decree of April 10, 2016 "concerning the use of remote-controlled aircrafts in the Belgian airspace", which regulates drone operations. It normalizes the os of private and professional use of drones, introduces a registration obligation for drones, regulates the certificates and defines the authorized take-off/landing spots for registered drones. Moreover, manufacturers of drones need technical requirements, the delivery of conformity certificates, the drafting of a flight manual and safety analysis reporting, maintenance requirements, flight tests, and so on (De Miguel Molina & Santamarina Campos, 2018). Table 2 summarizes the requirements for each of the

operations distinguished by the BCAA before the recently approved European Legislation is fully embraced.

Class 1B operations have a clearance of more than 50 m of people and/or goods on the ground while class 1A operations allow drones to be closer than 50 m to people and/or goods on the ground as well as over them or around an obstacle closer than 30 m. All operations that are not covered in the previous categories are to be considered as Class 1A operations. Therefore, only classes 1 and 2 can be used for commercial or professional purposes. The use of completely autonomous aircrafts is strictly forbidden.

	PRIVATE	**MODEL AIRCRAFT**	**CLASS 2**	**CLASS 1B**	**CLASS 1A**
MAX. HEIGHT	10 m	Specified in Aeronautical Information Package	≈ 45 m	≈ 90 m	≈ 90 m
MAX. WEIGHT	< 1 kg	≦ 150 kg	≤ 5 kg	< 150 kg	< 150 kg
REMOTE PILOT'S AGE	All ages	All ages	≥ 16 yo	≥ 18 yo	≥ 18 yo
REMOTE PILOT QUALIFICATION	None	None	Theoretical training + Practical skill test	Theoretical training + Practical skill test	Theoretical training + Practical skill test
REGISTRATION OF THE DRONE	No	No	Yes	Yes	Yes
CERTIFICATE OF CONFORMITY FOR DRONE	No	No	No	No	Yes
OPERATIONS MANUAL DRAFTED BY THE OPERATOR	No	No	No	Yes	Yes
RISK ASSESSMENT BY THE OPERATOR	No	No	No	Yes	Yes
DECLARATION OF COMPLIANCE MADE BY OPERATOR	No	No	No	Yes	No
AUTHORIZATION TO OPERATE RECEIVED FROM BCAA	No	No	No	No	Yes
FLIGHT NOTIFICATION TO BCAA BEFORE START OF FLIGHT	No	No	No	Yes	Yes

TABLE 2 Regulatory framework in Belgium

3.4 Perception of Drones for Civil Applications

As it can be observed in previous sections of this paper, the drone industry affects more than consumers and suppliers of drones either as goods or as services. Research done by De Molina's & Santamarina Campos (2018) reveals that the main stakeholders that should be considered are:

- Manufacturers: The producers should comply with EU country's requirements regardless if the final product is from an EU Member State or not.
- Operators, pilots and users: End-users and other people who make use of drones for purely professional and commercial purposes as well as people who do not hold a license and the drone is only used for leisure activities.
- The economy: Innovations in the drone industry are highly driven by the economy. Different lines of work will reach drones for lower costs and added value.
- General public: The general population's safety is also jeopardized due to the increased use of drones even though they might have a non-active role in the deployment of this technology in daily life. An adequate legislation will be the tool that safeguards public's concerns while entitling further developments of the drone industry.

The public attitude towards drones may be a mix of attraction to this new technology and multiple concerns about safety, security and privacy (EASA, 2015). The public has generally had a good impression of drones in particular for the development of commercial and leisure applications i.e. civil applications. Figure 3 exemplifies some accepted uses of unmanned aerial vehicles. Some are those related to health (transport of blood and defibrillators), humanitarian actions (drones for social goods and humanitarian purposes), shipping products to customers (Amazon's fleet of drones), or ecological applications (surveying fauna and forest monitoring), among others (De Miguel Molina & Santamarina Campos, 2018).

Some incidents where drones have somehow altered the public's attitude which is reflected in more and more critical articles in the media (EASA, 2015). For example, in December 2018, a series of drone sightings disrupted 120,000 passengers' flights at Gatwick Airport, near London. Police said they believed the incident was a deliberate attempt to disrupt the airport's operations, but unlikely to be terror-related. The incident highlighted the authorities' inability to stop illegal drones flying as the vulnerability of Britain's second biggest airport became apparent (Topham, Weaver, & Siddique, 2018). Lessons learned from such events will be key to successfully address safety, security and privacy concerns related to the drone industry.

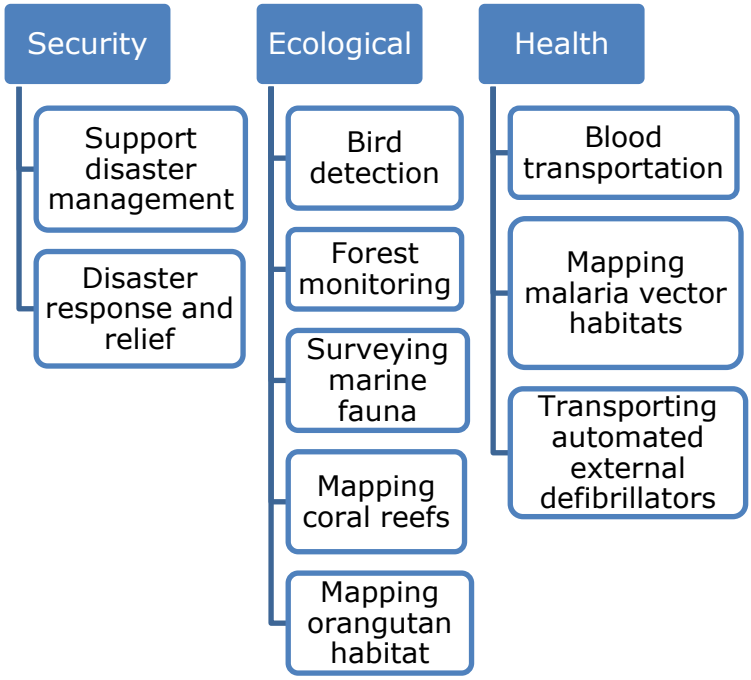


FIGURE 3 Accepted drone uses(De Miguel Molina & Santamarina Campos, 2018)

4 Research Methodology

The introduction of new technologies or products often represents an ambiguous problem for which not much is known regarding how does the procedure to solve it should look like. For example, the increased use of drones for civil applications has arisen a number of little understood issues, such as public acceptance and exemplary regulatory frameworks. On the other hand, in problems that are defined to some extent, the variables that are relevant for dealing with the problem are usually known but its relation is not. Drone manufacturers, operators, pilots and end-users drive the drone industry based on aspects like applications, economic impact, technical capacity and legislation allowance, yet the way these variables impact their projections is somehow uncertain.

Exploratory research can provide key elements for establishing research priorities and to transform an ambiguous problem into a well-defined one. In addition, the scope of the studied topic has the potential to generate hypotheses and measurement scales based on the results of an exploratory research. In-depth interviews are the selected exploratory research tool to comprehend the expectations from the drone industry. In-depth interviews consist of interviewer asking an interviewee a number of refined questions. In-depth interviews are unique in that they allow for probing on a one-to-one basis, fostering interaction between the interviewer and the respondent (Sarstedt & Mooi, 2014).

Descriptive research focuses in one or more variables and it describes situations, characteristics and market segments. Such descriptive research often builds upon previous exploratory research (Sarstedt & Mooi, 2014). Previous sections of this paper implicitly denote that the problems in this research are the public perception towards the use of drones, expectations from industry players and drone usage legislation. These variables will serve as an input for a survey regarding the perception of drones by the citizens of Hasselt.

The type of data that is collected is primary data. It serves the specific purpose of this study, which has not been carried out in an analogous manner in another site, so that secondary data could be consulted instead and then be compared to the applicable situation that is being dealt with. Its primary drawbacks are the collection time and the fact that the data is not so credible since it does not come from a relevant body or authority like the EASA, ICAO or the Belgian Drone Federation.

The studied variables are of (mostly) qualitative nature. A qualitative variable is one in which the naturally occurring levels or categories taken by that variable are not described as numbers but rather by verbal groupings. For such variables, comparisons are based solely on the *qualities* possessed by

that particular variable (Hensher, Rose, & William, 2005). Quantitative data are presented in values, whereas qualitative data are not and can take many forms such as words, stories, observations, pictures or audio (Sarstedt & Mooi, 2014). The distinction between one another is not so straightforward because quantitative data is based on a qualitative logic. The answers and attributed can be coded to turn it into quantitative data. Rather, what is important is how well qualitative data have been collected and/or coded into quantitative data (Sarstedt & Mooi, 2014).

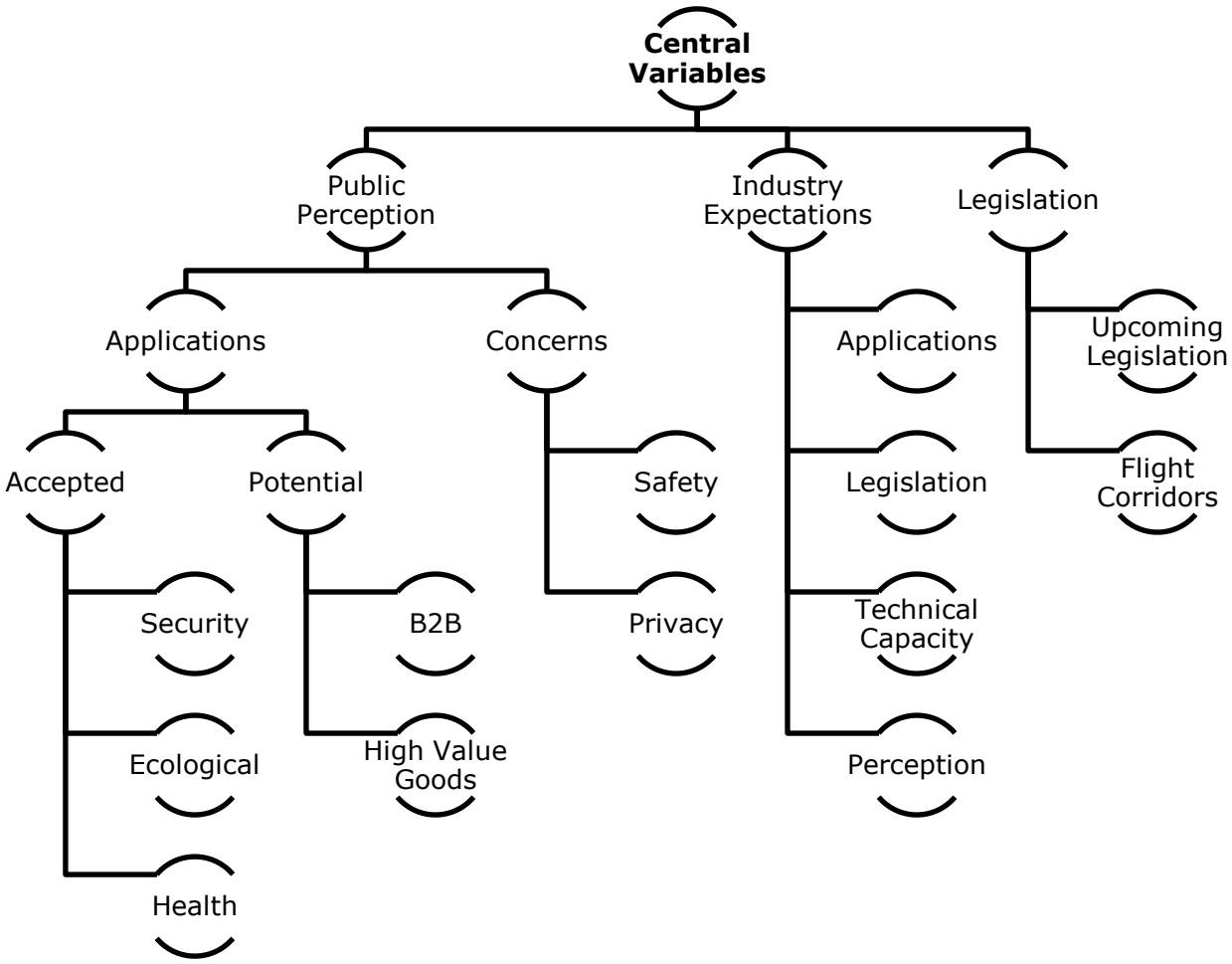


FIGURE 4 Schematic overview of central variables

4.1 In-depth Interviews to Industry Players

In-depth interviewing is a qualitative research technique that involves conducting intensive individual interviews with a small number of respondents to explore their perspectives on a particular idea, program or situation (Boyce & Neale, 2006). Different parties can be asked about a certain situation that concerns them. Thoughts, experiences, expectations, outcomes and other issues can be adequately explored with in-depth interviews.

Interviews are additionally used to provide all the necessary pieces of information to paint the whole picture of what is happening and its causes. In-depth interviews should be used in place of focus groups if the potential participants may not be included or comfortable talking openly in a group, or when one wants to distinguish individual (as opposed to group) opinions about the program. They are often used to refine questions for future surveys of a particular group (Boyce & Neale, 2006).

