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What are the critical barriers and facilitating factors influencing the adoption and integration of drone technology in last-mile delivery logistics for B2C transactions in Belgium?

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Declaration

During the preparation of this master's thesis, the author utilized ChatGPT for the following purpose:

1. **Language enhancement and clarity:** ChatGPT was used to refine the academic writing style, improve grammar, and enhance the clarity of arguments.
2. **Language translation:** ChatGPT was used to translate portions of the thesis written originally in French into English.
3. **Idea structuring and content planning:** ChatGPT was used during the drafting stage to explore different ways to organize chapters, present arguments more logically, and assist with content generation.
4. **Retranscription of expert's interviews:**
5. **Reference management:** ChatGPT was used to format references in a consistent citation style (APA) for the thesis.

After using ChatGPT, the author diligently reviewed and edited the content produced by the tool. We take full responsibility for the final content presented in this thesis.

By signing this declaration, we affirm that the content of this master's thesis reflects our original work, augmented by the responsible use of AI.

25/05/2025

Abstract:

This thesis is a study on the different barriers and facilitating factors to the adoption of drone technology for last-mile B2C parcel delivery in Belgium. Through a literature review and an empirical analysis of the Belgian context, including interviews with experts, this study exposes the important regulatory, technical, economic, and social factors that impact the implementation of such a delivery system.

Legislation is complex, particularly regarding BVLOS flights, which presents itself as the main obstacle, while technical constraints such as navigation and weather resistance also pose challenges. The main facilitating factors are related to environmental sustainability objectives, the potential for operational efficiency, and the growing market demand driven by consumer expectations for ever-faster deliveries. The research highlights that drone delivery in Belgium is more feasible through hybrid models, such as deliveries to local delivery points or smart lockers, rather than direct home solutions.

Although several obstacles remain, the study concludes that the evolution of the Belgian regulatory environment, collaboration between the public and private sectors, as well as targeted technological investments, offer promising prospects for integrating drones into sustainable and efficient last-mile logistics for B2C transactions.

Keywords: Drone delivery, last-mile logistics, B2C, Belgium

Foreword

This thesis marks the end of a lengthy and challenging journey that began in 2020, during my final year of my Master's program. After an initial supervisor change, I would like to thank Professor Pierre Semal, who offered invaluable help and guidance for which I am very grateful.

That same year, I faced difficult times that paused my thesis work. During this period, I also started my job as a consultant at PwC, where I've now worked for nearly three years. Despite these challenges, I kept faith in my ability and commitment to continue my thesis.

After submitting request to regain eligibility to enroll, I contacted Professor Benoît Gailly, who agreed to supervise my thesis. I would like to thank him for having accepted to supervise my work. His support was crucial, and I am deeply thankful for his precious guidance and encouragement.

I also want to thanks the experts I interviewed for this thesis, whose insights and expertise were invaluable to my research.

I extend my gratitude to my friends and family, whose support and belief in me during tough times helped me complete this work.

This thesis represents both my research and the support and encouragement from those who have been with me along the way.

List of Abbreviations:

ATM: Air Traffic Management

BCAA: Belgian Civil Aviation Authority

BVLOS: Beyond Visual Line of Sight

EASA: European Union Aviation Safety Agency

EU: European Union

EVLOS: Extend Visual Line of Sig

FAA: Federal Aviation Administration

GDPR: General Data Protection Regulation

GPS: Global Positioning System

RPAS: Remotely Piloted Aircraft Systems

SORA: Specific Operations Risk Assessment

UAV: Unmanned Aerial Vehicle

UAS: Unmanned Aircraft System

UTM: Unmanned Traffic Management

VLOS: Visual Line of Sight

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1. Introduction

1.1.Context

One of the major problems facing the logistics and supply chain sector is last-mile delivery. It describes the last phase of the delivery process, which involves moving products from a hub for transportation to the final delivery location. This stage, which accounts for a sizeable amount of the overall delivery cost, is frequently the most expensive, complicated, and ineffective aspect of the delivery process. These difficulties are caused by several factors, such as heavy traffic, fuel costs, and the requirement for prompt and dependable delivery services. The issue of last-mile delivery may have a viable solution in drone technology. Over the past ten years, drones, also known as unmanned aerial vehicles, or UAVs, have developed quickly, transitioning from military and recreational to commercial applications. Drones provide the opportunity to avoid typical delivery impediments while cutting costs, improving service accessibility, and shortening delivery times. There are benefits and drawbacks in introducing drone technology in Belgium due to its highly urbanized areas and intricate transportation systems. It is critical to understand the barriers and facilitators of drone adoption in last-mile delivery to maximize logistical effectiveness and raise customer happiness.