The greatest advantage of in-depth interviews is that, in comparison to other data collection methods, they provide information with the highest degree of detail in a less tense environment which may allow respondents to agreeably talk with the researcher about the program unlike completing an anonymous survey. Nevertheless, some drawbacks can be found when making use of in-depth interviews:

- Time constraints: Finding a time and place for the interviewer and the respondent to meet and carry out the interview can be laborious. On the researcher's side, analyzing data and disseminate findings are time-intensive activities.
- Prone to bias: Different stakeholders can have different points of view regarding the issue in matter. While answering, respondents might defend their position regarding a program leading to biased answers.
- Interviewing techniques: The use of effective interviewing techniques is crucial to obtain the most detailed and rich data from a respondent.
- Not generalizable: There is no sampling technique that exactly determines the sample size and methods so making general statements is not achievable. However, they do provide additional valuable information for supplementing data coming from other sources.

The interview template in Annex 9.1 accentuates the central variables related to industry expectations in Figure 4 i.e. (future) applications, legislation, technical capacity and perception regarding the work of industry players in Table 3 by means of eleven questions. These questions implicitly ask for their take on the role of Hasselt as a drone-facilitator and for relevant first-hand experiences. It is not expected that respondents give profound answers to some of the questions because of their daily activities do not necessarily

reflect upon these questions. Some questions can be ruled out in advance or adapted to the core businesses of the different organizations.

Language barriers could play a major when performing the interview. All respondents will be addressed in English even if none of them are native English speakers and it will be unknown until the time of the interview if it is too complicated to carry out the interview in a lingua franca. To solve this issue, the questions might be changed from an academic language to a more colloquial one while maintaining the core of the interrogation.

At the beginning of the interview, respondents are informed with goal of the research once more. Additionally, informed consent is dealt with by asking permission to record an audio of the interview which will be used to further analyze their responses at a later instance within the academic purposes of this research. Respondents can opt out of being recorded or from the whole interview as well.

4.1.1 Potential Respondents

Table 3 provides an overview of the thirteen industry players considered for in-depth interviews. As of January 2019, nine bodies have operations in Hasselt while the rest are in the neighboring cities of Sint-Truiden and Genk. The scope of the companies outside of Hasselt have the potential to provide relevant insights regarding the industry expectations. Together, Euka and Droneport (in Sint-Truiden), provide expansion conditions for the drone industry in terms of infrastructure and know-how. On the other hand, reaching out to Syntra's Drone Pilot Academy (in Genk) is done to gain perspective in the educational aspect of drones.

Most companies based in Hasselt and its surroundings offer drone-based products and services in a wide range of civil applications. However, the Jessa Hospital (Jessa Ziekenhuis) is the only body that makes of a drone-related service i.e. it is a consumer. The rest of the companies are naturally not restricted to only offer their solutions in the city of Hasselt. The hospital is of great interest because it looks for a particular business solution that deals with fixed flying corridors between two locations, transportation of a small highly-valued payload for a socially accepted application a per Figure 3.

All bodies will be contacted and asked if they are willing to participate; the interview will be then arranged for those who want to. The first contact with all potential respondents was done via e-mail and they were briefed about the purpose of the research plus the importance of their participation. In case of no response, friendly reminders via telephone and e-mail take place.

Company	Business Innovation
DroneMatrix Herkenrodesingel 4/1, 3500 Hasselt Francis Knudde – former CCO	Create highly innovative drone-based products and services that add value in terms of safety and efficiency.
Droneport & EUKA Lichtenberglaan 1090, 3800 Sint-Truiden Kevin Logist – former Community & Innovation Manager	DronePort is setting up an ecosystem, infrastructure and services to facilitate research, innovation and entrepreneurship in the aerospace and drone market. EUKA supports in the acceleration, expansion and deepening of the drone industry. Front office for multiple companies and organization involved in terms of legislation, matchmaking, idea to market and global market.
Acrolec Diepstraat 37, 3511 Kuringen Mark Bollingh – Founder info@acrolec.com	Acrolec is a technology agnostic UAV consulting company with an exclusive focus on drone intrusion prevention and protection.
Sky-view Paul Bellefroidlaan 4c/9, 3500 Hasselt Patrick Vannut – Pilot patrick.vannut@skyview-drones.be	Aerial photography and video: Control of buildings and/or infrastructures, thermal control, agriculture, follow-up of construction sites, insurance and damage after accident or severe weather, real estate.
Sky-watch Maastrichtersteenweg 195, 3500 Hasselt Bart Kerkhofs – Pilot info@skywatch.be	Aerial photography and video: Video in 4K, photography in high resolution, only pilots with a license, trained observers.

Syntra Limburg Kerkstraat 1, 3600 Genk Ludo Guisson – Head of Training Drone Pilot Academy ludo.guisson@syntra-limburg.be	Drone Pilot Academy: train full-fledged drone pilots who want to undertake a commercial activity and thus contribute to the drone industry.
Cegeka Universiteitslaan 9, 3500 Hasselt Erwin Nouwen – COO Professional Services erwin.nouwen@cegeka.com	Cegeka helps companies to stand strong and grow in a digital world. This is possible thanks to advanced IT solutions, a strategic way of thinking and a practical approach. Tailored IT solutions to business goals that create added value.
Airobot Lichtenberglaan 1090-201, 3800 Sint-Truiden Jan Leyssens – Managing Director jan@airobot.eu	Safety and convenience equipment that increase drone performance.
Jessa Ziekenhuis Stadsomvaart 11, 3500 Hasselt; Salvatorstraat 20, 3500 Hasselt Charlotte Van der Auwera – Policy Advisor charlotte.vanderauwera@jessazh.be	The Jessa Hospital in Hasselt wants to use drones to quickly transport medicines or blood and urine samples between their two locations in Hasselt. The first test flights are scheduled in the summer of 2019.
Argeye Drone Solutions Zonhovenstraat 23, 3500 Hasselt Piet Leyden – Pilot info@argeyedrones.be	Argeye Drone Solutions focused on 3 domains: • Videography in collaboration with Earl Fence • Certificate Photogrammetry (Stock pile measurement, 2D and 3D possibilities) • Inspections on request

PXL University College (AI & Robotics Lab) Kempische Steenweg 293 3500 Hasselt Tim Dupont – Researcher tim.dupont@pxl.be	PXL AI & Robotics Lab is active in the fields of Computer Vision, Robotics and Artificial Intelligence. The main focus is programming Robots and Vision Systems. The fundaments of the AI & Robotics are laid out in three research groups: Drones@PXL, FocusVision and AI&Robotics.
Hasselt City Limburgplein 1, 3500 Hasselt Leen Scheelen – Coordinator European Projects leen.scheelen@hasselt.be	Representative for Hasselt City regarding the Urban Air Mobility Initiative for the MAAHL cities.

TABLE 3 Overview of industry players

4.2 Online Survey

The goal of the survey is to understand what the public perception in Hasselt is regarding civil applications that are likely to happen soon and safety concerns that are later reflected in public policies. In addition, three different aspects are considered to refine the goal of the survey and the design of the questionnaire:

- Required analyses for the study: Descriptive analysis is not deep understanding of personal perspectives of a phenomenon, but a more general understanding of patterns across a population of interest (Loeb, et al., 2017). A good description of the public's perception yields appropriate results that are useful for the research questions or future law-making.
- Type of data required: Despite the qualitative nature of the public's perception, obtained data will be treated as quantitative data following the embedded collection and coding procedures.
- Desired type of recommendations for this study: Descriptive analysis can stand on its own as a research product, such as when it identifies phenomena or patterns in data that have not previously been recognized (Loeb, et al., 2017). This output can be suggested or reinforced as key factors that influence flight paths and the further deployment of drones.

4.2.1 Sampling

Hasselt is the capital city of the Belgian province of Limburg. The city center is surrounded by an inner and outer ring road that keep traffic outside the center. There are also several important corridors to Tongeren (20 km), Sint-Truiden (18 km), Genk (14 km) and Diest (30 km); as well as to the Dutch cities of Maastricht (40 km) and Eindhoven (65 km). The city has roughly 77,000 inhabitants and eight municipalities for a population density of 754 inhabitants per km^2 (Visit Hasselt, 2016). Projections for 2035 estimate that the population will increase to 83 thousand inhabitants (Stad Hasselt, 2019).

It can be observed in Table 4 how Hasselt and Kuringen are the predominant municipalities accounting for roughly three quarters of the total population. The remaining quarter is fairly distributed between the rest of the six municipalities. As shown in Figure 5, the age of the population is evenly spread, with values of 12% or 14% of the population total, across the five central ten-year-levels that range between 25 and 74 years old. The two levels with the youngest age ranges i.e. minors and young adults, account for 26% of the total population with 18% being underage while the two topmost elderly levels account for 12% of the total population (Stad Hasselt, 2019).

The total population is almost equally distributed amongst men and women with 49% and 51% of the population total respectively (Stad Hasselt, 2019). Residential buildings make up 97% of the constructions in the city as Figure 6 illustrates. Apartments i.e. enclosed housings represent 38% of the residential buildings whilst single-family houses are the prevailing housing type with 59%. Furthermore, single-family houses are distributed alike among detached, semi-detached and terraced houses.

Municipality	Population (2015)	% Population (2015)
Hasselt	47,971	62.85%
Kermt	4,501	5.9%
Kuringen	11,137	14.59%
Sint-Lambrechts-Herk	4,593	6.02%
Spalbeek	2,107	2.76%
Stevoort	3,726	4.88%
Stokrooie	1,990	2.61%
Wimmertingen	306	0.4%

TABLE 4 Population distribution per Municipality (Stad Hasselt, 2019)

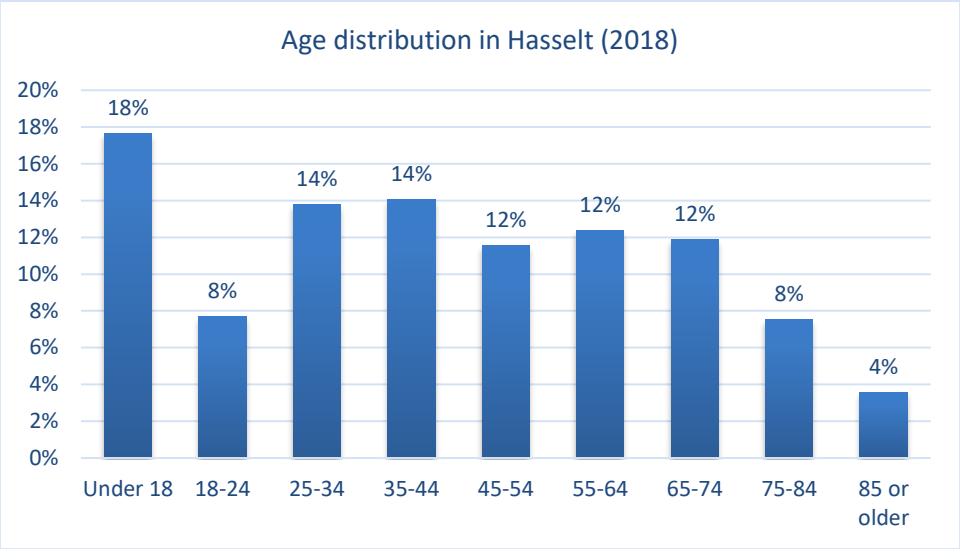


FIGURE 5 Age distribution in Hasselt (Stad Hasselt, 2019)

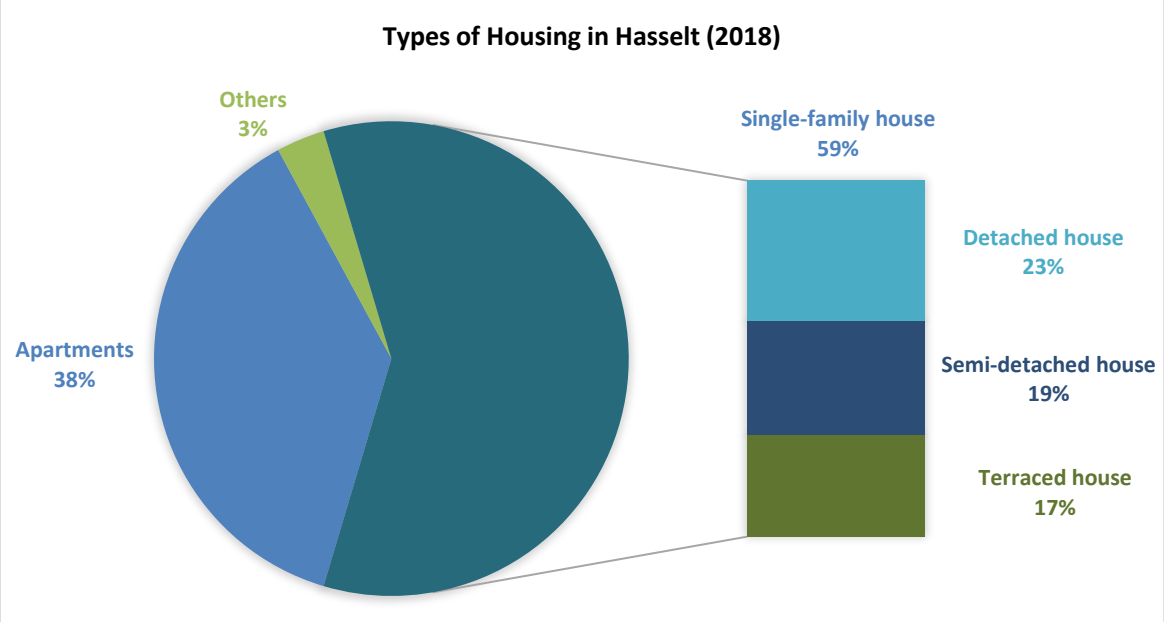


FIGURE 6 Housing types in Hasselt (Stad Hasselt, 2019)

The questionnaire was built and spread using the online survey software Qualtrics. IMOB and Hasselt City will provide further help spreading the survey by inviting citizens to access the survey on their organization websites as well as on their social media pages. Moreover, the survey will be spread amongst acquaintances from the author student. This corresponds to a convenience sampling mechanism because it is only based on analyzing responses by those who are accessible via internet or social media and that are willing to participate.

The results are prone to not accurately represent the previously described population i.e. selection bias because of under-coverage and voluntary

response bias issues. However, given the limited research resources and a very large population, the use a nonprobability sampling method such as this is enough for collecting information from the target population. Ideal sample size is calculated with Equation 1 where:

- E = Expected absolute allowable error in the mean.
- $z_{\alpha/2}$: Value of normal deviate at considered level of confidence.
- σ = Expected standard deviation of the variable in the group.

$$n = \frac{(z_{\alpha/2})^2 \sigma^2}{E^2}$$

EQUATION 1 Ideal sample size

Margin of error is set at $\pm 5\%$ and the Z-score for a 95% confidence level is 1.96. Finally, the standard deviation is set at 0.5 for lack of historical values. This is the most conservative procedure where n takes its highest value which might yield a larger than necessary value, but it at least ensures that the size of the sample will not be too small. After computing, this gives an ideal sample size of $n = 384.16 \approx 385$ respondents.

4.2.2 Survey Design

A quantitative survey is an adequate data collection tool for obtaining opinions and knowledge about a given topic for large populations. The information can be then summarized by means of tables, graphs and other statistical analyses. The survey features non-forced responses and a progress bar for both survey enjoyment and focus. All questions were designed and composed in English. IMOB kindly took care of translating the questionnaire to Dutch, the official language in Hasselt. Respondents could switch between languages at any given time without affecting response collection. The aspect of the survey when answering with a smartphone can be observed in Figure 7. The complete questionnaire in English can be found in Annex 9.2 along with the coding values for the answers.

FIGURE 7 Online survey style on smartphone

The breakdown of the survey blocks is as follows:

I. Consent

The opening survey block introduces the respondent to the survey itself. It contains not only a brief summary of the purpose of the study, but also some practical affairs regarding the type of questions that will be asked as well as the approximate time that it takes to complete them. To boost response rate, two movie tickets will be raffled amongst the respondents who enter their e-mail addresses at the very last question which allows to leave comments. This raffle is also explained in this section.

Very important is how this block also described the approach related to the informed consent of the participants. The survey will be terminated if they do not consent that any personal data collected may be used for the research purposes. In addition, it is clearly stated that they can terminate their participation at any given time. No additional personal data is collected without the respondents' knowledge. This includes anonymizing responses in Qualtrics i.e. no personal information is recorded and contact association is removed e.g. IP addresses.

II. Screen for citizens in Hasselt

Although the entire research is primarily addressed to the citizens of Hasselt, it will not be exclusive in this study for them to be the only valid respondents. For those who are citizens of Hasselt, this section draws a clearer picture of their municipality of residence.

III. Residence Demographics

A potential explanation for the approval of drone usage lies on the population's demographics. Of great relevance for this study are the residence house features i.e. living area and housing type. For example, given a positive acceptance for the use of drones in urban areas for single-family houses detached from any other houses, such an environment might be favorable for the elaboration of flight corridors. Further on the block, occupation, education level and income are inquired.

IV. Time intervals at home

The objective is to filter those individuals who have regular weekly schedules to find out the time that they (do not) spend at home. Since citizens might not prefer to hear or see drones while they are at home, it is crucial to find out the time windows that suit potential drone organizations to carry out their activities. Likewise, deliveries by means of drones might only occur if there is someone in the residence to sign-off the package.

V. Last basic demographics

Unwind the respondents by asking age range and sex before jumping into the main body of the survey.

VI. Introduction main body

Clarify the type of questions that compose the main body of the survey i.e. poll the level of acceptance for given drone applications and select between two different scenarios according to their level of tolerance towards these.

VII. Introduction parcel delivery

Truly brief introduction of the use of drones for parcel deliveries with two images that depict the appearance of this technology.

VIII. Concerns personal package delivery

A drone that carries medical equipment is technically speaking not so different from one bringing a personal package. A real-life example are land emergency vehicles that when having a non-emergency driving behavior, they pose the same risk as any private-owned vehicles. Furthermore, citizens are willing to tolerate their conceived audacious driving under emergencies that call for it. The concealed attitude towards delivery drones is measured

with a five-point Likert scale for six different arguments that address distress, regulation knowledge, acceptance, enthusiasm and technology acquaintance.

IX. Concerns medical parcel delivery

Same as block VIII. By having the same arguments in both survey blocks, the citizens' underlying tolerance towards one technology or the other is therefore revealed even though the technical features are nearly the same.

X, XI, XII & XIII. Stated preference for parcel delivery

Stated preference (SP) surveys are a commonly used tool in transportation sciences, which seek to explain variability in behavioral response for a given sampled population. The nature of SP data serves as choices made for a set of hypothetical situations, so it allows analysts to dig into issues past the current technological limitations. Additionally, responses normally include several choice sets per respondent, each of which has different attribute levels i.e. numerous observations per respondents can be obtained whilst revealed preference (RP) data usually provides information about a single choice. The methodology by Hensher, Rose and Greene (2005) to generate SP experiments was followed as an exploratory tool for the use of drones for civil applications:

1. Problem refinement: acute understanding of what the research project hopes to achieve by the time of completion.
    - Sub research question in section 2.2: What are the key factors that could shape flight paths in the city for civil applications of drones?
2. Stimuli refinement: decide upon the list of alternatives, attributes and attribute levels to be used. One might limit the compilation of data to a few easy-to-measure attributes of alternatives and descriptors of individuals. One often-employed strategy is to utilize the attribute levels at the extremes only. Such designs are known as end-point designs. End-point designs are particularly useful if the analyst believes that linear relationships exist amongst the part-worth utilities. Table 5 summarizes the four selected attributes along with their far-out attribute levels.
   Noise as a function of height (or vice versa) along with proximity and frequency, denote resilience to bear additional noise and visual input. Like road traffic, citizens' comfort is compromised the closer and the more often vehicles transit from the place of residence. The most notable difference is that, unlike road traffic, drones can decrease levels of noise by flying at higher altitudes. Thus, the need for the height/noise, frequency and proximity attributes to address comfort issues as closeness and recurrence of drone flights varies. Finally, the application attribute tests the preference towards one accepted against

one potential drone application as per Figure 4 i.e. the delivery of high value goods for health or personal intentions.

Attributes	A. Noise/Height	B. Frequency	C. Application	D. Proximity
Attribute levels	I. Low	I. Low	I. Personal	I. Far
	II. High	II. High	II. Medical	II. Close

TABLE 5 Selected attributes and attribute levels

3. Experimental design consideration: the statistical properties that will be allied with the final design. It is possible to use only a fraction of the treatment combinations. To choose which treatment combinations to use, the analyst may randomly select a number of treatment combinations from the total number of treatment combinations without replacement. However, random selection is likely to produce statistically inefficient or sub-optimal designs. What is required is a scientific method that may be used to select the optimal treatment combinations to use.
   For the beginner, several statistical packages can generate simple experimental designs that may be of use. Such a design was obtained with the statistical software SAS. Table 6 contains the correlations i.e. orthogonality for the 2**4 1/2 fractional factorial design for the experiment. An orthogonal design is a design in which the columns display zero correlations between attributes.

	A	**B**	**C**	**D**	**AB**	**AC**	**AD**	**BC**	**BD**	**CD**
A	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
AB	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00
AC	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00
AD	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	0.00
BC	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	0.00
BD	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00
CD	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00

TABLE 6 Orthogonality in experimental design

4. Generate experimental design
5. Allocate the attributes selected in step 2 to specific columns of the design.

6. Construct choice sets that will be used in the survey instrument.

Set	Choice	A	B	C	D	Set	Choice	A	B	C	D
1	1	I	II	II	I	2	1	I	I	II	II
	2	II	I	I	II		2	II	II	I	I
3	1	I	I	I	I	4	1	I	II	I	II
	2	II	II	II	II		2	II	I	II	I

TABLE 7 Fractional factorial design choice sets

7. Construct the survey: The attribute levels in Table 5 were further described and illustrated for ease of understanding to then be merged with the choice sets from Table 7 and this results in Table 8. In the online survey the choice sets are accompanied by the question: From your own perspective, which of the following drone-related scenarios would you tolerate the most?

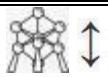
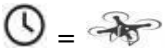
AI	AII
 Fly 25 meters off the ground (Just above tree level) and sounds like an electric lawnmower	 Fly 90 meters off the ground (near Atomium's height), light sound in quiet areas
BI	**BII**
 Few times per day	 Several times per hour
CI	**CII**
 Deliver personal packages from online shopping	 Deliver urgent medical deliveries
DI	**DII**
 Drones do not fly around my house or neighborhood	 Drones fly around my house or neighborhood

TABLE 8 Attribute levels final survey input

XIV. Introduction drone monitoring

Analogous to block VII, this is a brief introduction for the use of drones equipped with cameras for police surveillance, emergency response and other economic activities. One image depicts the look of a camera-enhanced drone.

XV. Concerns drone monitoring

Due to some preliminary feedback regarding the survey from close acquaintances, it could be observed that some respondents might obviate who is the operating body or what was the intended purpose of the surveillance drones. Therefore, the respondents' opinion towards surveillance drones was only asked once instead of having the same arguments for two

different scenarios as it was the case for the concerns regarding medical or personal parcel deliveries. It is additionally done this way to not make the survey any longer and tiring. Likewise, the measurement instrument is a five-point Likert scale but for five instead of six arguments. The arguments focus on privacy concerns, technology acquaintance, acceptance and regulation knowledge.

XVI, XVII, XVIII & XIX. Stated preference for drone monitoring

The same SP survey design was used for this drone application except for the attribute levels of the application attribute in Table 5. An additional change is that the order of the sets was reversed. The resulting SP survey design are Tables 9 and 10.

Set	Choice	A	B	C	D	Set	Choice	A	B	C	D
1	1	I	II	I	II	2	1	I	I	I	I
	2	II	I	II	I		2	II	II	II	II
3	1	I	I	II	II	4	1	I	II	II	I
	2	II	II	I	I		2	II	I	I	II

TABLE 9 Fractional factorial design choice sets

AI	AII
Fly 25 meters off the ground (Just above tree level) and sounds like an electric lawnmower	Fly 90 meters off the ground (near Atomium's height), light sound in quiet areas
BI	BII
= Few times per day	= Several times per hour
CI	CII
Professional photography drones	Police surveillance drones
DI	DII
Drones do not fly around my house or neighborhood	Drones fly around my house or neighborhood

TABLE 10 Attribute levels final survey input

XX. Comments and e-mail

Respondents are free to leave comments as well as an e-mail address in case they wish to participate in the raffle for the movie tickets.

4.3 Research Process

4.3.1 Planning

This section contains the most important dates for the master thesis. The master thesis is divided into two course units that are carried out separately during the academic year 2018-2019 at Hasselt University. That is, the first part takes place during the winter semester while the second part takes place during the summer semester. The methodological aspects which are present in the first part are the problem definition, the research plan, a written report and an oral defense. The second part of the thesis is merely a fluent continuation of the research work given that the first part was successfully evaluated. The elements to be considered in part 2 are the elaboration of the research process, analysis of research results, practical recommendations and conclusions. In the same way, a written report and an oral defense are necessary.

As part of the author student's academic duties, an internship in Spain, in principle unrelated to the master thesis, took place for roughly three months between March and May 2019. The location and the dates of the internship were a major drawback for the progress of the thesis. Nevertheless, this inconvenience was coped with and both academic events were somewhat consolidated, as section 4.3.4 further elaborates, which only meant a delay of around two months.

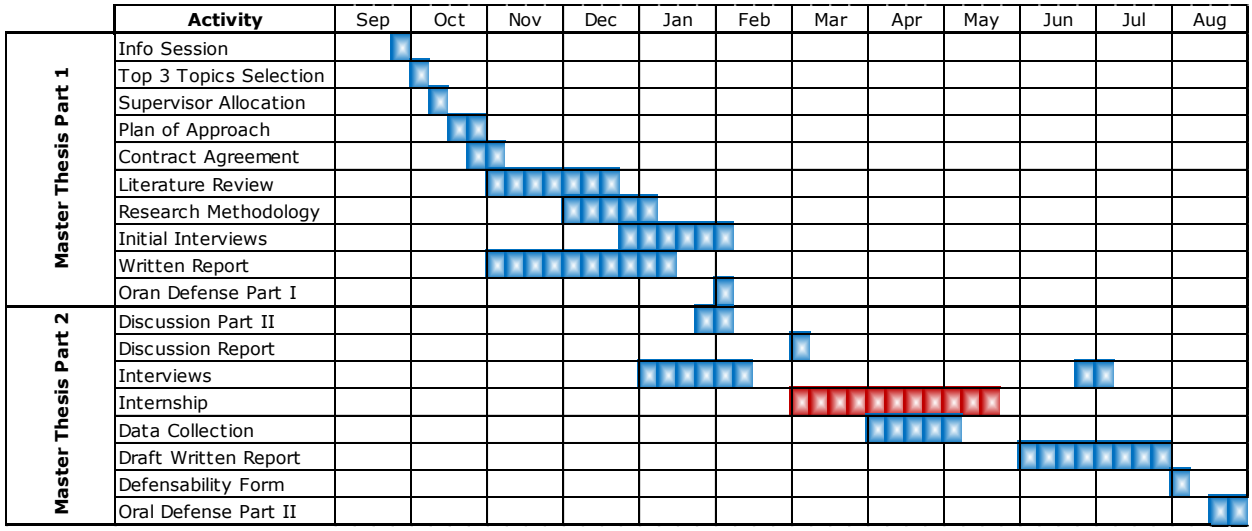


FIGURE 8 Master thesis time schedule

4.3.2 In-depth Interviews to Industry Players

As early as of December 2018, some of the potential interviewees from Table 3 were contacted hoping to schedule some interviews before the start of the previously mentioned internship in Spain and finish the rest upon its ending as it can be observed in Figure 8. Unfortunately, this was not the case. Between January and March 2019 only six contact persons accounting for

seven organizations (same contact person for EUKA and Droneport) had replied to the numerous interview requests. Furthermore, it was only possible to complete interviews with DoneMatrix, Acrolec and Argeye Drone Solutions i.e. merely 23% of the potential interviewees. Hasselt City can be considered an isolated case for they are not industry players or (drone) policy makers as such. Thus, no interview with a representative of Hasselt City took place.

Communications with the Community & Innovation Manager and contact person for EUKA and Droneport in fact concurred with the launching of Droneport itself. Thus, a busy agenda on their side did not allow to concrete a meeting. Not long after this he left his position at the company. The Jessa Ziekenhuis had an incredibly positive initial response, but contact was abruptly ended by their representative. Before this occurred, she kindly shared the details about the drone company carrying out the technical aspects of the project. However, contacting this company was neither a priority nor part of the scope as they were not located in Hasselt or its immediate surrounding cities.

The interview with Mark Bollingh (Acrolec) took place on January 4, 2019 in a café in the city center. Piet Leyden (Argeye Drone Solutions) was met at the facilities from the university on January 14, 2019. Finally, Francis Knudde (DroneMatrix) agreed to meet on January 21, 2019. The lessons learned from the interviews can be found in section 5.1. The three questioning sessions went down very smoothly since they all showed great interest for the topic and are looking forward for its development in the upcoming months.

4.3.3 Online survey in Hasselt

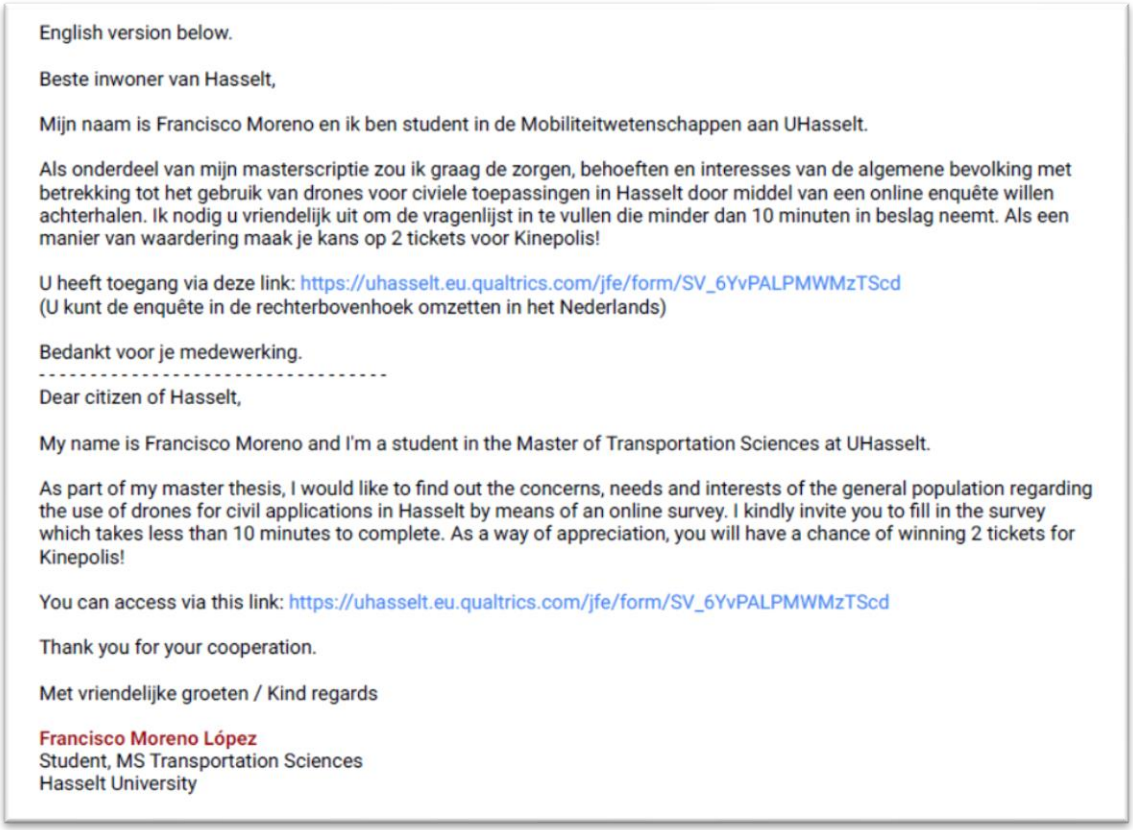
Response collection for the online survey took place between April 2 and May 5, 2019 i.e. data was recollected throughout five weeks although it was not contemplated that it would take more than three weeks. Eastern Holidays in Belgium took place from April 4 until April 22, 2019 so to compensate for possible low response rates during those weeks, the survey was available for the previously mentioned longer period.

Qualtrics provides an anonymous link to access the questionnaire on any device with internet connection. The main distribution channels were IMOB's website and Facebook page, as well as via social media and e-mail accounts from the author student and some close acquaintances. A clear emphasis was always stated that the questionnaire is addressed to citizens in Hasselt but anyone with access to the link was able to answer the survey.

No additional information is available regarding the origin of the respondents as per the anonymized response data collection discussed before. However, it is known that the survey reached not only Belgium but also Mexico, Germany and Spain. Figures 9 and 10 are examples of the survey being distributed via social media and e-mail respectively. The participation of

Hasselt City for the survey distribution via their social media channels was asked for but it unfortunately did not take place due to internal policies. Their help would have really boosted the survey in terms of reaching the truly general population i.e. Hasselt citizens.

FIGURE 9 Survey distribution via IMOB's Facebook page


English version below.

Beste inwoner van Hasselt,

Mijn naam is Francisco Moreno en ik ben student in de Mobiliteitwetenschappen aan UHasselt.

Als onderdeel van mijn masterscriptie zou ik graag de zorgen, behoeften en interesses van de algemene bevolking met betrekking tot het gebruik van drones voor civiele toepassingen in Hasselt door middel van een online enquête willen achterhalen. Ik nodig u vriendelijk uit om de vragenlijst in te vullen die minder dan 10 minuten in beslag neemt. Als een manier van waardering maak je kans op 2 tickets voor Kinepolis!

U heeft toegang via deze link: https://uhasselt.eu.qualtrics.com/jfe/form/SV_6YvPALPMWMzTScd
(U kunt de enquête in de rechterbovenhoek omzetten in het Nederlands)

Bedankt voor je medewerking.

Dear citizen of Hasselt,

My name is Francisco Moreno and I'm a student in the Master of Transportation Sciences at UHasselt.

As part of my master thesis, I would like to find out the concerns, needs and interests of the general population regarding the use of drones for civil applications in Hasselt by means of an online survey. I kindly invite you to fill in the survey which takes less than 10 minutes to complete. As a way of appreciation, you will have a chance of winning 2 tickets for Kinepolis!

You can access via this link: https://uhasselt.eu.qualtrics.com/jfe/form/SV_6YvPALPMWMzTScd

Thank you for your cooperation.

Met vriendelijke groeten / Kind regards

Francisco Moreno López
Student, MS Transportation Sciences
Hasselt University

FIGURE 10 Template for survey distribution via e-mail

4.3.4 Public perception of Drones in Pamplona

As mentioned in section 4.3.1, spreading and collecting data from the survey overlapped with the entire duration of the internship. The internship took place at the Institute of Smart Cities (ISC) from the Public University of Navarre, which is a research and development institute dedicated to design and develop technology and services for smart cities. Their research in

transportation, (green) logistics, vehicle routing problems, simulation models and operations research has led to an increased interest in studying the delivery of goods in city centers due to the combination of traditional logistical concerns with mobility-related constraints that are commonly found in city centers across Europe. The city of Pamplona in Spain, which hosts the ISC, experiences a similar situation in its Old City Center.

Pamplona is the capital of the Autonomous Community of Navarre in Spain. The city extends 23.55 km^2 and has a population of approximately 200,000 people. The Old City Center corresponds to roughly 0.5 km^2 i.e. 1.7% of the total area of the city. In May 2019, there were 11,268 inhabitants living in this area (Ayuntamiento de Pamplona, 2019) i.e. 5.6% of the total population. The neighborhood is distinguished by its monuments, old buildings, irregular blocks, pedestrian-only streets, high population density and no open public parking lots. Despite its relatively small size, the Old City Center remains as one of the most important leisure and business zones in Navarre throughout the entire year.

A new mobility plan was released for the city of Pamplona in September 2017. A central point of the mobility plan was setting controlled access norms in the Old City Center. Among other things, it seeks to reduce vehicular traffic, bring public transport routes closer to the city center and prioritize sustainable and active mobility. The mobility plan directly and indirectly encourages last mile delivery services that use (electric) bicycles and tricycles.

An additional internship task was to adapt and include sections of the author student's master thesis survey in the bachelor thesis of bachelor's degree student in Industrial Engineering Julen Arza. The main goal of merging both research efforts is to benefit of the expertise that the students have in freight transport, urban mobility, the city of Pamplona and the Spanish language. Julen Arza's research objectives include:

- Exanimate the current freight transport scheme in the Old Town of Pamplona and the problems originated by it.
- Find out what is the population's opinion regarding different measures that seek to promote sustainability in transportation.
- Analyze the viability of alternative transport means for freight transport.
- Obtain a basic understanding of the population's opinion regarding alternative vehicles for freight delivery such as drones.

The adapted survey blocks from the survey design in section 4.2.2 were those related to the time schedule intervals, the delivery drone (medical and personal) concerns and the SP survey for delivery drones. The design itself remained the same with the only exception that the illustrations and descriptions from the attribute levels in Table 8 had to be adapted to fit the drone flying allowances in Spain as shown in Table 11. The concerns

regarding personal package and medical deliveries were also measured using a Likert scale for the same six arguments. In this case, it was suggested at the ISC to use a Likert scale with four instead of five points to avoid respondents from adopting a neutral position.

Data collection took place between April 4 and May 3, 2019. Naturally, the survey was deployed in the two official languages in Pamplona i.e. Basque and Spanish. Like the survey in Hasselt, the target population consisted of citizens in the city of Pamplona, but it was not restricted to anyone else to respond it. The online questionnaire was spread predominantly via e-mail to staff and students from the Public University of Navarre.

AI	AII
 Fly 20 m above the ground (average height of a pine tree) and sounds like an electric lawnmower	 Fly 120 m above the ground (football field length) and light sound in quiet areas
BI	BII
 Several times per hour	 Few times per day
CI	CII
 Deliver urgent medical deliveries	 Deliver personal packages from online shopping
DI	DII
 Drones do not fly around my house or neighborhood	 Drones fly around my house or neighborhood

TABLE 11 Attribute levels in Spain

5 Results

5.1 Interview Results

The following sections summarize the key points obtained from the three in-depth interviews to industry players. The three interviews were done in just a fraction of the time schedule planning in Figure 8. Nevertheless, that established timeframe was adhered to since appointments with all organizations were continuously asked for during that time period. Mark Bollingh, Piet Leyden and Francis Knudde were all truly attentive and sympathetic. Mr. Bollingh and Mr. Leyden had a greater deal of personal involvement and connection to the master thesis itself since they are virtually unaccompanied in their organizations and have experienced by themselves the struggles that the legislation and public perception can impose.

5.1.1 Mark Bollingh – Acrolec

Date: January 4, 2019. 9:00 – 9:30 AM.

Place: Coffee café - Badderijstraat 6, 3500 Hasselt.

Lessons learned:

- Great concerns about safety and security. Very little protection by organizations e.g. Brussels airport does not count with any geofencing against drones. Malicious use of drones can always occur so developments should not only focus in the development of additional applications.
- The public perception is not aligned whatsoever with industry expectations. The legislation is the best tool to somehow align them. For example, with defined flight corridors people will know what to expect and do industry will know what they are allowed to do. In Belgium this represents a major challenge because of high population density and long semi-urban corridors.
- Limburg has a great potential to become a hub for drone development and testing but not so much as users. Local authorities should define a vision and the different steps to achieve it.
- The use of drones for industrial applications where the general public is not involved is the most promising use of drones in a short-term period. Technically speaking, payload and battery capabilities do not allow for further introduction of applications, but this will change soon. Security remains as the main concern though.

5.1.2 Piet Leyden – Argeye Drone Solutions

Date: January 14, 2019. 10:00 – 11:00 AM.

Place: Hasselt University, Hasselt Campus – Martelarenlaan 42, 3500 Hasselt.

Lessons learned:

- A very logical solution for several industry-related work situations is to make use of innovative drone applications. Thus, it is highly recommended that several industry sectors step into this domain before it is too late, and they are not competitive anymore. The development of civil applications is heavily dependent in the ability to convince the industry sector about the benefits of drones.
- The drone legislation is Belgium is too severe at first glance. Nevertheless, the market is quite young, so it was not a bad decision to be more strict than other countries and then adapt as more research is done and more applications exist. Even though this situation has prioritized safety, it can still be much more improved in the upcoming legislation.
- Despite having proved in a straightforward manner the potential benefits of drones, not only technology illiterate citizens but also some mature companies are reluctant to this technology for no apparent reason.
- Many technical features make Hasselt an ideal place for drone development. However, objectives have not been set yet in the political level. Moreover, the expectations of the drone industry are already ahead of the interests of governments and citizens.
- These urban air mobility efforts will eventually trigger the right actors, and this will lead in the implementation of flight corridors and other drone-related affairs.

5.1.3 Francis Knudde – DroneMatrix

Date: January 21, 2019. 11:00 – 11:30 AM.

Place: DroneMatrix – Herkenrodesingel 4 bus 1, 3500 Hasselt.

Lessons learned:

- A drone is nothing but a mean to achieve something. They have very distinctive functions which can be deemed as solutions for potential customers. However, their added value towards the future will lie in the larger environment in which they function i.e. push automation efforts of drones into the network used to deliver a service.
- Legislation will continuously evolve as it is needed. A new application will be desired by some organization and this triggers different

reactions among the public and government bodies. Legislation will then be slowly adapted in combination of a positive public perception.

- The upcoming changes in legislation are the cornerstone for flight corridors with a degree of automation within an integrated traffic management system. Key aspects to be considered are the communication infrastructure, reliable recharging network, traffic management system, remote piloting and safety procedures.
- The efforts in Limburg, although remarkably good, do not particularly position Hasselt as a highly superior place for the development of the drone industry. Belgium as a whole can be considered to have an upper-hand though. Hasselt is only part of a larger ecosystem.
- The capabilities of drones have surpassed its general acceptance. The general public looks at them, in great measure, the wrong way. Drones offer an additional travel format, but the technology does not differ that much from other automated services in the robotics world. With proven business cases, the adoption cycle and the public acceptance will be aligned to their true potential capabilities.

5.2 Online Survey Results

5.2.1 Basic Demographics Hasselt & Pamplona

Between April 2 and May 5, 193 records were captured for the online survey addressed to Hasselt citizens. However, filtered results include only 155 records. Those responses that were left out either only contained the first demographic questions or did not give their consent to participate in the study. For the first week of the study it was possible to skip the first survey block which asks for consent to the respondents as well as selecting that they did not wish to participate. Some respondents' records showed the previously mentioned condition and yet continued to answer the survey. Their responses have been removed from the final dataset. The questionnaire that was spread in Spain includes 107 responses collected between April 12 and May 3.

In the dataset addressed to citizens in Hasselt, 111 respondents have it as their main place of residence i.e. 72% of the sample. As previously mentioned, it is not possible to determine the origin of the rest of the respondents due to privacy issues, but it is known that the respondents are distributed between Germany, Mexico, Spain and mainly from other parts of Belgium. The sex distribution differs by only 4% between both populations in Hasselt and Pamplona; and their respective samples as shown in Table 12.

	Hasselt			Pamplona	
	Population	Hasselt sample	Total sample	Population	Total sample
Men	49%	45%	45%	47%	51%
Women	51%	55%	55%	53%	49%

TABLE 12 Sex distribution in Hasselt and Pamplona

The sample distribution per municipality in Hasselt overestimates the population's distribution in Table 4 by 9.22% and underestimates the rest of the municipalities between 0.4% and 5.58% as Table 13 indicates. In Figure 11 i.e. the age distribution of the population vs the sample, the underage population and the two oldest age groups are practically nonexistent in the samples. The 18 – 24 and the 45 – 54 age groups are accurately represented while the rest of the groups are under/overrepresented. The sampled 25 – 34 groups are more than twice the population's real proportion. On the other hand, the housing types distribution in Figure 12 has medium disparities for its three residential categories between the total population and the two samples. The semi-detached and terraced houses were merged into a single category as per the possible answer in question 5 from the survey (Family house attached to one or more houses).

Municipality	Sample	% Sample	% Difference
Hasselt	80	72.07%	9.22%
Kermt	5	4.50%	-1.40%
Kuringen	10	9.01%	-5.58%
Sint-Lambrechts-Herk	4	3.60%	-2.42%
Spalbeek	1	0.90%	-1.86%
Stevoort	2	1.80%	-3.08%
Stokrooie	2	1.80%	-0.81%
Wimmertingen	0	0.00%	-0.40%
Other	7	6.31%	6.31%

TABLE 13 Sample distribution per Municipality

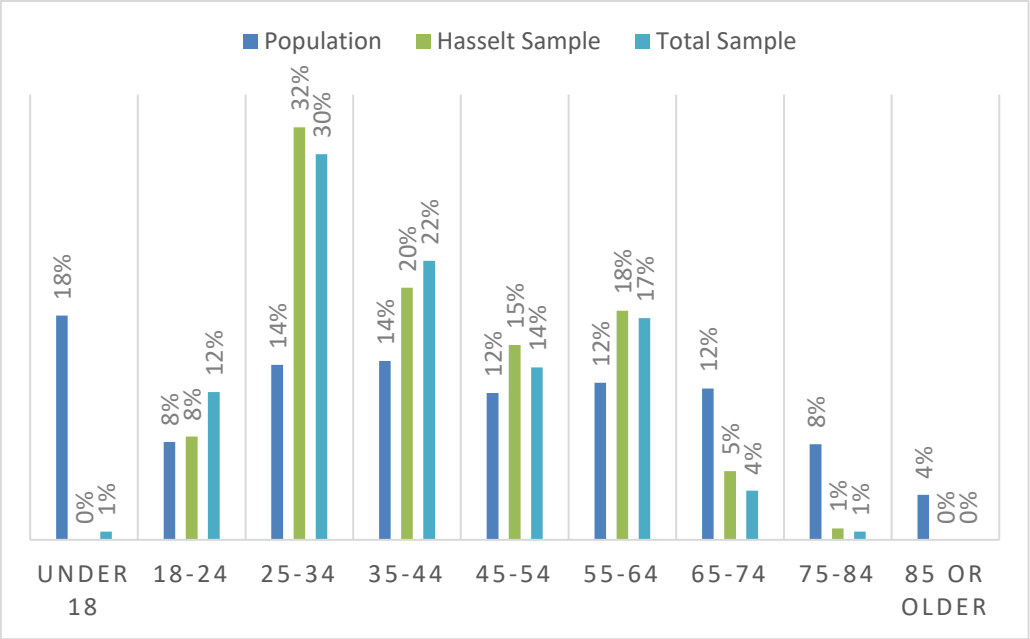


FIGURE 11 Sampled age distribution in Hasselt

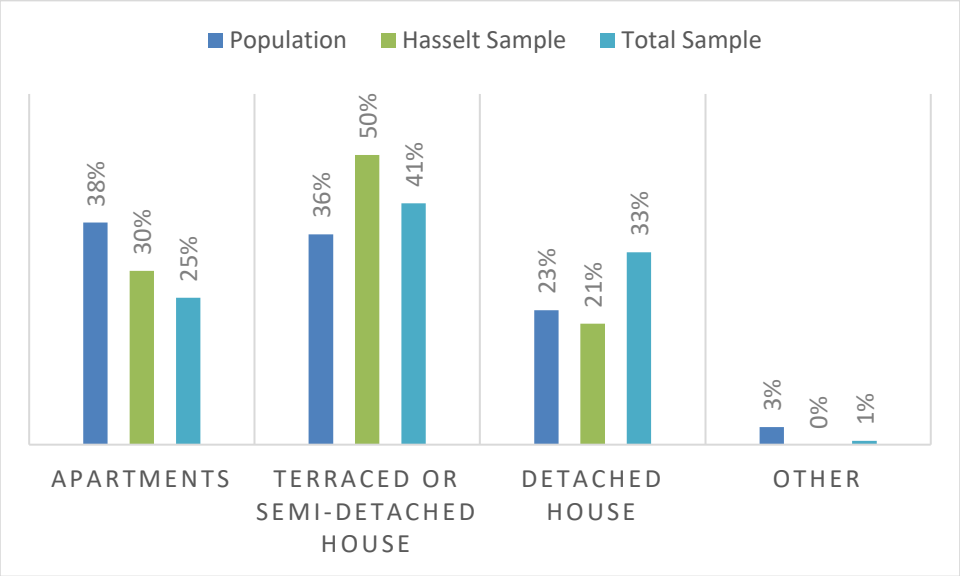


FIGURE 12 Samples housing types distribution in Hasselt

The population's occupation completed education level and personal income information are not contrasted against the survey samples. For none of these three demographic indicators is the difference between the two samples significantly different as Figures 13, 14 and 15 illustrate. The age distribution for the sample in Pamplona in Figure 16 is accurate in between the ages of 25 and 64, as well as the 85+ age group. The 18 – 24 years group is drastically overrepresented and the remaining two groups, 64 – 74 and 75 – 84, are moderately underrepresented.

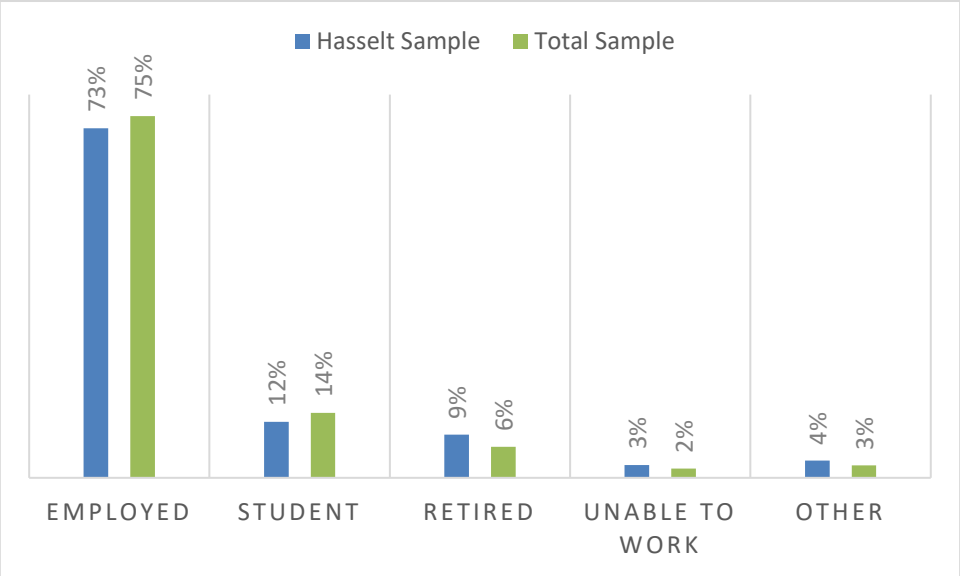


FIGURE 13 Sampled occupation distribution in Hasselt

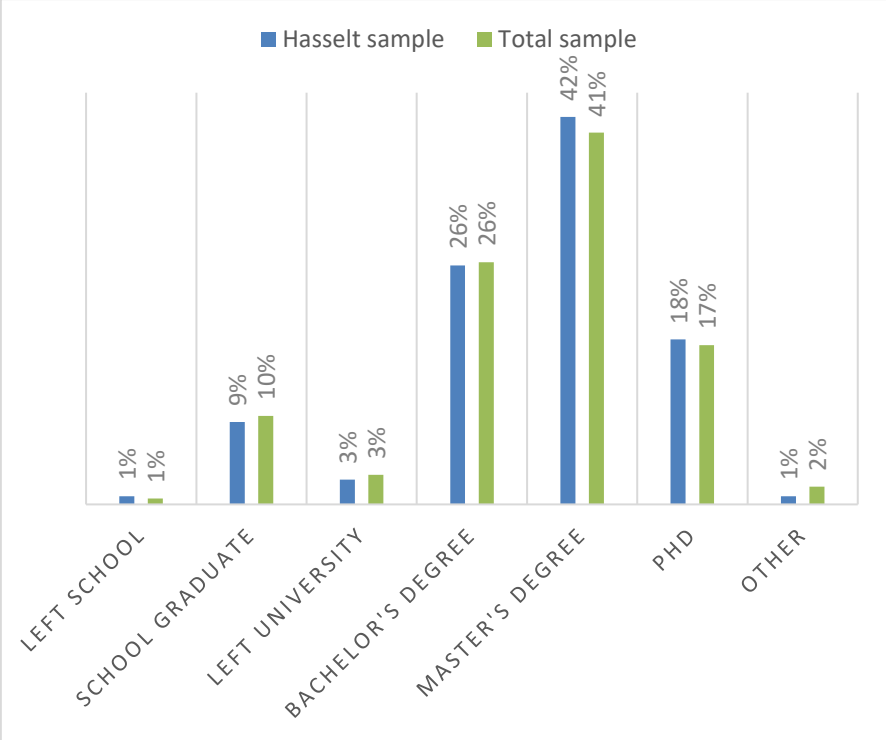


FIGURE 14 Sampled education distribution in Hasselt

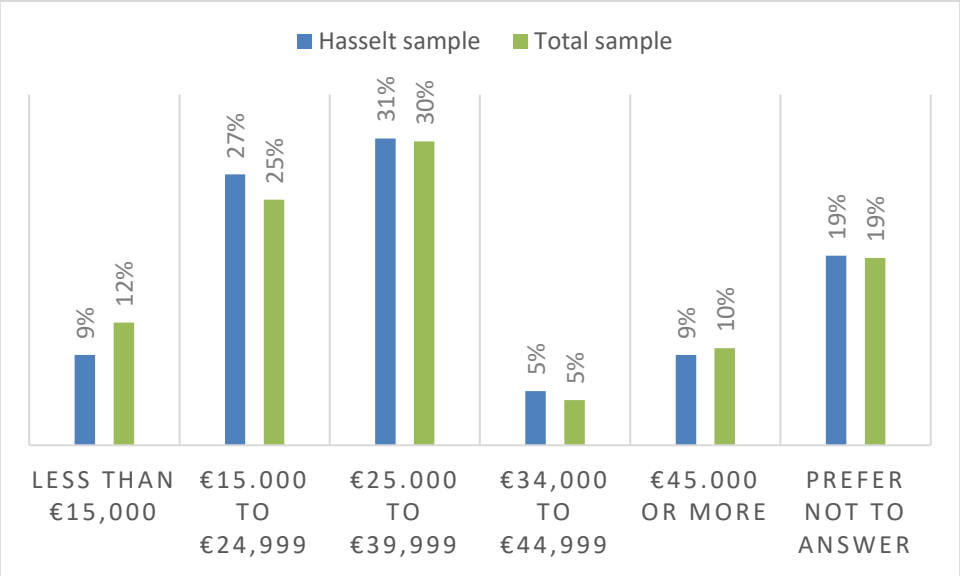


FIGURE 15 Sampled income distribution in Hasselt

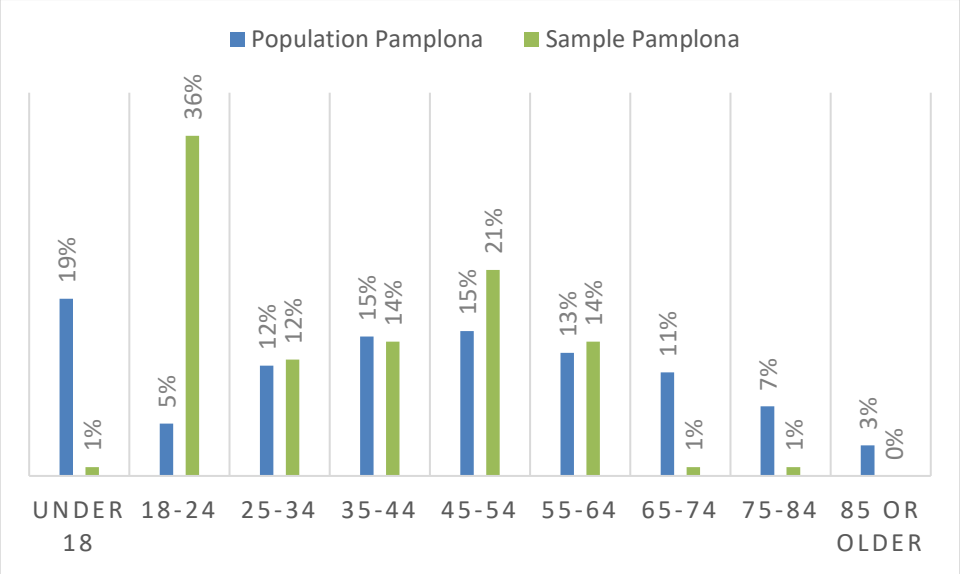


FIGURE 16 Age distribution in Pamplona

5.2.2 Time Schedules

Figures 17 and 18 show the time intervals of those who have either consistent or semi-consistent weekly schedules in Hasselt and Pamplona respectively. The multiple-choice answer includes the records from 132 people in the Hasselt and 99 in its counterpart in Pamplona.

The studied sample in Pamplona presents a typical weekly activities schedule in which from Monday to Friday between 9:00-11:59 only 6.25% of the respondents can be found at home. This number steadily increases between 12:00-20:59 before most people are back home by 21:00. During day hours on the weekends, at least half of the respondents can be found at home. The

sample for Hasselt presents a similar weekly activities pattern with the exception that there is no steady increase and most people come back home by 18:00. After 21:00 on the weekend, most Hasselt citizens can be found at home while in Pamplona not even half can be found during this same time schedule.

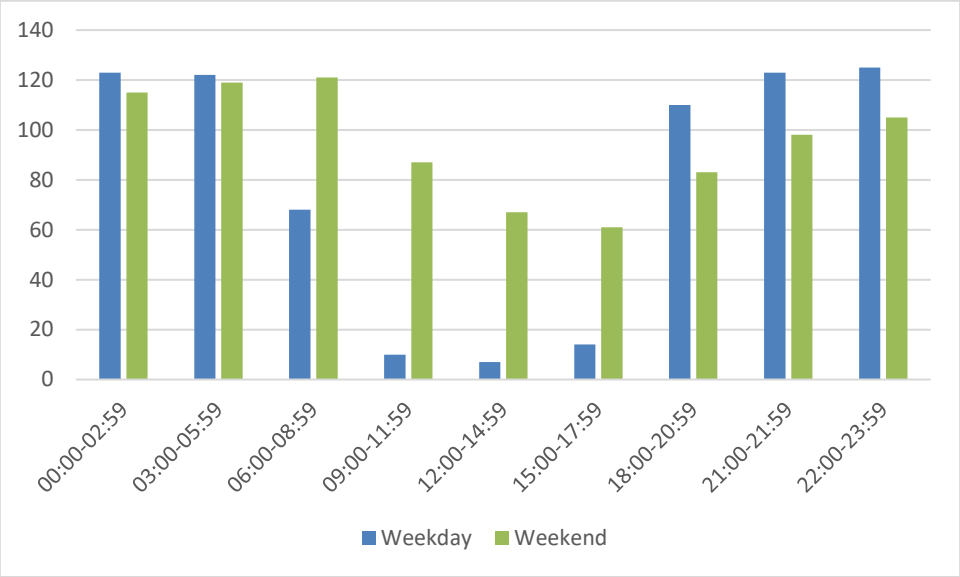


FIGURE 17 Weekly time schedules in Hasselt

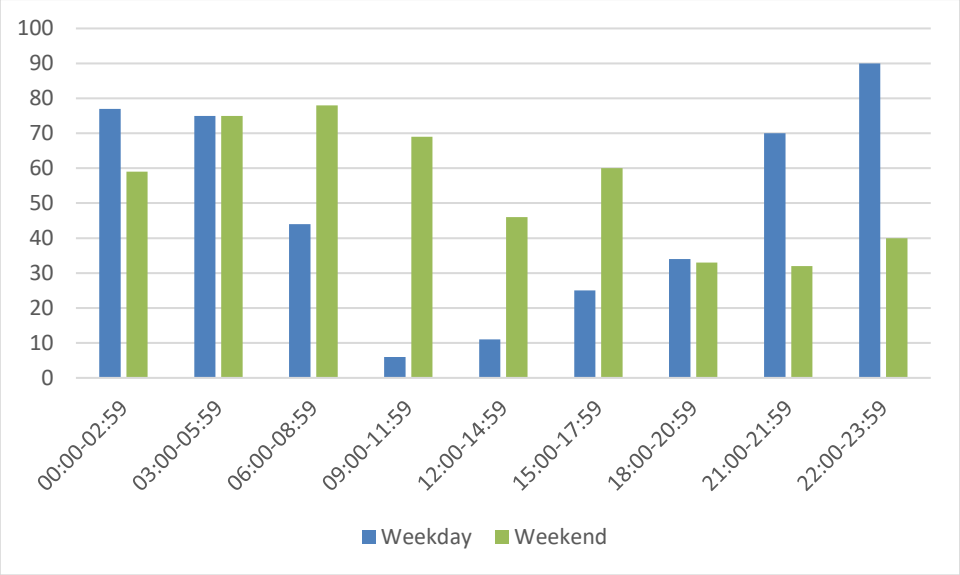


FIGURE 18 Weekly time schedules in Pamplona

5.2.3 Parcel Delivery Concerns

The public opinion was initially measured with a five-point Likert scale for six different concern-related arguments. Nevertheless, these questions were also asked as part of the author student's internship in Pamplona. In accordance with the internship supervisors, that survey did not include the middle point that represented a neutral attitude towards the argument. Thus, the responses from the master thesis survey with this neutral opinion selected have been omitted under the assumption that they indeed represent an unbiased opinion in order to have the same scale for comparison purposes.

The sample for these questions in Hasselt ranges between 112 and 132 respondents while in Pamplona, between 105 and 106. Table 14 breaks down the percentage response rate per argument. Some uniform observations are that in both cities people are somewhat reluctant towards the use of drones for personal deliveries; this is specially accentuated in Pamplona. A fair approval of the use medical deliveries in Hasselt exists. These concerns moderately ease down in Pamplona but they are still not particularly keen to medical drones either. The observations per statement are as follow:

1. For all cases, there is a fair degree of safety distress by the population towards possible malfunctioning of the aircraft.
2. The tendency in Hasselt is to somewhat disagree that drones might be intended for malicious purposes. In Pamplona the tendency is to somewhat agree.
3. With the slight exception of medical drones in Hasselt, there is a latent concern for privacy issues among respondents.
4. There is low to minimal approval for the flight of personal delivery drones above the respondents' homes. A remarkable acceptance of the use medical drones in Hasselt exists but in Pamplona it barely exceeds half of the sample.
5. Both samples find personal deliveries almost equally unpleasant to look at. Hasselt citizens consider, to a small extent, medical drones appealing to watch whilst in Pamplona, opinions are almost equally divided.
6. A medical drone is more prone to be perceived as an enhancement than its personal delivery counterpart. Once more, approval is emphasized in Hasselt and not in Pamplona.

			Strongly agree	Somewhat agree	Somewhat disagree	Strongly disagree
1. I'm concerned that they might malfunction and damage property or people	Belgium	Online	16%	52%	27%	5%
		Medical	10%	43%	33%	14%
	Spain	Online	52%	35%	7%	7%
		Medical	33%	42%	18%	7%
2. I'm concerned that they might be used to damage property or people	Belgium	Online	12%	27%	34%	27%
		Medical	6%	20%	43%	32%
	Spain	Online	33%	36%	19%	12%
		Medical	28%	30%	25%	17%
3. I'm concerned that they might not be used in a way that respects my privacy	Belgium	Online	23%	38%	29%	9%
		Medical	13%	20%	42%	24%
	Spain	Online	47%	40%	7%	7%
		Medical	31%	30%	20%	19%
4.I wouldn't allow package delivery drones to fly above my house or neighborhood	Belgium	Online	29%	17%	40%	14%
		Medical	11%	10%	41%	38%
	Spain	Online	38%	25%	21%	16%
		Medical	23%	22%	30%	26%
5. Package delivery drones will make the sky less pleasant to look at	Belgium	Online	33%	30%	28%	9%
		Medical	17%	22%	43%	18%
	Spain	Online	34%	32%	22%	12%
		Medical	23%	25%	26%	26%
6. This technology is as good or better than a human performing the same task	Belgium	Online	13%	38%	32%	17%
		Medical	23%	42%	16%	19%
	Spain	Online	8%	25%	35%	31%
		Medical	17%	32%	23%	28%

TABLE 14 Parcel delivery concerns in Hasselt and Pamplona

5.2.4 Surveillance Drones Concerns

The opinion towards drones enhanced with cameras for surveillance or monitoring activities was still measured with a five-point scale but for five instead of six different concern-related statements. Based on the response rate in Table 15, the following observations per statement are derived:

1. As expected, a prominent angst regarding spying drones is observed.
2. Drones are deemed as enhancing working tools in this domain although a quarter of the sample is undetermined.
3. Only 22% of the sample strongly agrees that drones should be also used by nongovernmental bodies.
4. One quarter of the sample would permit drones flying near them while more than half would not.
5. Only 21% do not believe to some extent in the potential of drone technology. The unfamiliarity with the performance of this technology remains remarkable high at 36% of the sampled population.

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
1. I'm concerned that these they might be used to spy on me	21%	37%	20%	8%	14%
2. Drones are a great tool for businesses	15%	42%	26%	5%	12%
3. Drones should only be used by the police and military	18%	32%	18%	11%	22%
4. I wouldn't allow them to fly above my house or around my neighborhood	30%	26%	18%	5%	21%
5. This technology is as good or better than a human doing the same	15%	28%	36%	8%	13%

TABLE 15 Monitoring drones concerns in Hasselt

5.2.5 Stated Preference Surveys

A binary logistic regression was performed to ascertain the effects of noise, frequency, application and vicinity of drone flights on the likelihood that participants will tolerate the flight. Preliminary models were fitted, but not reported, as it was found that no inherent difference existed in acceptance levels between the sociodemographic strata of this sample. The sample in Pamplona is mainly composed of students because of separate research processes that took place there. A different survey design was used so this is another reason that demographics information was not fitted into the data obtained from the SP survey.

As exemplified in Table 16, responses are rearranged so that they can be measured on a dichotomous scale (No = 0, Yes = 1) i.e. given the attribute levels for option 1, is the flight tolerated? and then, given the attribute levels for option 2, is the flight tolerated?. Table 17 summarizes the coefficients, p-values and odds ratio for the three models from the sections below.

Respondent	Tolerate	Height	Frequency	Application	Proximity
1	0	0	0	0	0
1	1	1	1	1	1
2	0	0	0	0	0
2	1	1	1	1	1

TABLE 16 Data arrangement example for SP survey

	Parcel Delivery Hasselt			Parcel Delivery Pamplona			Monitoring Drones Hasseelt		
	B	Sig.	Exp(B)	B	Sig.	Exp(B)	B	Sig.	Exp(B)
Noise	2.317	0	10.147	1.568	0	4.797	1.539	0	4.661
Frequency	-0.302	0.075	0.739	-0.654	0	0.52	-0.668	0	0.513
Application	2.462	0	11.724	1.836	0	6.271	2.27	0	9.683
Proximity	-0.211	0.213	0.81	-0.424	0.014	0.655	-1.261	0	0.283
Constant	-2.133	0	0.119	-1.163	0	0.312	-0.94	0	0.39

TABLE 17 Binary regression models summary

i. Parcel delivery SP survey in Hasselt

For 1210 cases, the explained variation in the dependent variables ranges from 33.1% to 44.2% for the Cox & Snell R^2 and Nagelkerke R^2 methods respectively i.e. the probability of tolerating the flight explained by the logistic model. The predicted classification results were moderate with 71.6% correctly classified against the actual classification. Only the attributes noise and application are significant where $\exp(\beta)$ equals to 10.147 and 11.724 respectively at the 5% significance level. That is, the acceptance level for flights with high altitudes and medical applications, the odds is multiplied by 10.147 and 11.724 respectively. At the 10% significance level, the frequency attribute is also significant with $\exp(\beta)$ equal to 0.739.

Step	-2 Log likelihood	Cox and Snell R Square	Nagelkerke R Square
1	1190.358[a]	.331	.442
a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.			

TABLE 18 Variance for parcel delivery SP survey in Hasselt

Observed			Predicted Tolerance		Percentage correct
			No	Yes	
Step 1	Tolerance	No	433	172	71.6
		Yes	172	433	71.6
	Overall Percentage				71.6

* Cut value is 0.500

TABLE 19 Classification table for parcel delivery SP survey in Hasselt

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B) Lower	Upper
Step 1[a]	Noise	2.317	.170	186.840	1	.000	10.147	7.279	14.146
	Frequency	-.302	.170	3.180	1	.075	.739	.530	1.030
	Application	2.462	.170	210.860	1	.000	11.724	8.410	16.345
	Proximity	-.211	.170	1.552	1	.213	.810	.581	1.129
	Constant	-2.133	.200	113.733	1	.000	.119		

TABLE 20 Variables in the regression for parcel delivery SP survey in Hasselt

ii. Parcel delivery SP survey in Pamplona

For 838 cases, the explained variation in the dependent variables ranges from 23.1% to 30.8% for the Cox & Snell R^2 and Nagelkerke R^2 methods respectively i.e. the probability of tolerating the flight explained by the logistic model. The predicted classification results were moderate with 68.3% correctly classified against the actual classification. The four attributes are significant where $\exp(\beta)$ equals to 4.797 for height, 0.520 for frequency, 6.271 for the application and 0.655 for proximity. That is, the acceptance level for flights with high altitudes and medical applications the odds increases by a factor of 4.797 and 6.271 respectively. The tolerance for high flight frequencies and drones flying in the vicinity decreases by a factor of 0.520 and 0.655 respectively.

Step	-2 Log likelihood	Cox and Snell R Square	Nagelkerke R Square
1	941.209[a]	.231	.308

a. Estimation terminated at iteration number 5 because parameter estimates changed by les than .001.

TABLE 21 Variance for parcel delivery SP survey in Pamplona

Observed			Predicted		
			Tolerance		Percentage
			No	Yes	correct
Step 1	Tolerance	No	286	133	68.3
		Yes	133	286	68.3
	Overall Percentage				68.3

* Cut value is 0.500

TABLE 22 Classification table for parcel delivery SP survey in Pamplona

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
								Lower	Upper
Step 1[a]	Noise	1.568	.173	81.975	1	.000	4.797	3.416	6.735
	Frequency	-.654	.173	14.249	1	.000	.520	.370	.730
	Application	1.836	.173	112.386	1	.000	6.271	4.466	8.805
	Proximity	-.424	.173	5.990	1	.014	.655	.466	.919
	Constant	-1.163	.180	41.646	1	.000	.312		

TABLE 23 Variables in the regression for parcel delivery SP survey in Pamplona

iii. Monitoring drones SP survey in Hasselt

For 1168 cases, the explained variation in the dependent variables ranges from 27.6% to 36.8% for the Cox & Snell R^2 and Nagelkerke R^2 methods respectively i.e. the probability of tolerating the flight explained by the logistic model. The predicted classification results were moderate with 71.2% correctly classified against the actual classification. The four attributes are significant where $\exp(\beta)$ equals to 4.661 for height, 0.513 for frequency, 9.683 for the application and 0.283 for proximity. That is, the acceptance level for flights with high altitudes and police applications the odds increases by a factor of 4.661 and 6.973 respectively. The tolerance for high flight frequencies and drones flying in the vicinity decreases by a factor of 0.513 and 0.283 respectively.

Step	-2 Log likelihood	Cox and Snell R Square	Nagelkerke R Square
1	1242.469[a]	.276	.368

a. Estimation terminated at iteration number 5 because parameter estimates changed by les than .001.

TABLE 24 Variance for monitoring drones SP survey in Hasselt

			Predicted		
			Tolerance		Percentage
	Observed		No	Yes	correct
Step 1	Tolerance	No	416	168	71.2
		Yes	168	416	71.2
	Overall Percentage				71.2
* Cut value is 0.500					

TABLE 25 Classification table for monitoring drones SP survey in Hasselt

							95% C.I. for EXP(B)	
		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1[a]	Noise	1.539	.168	84.415	1	.000	4.661	3.357	6.473
	Frequency	-.668	.168	15.894	1	.000	.513	.369	.712
	Application	2.270	.168	183.635	1	.000	9.683	6.973	13.447
	Proximity	-1.261	.168	56.648	1	.000	.283	.204	.394
	Constant	-.940	.147	40.767	1	.000	.390		

TABLE 26 Variables in the regression for monitoring drones SP survey in Hasselt

6 Discussion

Drone-enhanced business solutions are a truly young industry sector with vast room for improvement. Nevertheless, its true capabilities should not be obviated. The use of drone for civil applications remains as the next logical step for several scenarios that call for state-of-the-art strategies. Several drone applications are set back due to technical constraints, but it all indicates that they will be promptly overcome. Naturally, the use of drones for civil applications is also bound to operation guidelines which in turn, are the result of the public's point of view.

Citizens have been proven to be reluctant to the use of this technology but surprisingly enough, potential customers too. Efforts such as the urban air mobility initiative in the MAAHL cities effectively prompt actions amongst the pertinent stakeholders. For now, the industrial sector is still the most encouraging area to implement drone usage by means of punctual business cases. The involvement of the general public is ideally limited until adequate safety conditions can be met.

Belgium, and specifically Limburg, can be considered as a role model to other drone-oriented hubs in terms of technology development. This situation could be further reinforced if the local authorities define an own agenda instead of only complying with the urban air mobility initiative. The much-needed European Legislation is only coming into place in the upcoming months. Before this happens, the drone legislation in Belgium has already been safeguarding the citizens' concerns more than in other EU State Members. Until some technological breakthroughs take place and the current applications portfolio can be widely expanded, the Belgian Legislation provides an appropriate working scenario despite looking more severe than others at first glance.

The in-depth interviews did not represent any direct added value to the organizations, so they unfortunately were continuously indisposed. The interviews were few and they do not necessarily represent the entire drone industry in Hasselt. Therefore, they could not be used as a direct input to the online survey which would have resulted in more pragmatic scenarios. The quality of the interviews was not bad at all, but acquiring interviewing skills is of course a continuous improvement process. Thus, the interview techniques could not be further improved and implemented with other industry players.

The survey samples reasonably differ from the ideal sample size and from the demographic's proportions of the total population in both Hasselt and Pamplona. Nevertheless, they both suffice the academic purposes of this exploratory research. The sample made up exclusively of Hasselt citizens differs in almost the same proportion as the added respondents from other

parts of Hasselt i.e. the total sample for the Hasselt survey was benefited by those who do not have Hasselt as their primary residence city. Moreover, it is not part of the scope calculating how much exactly did raffling movie tickets improved the response rate, but 70% of the respondents left their e-mail address to participate in the raffle, which denotes that it was a great incentive.

The time windows that respondents spend at home have not yet been coped to any theory. When respondents spend too much time at home (or vice versa), no middle ground can be found for drone companies i.e. this is either beneficial or detrimental. What is the key factor that can be subtracted from this data depends on the approach that a given drone organization decides to take and it is not part of this study.

Safety and privacy concerns are unmistakably present among the general population. In a somewhat contradictory fashion, the citizens' worries are significantly influenced by the different drone applications despite having almost the same technical scenario. This reflects their confidence levels in the drone operating bodies more than in the application itself. Moreover, the new European Drone Legislation is an outcome that implicitly considered the public's opinion. Nevertheless, this paper exemplified how two populations have divergent takes on the subject even though they will soon fall into the same regulatory framework.

Among the studied explanatory variables, low noise levels (as a function of height) along with drone applications that safeguard the well-being of the general population, have proven to be the two most important key factors that influence the acceptance of the use of drones for civil applications. Approval levels will further increase if the upcoming innovative drone solutions are part of a business-to-business environment that does not involve the general population directly.

The development of the use of drones for civil applications is significantly heading towards flight corridors and (semi-) automated flight environments. Thus, among others, future research efforts could study the relationships between important attributes or variables and take some of the following directions:

- Develop sound business cases as per the positively perceived applications in a, preferably, business-to-business environment.
- Create a robust survey design than considers additional attributes that are specific to the new business cases.
- Target the population that would be the most involved in case a flight corridor is contemplated.
- Set the basis for development strategies of the drone industry (as user and facilitator) at the governmental level in Hasselt.

7 Conclusion

This paper has given a thorough overview of drone classification schemes and the imminent adoption of some of the most promising civilian applications because of their commercial potential in Belgium and the rest of the European Union. The current operation guidelines as well as the new legislation at European level have also been reviewed. Moreover, this work has a clear emphasis on the public's perception for this is a commonly overruled aspect among industry players, yet an underlying component of policy making. To find out the public's perception and the industry expectations regarding the use of drones for civil applications, a descriptive and an exploratory study were respectively conducted. These have helped formulate the problem precisely, generate hypotheses and understand the relation between variables.

The industry expectations exceed the current portfolio of civil applications available to the general population as it was revealed during the in-depth interviews to industry players in Hasselt. Thus, the perception among citizens is partly clouded by empirical knowledge of this technology. The gradual deployment of civil applications will improve the public's acceptance. Nevertheless, safety should be the cornerstone for all future developments. Furthermore, what citizens can expect should be become clearer due to the recent changes in the drone legislation at the European level which clearly define the limits of drone operators.

It was found that the citizens of Hasselt are not completely in favor of the use of drones due to safety and privacy concerns; the citizens of Pamplona even more so. However, the use of drones will be somewhat approved as long as it can potentially benefit the citizens' well-being in terms of safety and health. Finally, the acceptance for the use of drones for civil applications mainly depends on noise pollution and the intended application, but not to socio-demographic characteristics of the population or to other flight explanatory variables. Thus, it is highly recommended that the future of the drone industry in Hasselt first inquiries into the business-to-business environment for health-related solutions.

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9 Annexes

9.1 In-depth interview template

Date: _____

Dear _____, I would like to thank you for taking the time to meet with me today. As you already know, drones are strengthening its presence in many aspects of human life; however, there are some limitations like safety and privacy for different civil applications. The purpose of this interview is to learn more about the expectations of _____ regarding the use of drones. Part of the results of the interview will be used to design a survey for the citizens of Hasselt to accurately find out their perception regarding the use of drones for civil applications in Hasselt. Finally, the results of the interviews and the survey will be compared against each other. The results could be beneficial for shaping future policies.

The interview should take around 30 minutes. I would like to tape the session so that I do not miss any of your comments. All responses will be kept confidential and will only be used for academic purposes. If you do not wish your answers to be recorded please let me know.

Are there any questions about what I have just explained?

Are you willing to participate in this interview?

---

1. The portfolio of drone civil applications has a global growing trend. Is the company envisioning to work in additional industries and applications? Please elaborate.
2. What are your technical and social expectations for the company regarding topics like Mobility-as-a-Service, the Internet-of-Things, self-driving cars and Smart Cities?
3. For your (intended) commercial drone activities, what kind of drone is (ideally) required and for what kind of flights? E.g. multirotor/fixed wing; large/small and high-/low-altitude; large/small; etc.
4. What are some of the struggles that you have encountered for the deployment of your systems? E.g. legislation, complaints from citizens, etc.
5. What is your approach to overcome these barriers?

6. Do you think the upcoming changes in legislation will bring improvements for you?*
7. Could you illustrate what would be an ideal operational scenario for your company if these and other similar issues are properly addressed?
8. Some common misconceptions about drones are that they are only used for espionage and military applications; and that they trespass one's property if it flies above it (above a certain height). Have you experienced similar experiences between potential clients and other stakeholders?
9. Do you consider Hasselt to be a role model for other cities that are also doing efforts towards having a better urban air mobility and why (not)?
10. Do you believe that the expectations for the drone industry aligned with the interests of governments and citizens?
11. A lot of efforts are being made regarding autonomous flights where drones fly on dedicated flight paths or on other routes where they only avoid possible obstacles between origin and destination with little to none human intervention. What do you believe are the key factors that could shape autonomous flights in the city of Hasselt for civil applications of drones?

*Only in case legislation is mentioned in question 4.

Is there anything else you would like to add?

If you are interested, I can gladly share a copy of my research when it is finished.

Thank you for your time.

9.2 Online Survey

Start of Block: Consent

Q1 **Thank you very much for taking part in this survey!**

Dear **Hasselt Citizen**,

My name is Francisco Moreno and I'm a student in the Master of Transportation Sciences at Hasselt University.

Unmanned Aerial Vehicles (**UAV**s), also known as **drones**, are an increasingly popular technology in Belgium, the EU and the rest of the world. However, the regulations regarding the use of drones for civil applications in the EU are still a work in progress.

As part of my master thesis, I'm conducting this survey to find out the public perception regarding the use of drones for civil applications in Hasselt. Your participation will help the drone industry and government leaders understand your concerns, needs and interests about this technology.

You will be asked some basic demographics information and your opinion about some scenarios involving the use of drones. The survey should take less than 10 minutes and your responses are completely anonymous. You may choose to terminate your participation in the study at any time and for any reason.

As a way of appreciation, you will have a chance of winning 2 tickets for Kinepolis! If you want to win this prize, please enter your e-mail address at the end of the questionnaire (this information will be treated confidentially and only used to contact the winner).

For any questions, feel free to contact me:
francisco.morenolopezpedraza@student.uhasselt.be

Thank you in advance!

- ○ I consent that any personal data collected in an explicit fashion may be used for research purposes. I acknowledge that no personal data is collected without my knowledge. (1)
- ○ I do not consent or I do not wish to participate. (2)

Skip To: End of Survey If Thank you very much for taking part in this survey! Dear Hasselt Citizen, My name is Francisco M... = I do not consent or I do not wish to participate.

End of Block: Consent

Start of Block: Screen for Citizens in Hasselt

Q2 To start, is your primary residence in Hasselt?

- ○ Yes (1)
- ○ No (2)

Skip To: End of Block If To start, is your primary residence in Hasselt? = No

Q3 In which district of Hasselt do you live?

▼ Hasselt (1) ... Other (9)

End of Block: Screen for Citizens in Hasselt

Start of Block: Residence Demographics

Q4 Which of the following best describes the area where you live?

- ○ City or urban area (1)
- ○ Town or suburban area (2)
- ○ Small town (3)
- ○ Rural area (4)
- ○ Remote area with few other nearby residents (5)

Q5 Which of the following describes the type of home where you currently live?

- ○ Family house attached to one or more houses (1)
- ○ Family house detached from any other house (2)
- ○ Building with 4 or fewer apartments (3)
- ○ Building with 5 or more apartments (4)
- ○ Other (5)

_____

End of Block: Residence Demographics

Start of Block: Occupation, income, education demographics

Q6 Are you currently...

- ○ Employed (1)
- ○ Retired (2)
- ○ Student (3)
- ○ Unable to work (4)
- ○ Other (5)

Q7 What is the highest level of education that you have completed?

- ○ Left school before completion - no diploma (1)
- ○ School graduate (2)
- ○ Left university/college before completion - no diploma (3)
- ○ Bachelor's degree (4)
- ○ Master's degree (5)
- ○ PhD (6)
- ○ Other (7)

Q8 What was your total personal income after taxes during the past 12 months?

- ○ Less than €15.000 (1)
- ○ €15.000 to €24.999 (2)
- ○ €25.000 to €39.999 (3)
- ○ €34.000 to €44.999 (4)
- ○ €45.000 or more (5)
- ○ Prefer not to answer (6)

End of Block: Occupation, income, education demographics

Start of Block: Time Intervals at Home

Q9 Do you have the same schedule every week? For example: work from 09:00 to 17:00 and weekends free; go to school in the morning and part-time job in the afternoon, etc.

- ○ Yes, I have almost the same schedule every week. (1)
- ○ My schedule can vary a bit from week to week (2)
- ○ No, I have a very different schedule every week. (3)

Skip To: End of Block If Do you have the same schedule every week? For example: work from 09:00 to 17:00 and weekends free... = No, I have a very different schedule every week.

Q10 In which time intervals are you usually at home between Monday-Friday? You can select more than 1 option.

- ☐ 00:00-02:59 (1)
- ☐ 03:00-05:59 (2)
- ☐ 06:00-08:59 (3)
- ☐ 09:00-11:59 (4)
- ☐ 12:00-14:59 (5)
- ☐ 15:00-17:59 (6)
- ☐ 18:00-20:59 (7)
- ☐ 21:00-21:59 (8)
- ☐ 22:00-23:59 (9)

Q11 In which time intervals are you usually at home on the weekend? You can select more than 1 option.

- ☐ 00:00-02:59 (1)
- ☐ 03:00-05:59 (2)
- ☐ 06:00-08:59 (3)
- ☐ 09:00-11:59 (4)
- ☐ 12:00-14:59 (5)
- ☐ 15:00-17:59 (6)
- ☐ 18:00-20:59 (7)
- ☐ 21:00-21:59 (8)
- ☐ 22:00-23:59 (9)

End of Block: Time Interrvals at Home

Start of Block: Last basic demographics

Q12-EN What is your gender?

- ○ Male (1)
- ○ Female (2)

Q13 What is your age?

- ○ Under 18 (1)
- ○ 18 - 24 (2)
- ○ 25 - 34 (3)
- ○ 35 - 44 (4)
- ○ 45 - 54 (5)
- ○ 55 - 64 (6)
- ○ 65 - 74 (7)
- ○ 75 - 84 (8)
- ○ 85 or older (9)

End of Block: Last basic demographics

Start of Block: Introduction Main Body

Q14 In the following questions you will have to: Poll your level of acceptance for certain drone applications (Strongly agree, somewhat agree, neither agree nor disagree, somewhat disagree or strongly disagree).

From two different scenarios, indicate which one would you tolerate the most from your own perspective.

End of Block: Introduction Main Body

Start of Block: Introduction Parcel Delivery

Q15 Some organizations are considering delivering packages with Unmanned Aerial Vehicles (UAVs) also known as drones. This technology can make faster deliveries and is eco-friendly.

These drones do not have cameras mounted on them and they might look like this:


End of Block: Introduction Parcel Delivery

Start of Block: Concerns Personal Package Delivery

Q16 One approach is to send a drone with a package from **online shopping** or **post** to the occupant(s) of a single residence. Based on this application, how strongly do you agree with the following statements?

Based on this application, how strongly do you agree with the following statements?

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
I'm concerned that they might malfunction and damage property or people (1)	○	○	○	○	○
I'm concerned that they might intentionally be used to damage property or people (2)	○	○	○	○	○
I'm concerned that they might not be used in a way that respects my privacy (3)	○	○	○	○	○
If possible, I wouldn't allow package delivery drones to fly above	○	○	○	○	○

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
my house or around my neighborhood (4)					
Package delivery drones will make the sky less pleasant to look at (5)	○	○	○	○	○
This technology is as good or better than a human performing the same task (6)	○	○	○	○	○

End of Block: Concerns Personal Package Delivery

Start of Block: Concerns Medical Parcel Delivery

Q17 Another approach is that the drone carries medical equipment, blood and organs to **hospitals** and **clinics**.

Based on this application, how strongly do you agree with the following statements?

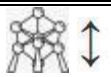
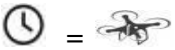
	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
I'm concerned that they might malfunction and damage property or people (1)	○	○	○	○	○
I'm concerned that they might intentionally be used to damage property or people (2)	○	○	○	○	○
I'm concerned that they might not be used in a way that respects my privacy (3)	○	○	○	○	○
If possible, I wouldn't allow medical drones to fly above my house or	○	○	○	○	○

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
around my neighborhood (4)					
Medical drones will make the sky less pleasant to look at (5)	○	○	○	○	○
This technology is as good or better than a human performing the same task (6)	○	○	○	○	○

End of Block: Concerns Medical Parcel Delivery

Start of Block: SP Parcel Delivery Set 1

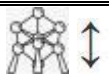
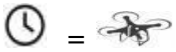
Q18-EN From your own perspective, which of the following 2 scenarios involving flying drones would you tolerate the most?

Option 1 (1)	**Option 2** (2)
 Fly 25 meters off the ground (Just above tree level) and sounds like an electric lawnmower	 Fly 90 meters off the ground (near Atomium's height), light sound in quiet areas
 Multiple times per hour	 Few times per day
 Deliver urgent medical items	 Deliver packages from personal online shopping
 Drones do not fly around my house or neighborhood	 Drones fly around my house or neighborhood

End of Block: SP Parcel Delivery Set 1

Start of Block: SP Parcel Delivery Set 2

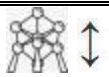
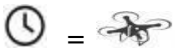
Q19 From your own perspective, which of the following 2 scenarios involving flying drones would you tolerate the most?

Option 1 (1)	**Option 2** (2)
 Fly 25 meters off the ground (Just above tree level) and sounds like an electric lawnmower	 Fly 90 meters off the ground (near Atomium's height), light sound in quiet areas
 Few times per day	 Multiple times per hour
 Deliver urgent medical items	 Deliver packages from personal online shopping
 Drones fly around my house or neighborhood	 Drones do not fly around my house or neighborhood

End of Block: SP Parcel Delivery Set 2

Start of Block: SP Parcel Delivery Set 3

Q20 From your own perspective, which of the following 2 scenarios involving flying drones would you tolerate the most?

Option 1 (1)	**Option 2** (2)
 Fly 25 meters off the ground (Just above tree level) and sounds like an electric lawnmower	 Fly 90 meters off the ground (near Atomium's height), light sound in quiet areas
 Few times per day	 Multiple times per hour
 Deliver packages from personal online shopping	 Deliver urgent medical ítems
 Drones do not fly around my house or neighborhood	 Drones fly around my house or neighborhood

End of Block: SP Parcel Delivery Set 3

Start of Block: SP Parcel Delivery Set 4

Q21-EN From your own perspective, which of the following 2 scenarios involving flying drones would you tolerate the most?

Option 1 (1)	**Option 2** (2)
Fly 25 meters off the ground (Just above tree level) and sounds like an electric lawnmower	Fly 90 meters off the ground (near Atomium's height), light sound in quiet areas
= Multiple times per hour	= Few times per day
Deliver packages from personal online shopping	Deliver urgent medical ítems
Drones fly around my house or neighborhood	Drones do not fly around my house or neighborhood

End of Block: SP Parcel Delivery Set 4

Start of Block: Introduction Surveillance

Q22 Some organizations make use of footage from cameras mounted on drones for different types of surveillance and monitoring:

- Police surveillance: border control and counter-terrorism
- Emergency response: natural disasters and search & rescue
- Economic activities: monitor infrastructure, professional photography and agriculture
- Environmental conservation: monitoring of national parks

End of Block: Introduction Surveillance

Start of Block: Concerns Surveillance

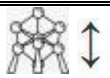
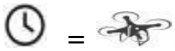
Q23 Regarding the use of drones for monitoring activities, how strongly do you agree with the following statements?

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
I'm concerned that these type of drones might be used to spy on me (1)	○	○	○	○	○
Drones are a great tool for businesses (2)	○	○	○	○	○
Drones should only be used by the police and military (3)	○	○	○	○	○
If possible, I wouldn't allow monitoring drones to fly above my house or around my neighborhood (4)	○	○	○	○	○
This technology is as good or better than a human performing the same task (5)	○	○	○	○	○

End of Block: Concerns Surveillance

Start of Block: SP Surveillance Set 1

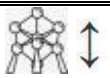
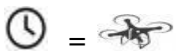
Q24 From your own perspective, which of the following 2 scenarios involving flying drones would you tolerate the most?

Option 1 (1)	**Option 2** (2)
 Fly 25 meters off the ground (Just above tree level) and sounds like an electric lawnmower	 Fly 90 meters off the ground (near Atomium's height), light sound in quiet areas
 Multiple times per hour	 Few times per day
 Professional photography drones	 Police surveillance drones
 Drones fly around my house or neighborhood	 Drones do not fly around my house or neighborhood

End of Block: SP Surveillance Set 1

Start of Block: SP Surveillance Set 2

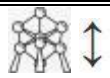
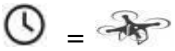
Q25 From your own perspective, which of the following 2 scenarios involving flying drones would you tolerate the most?

Option 1 (1)	**Option 2** (2)
 Fly 25 meters off the ground (Just above tree level) and sounds like an electric lawnmower	 Fly 90 meters off the ground (near Atomium's height), light sound in quiet areas
 Few times per day	 Multiple times per hour
 Professional photography drones	 Police surveillance drones
 Drones do not fly around my house or neighborhood	 Drones fly around my house or neighborhood

End of Block: SP Surveillance Set 2

Start of Block: SP Surveillance Set 3

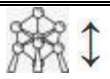
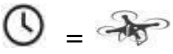
Q26 From your own perspective, which of the following 2 scenarios involving flying drones would you tolerate the most?

Option 1 (1)	**Option 2** (2)
 Fly 25 meters off the ground (Just above tree level) and sounds like an electric lawnmower	 Fly 90 meters off the ground (near Atomium's height), light sound in quiet areas
 Few times per day	 Multiple times per hour
 Police surveillance drones	 Professional photography drones
 Drones fly around my house or neighborhood	 Drones do not fly around my house or neighborhood

End of Block: SP Surveillance Set 3

Start of Block: SP Surveillance Set 4

Q27 From your own perspective, which of the following 2 scenarios involving flying drones would you tolerate the most?

Option 1 (1)	**Option 2** (2)
 Fly 25 meters off the ground (Just above tree level) and sounds like an electric lawnmower	 Fly 90 meters off the ground (near Atomium's height), light sound in quiet areas
 Multiple times per hour	 Few times per day
 Police surveillance drones	 Professional photography drones
 Drones do not fly around my house or neighborhood	 Drones fly around my house or neighborhood

End of Block: SP Surveillance Set 4

Start of Block: Comments and email

Q28 Feel free to write your email address for the movie tickets contest or any comments you have!

Don't forget to press the button below to submit your responses!

End of Block: Comments and email