1.2.Objective

The objective of this thesis is to analyze the critical barriers and facilitating factors affecting the adoption and integration of drone technology for last-mile delivery logistics in Belgium within the context of and B2C transactions. By identifying these key elements, this research aims to provide actionable insights for policymakers, logistics companies, and technology developers to foster the successful implementation of drone-based delivery systems. Specific objectives include:

Identifying Key Barriers: To analyze and identify the main obstacles to the use of drone technology in last-mile delivery. These could include difficulties with regulations, technical constraints, safety worries, and public opinion.

Identifying Facilitating Factors: To identify the key components that can improve the implementation of drones into last-mile logistics operations. This could involve evaluating regulatory frameworks that facilitate innovation, technical improvements, and logistical effectiveness.

Assessing the Relevance of Delivery Drone Barriers and Facilitators in Belgium: To apply the gathered insight to the context of Belgium. Which factors are particularly relevant for Belgium, considering Belgium's unique geographical, regulatory, and infrastructural characteristics.

Making Recommendations: To develop strategic recommendations for getting around barriers while taking benefit of beneficial circumstances to ensure the effective and wide use of drone technology for last-mile delivery in Belgium.

1.3.Scope Clarification and Uses Cases

Although this thesis focuses on the use of drone delivery for last-mile logistics in B2C transactions (e.g., on e-commerce platforms like Amazon), it is crucial to recognize that the effectiveness and relevance of drone technology vary considerably depending on the use case. For comparative and contextual analysis, this study refers to a typology of drone delivery applications, including emergency medical delivery, high-volume urban logistics, and B2B transfers. This allows us to better identify driving factors and barriers, highlighting cases where specific findings apply only to certain contexts. Therefore, while the thesis is grounded in B2C last-mile delivery, other use cases will be referred to for comparative analysis where relevant.

1.4.Research Question

What are the critical barriers and facilitating factors influencing the adoption and integration of drone technology in last-mile delivery logistics for B2C transactions in Belgium?

1.5.Methodology

This thesis' methodology takes an in-depth approach to addressing research goals. First, a comprehensive literature review will be part of the theoretical section to lay the groundwork. This will be based on relevant data sources and key journals in Logistics and Supply Chain Management such as “Journal of business logistic”, “International journal of operations & production management”, “Journal of Economic Growth” or “Transportation Research: Part E - Logistics and Transportation Review”. These sources were accessed through Scopus, JSTOR, IEEE, ScienceDirect and Discovery. The targeted keywords used are “drone delivery,” “barriers to drone adoption,” “facilitating factors to drone adoption”, “economics of drone”, “last-mile logistics,” “drone logistics,” and “drone technology adoption”. Selection criteria will be established to include or exclude specific sources. For inclusion, peer-reviewed sources, publication date, relevance to the topic, and source in English. For exclusion, poor publications

such as sources not peer-reviewed, insufficient data, and irrelevant subject matter. To challenge, validate, or invalidate the results obtained from the literature review, semi-structured interviews with experts will be conducted, allowing experts to evaluate identified and presented themes. Finally, the output of the literature review and expert feedback will be synthesized to create a conceptual framework. This comprehensive approach will highlight the existing barriers and facilitating factors and strengthen the credibility of the findings, emphasizing the conscientious methodology employed throughout the research process.

1.6.Structure

The first chapter, "Literature Review," is divided into six sections. It begins with an introduction to the issue of last-mile delivery and modern delivery methods as well as the technology that equipped delivery drones. The different use cases covered by in the thesis are presented. It identifies barriers and facilitators grouped across regulatory, technological, operational, economic, and social dimensions through an analysis of the literature and the application of the defined methodology. The next next chapter, "Empirical Analysis I: The Belgian Context," is divided into five sections starting with used cases. It integrates knowledge from the results of the literature research to concentrate on barriers and facilitators that apply to drone delivery in the context of Belgium. A following chapter names “Empirical Analysis II: Validation and Experts Insights” presents the experts interview results to validate, invalidate and challenge the identified barriers and facilitating factors for the Belgian context. The thesis concludes with the interpretation of the findings, the limitation, recommendations and conclusions intended to assist Belgium in implementing drone technology successfully for last-mile delivery.

2. Literature Review

2.1.Introduction

The objective of the literature review is to identify and synthesize significant findings, theoretical frameworks, and perspectives from various scientific literature and peer-reviewed articles studies to provide an in-depth understanding of the determining factors that can block or favor the implementation of drones in logistics for the last mile the context of B2C.

The first section sets the context by defining what last mile is, its importance in the supply chain, and explaining the various challenges involved. Understanding these challenges is crucial because it paves the way for potential solutions.

The following section discusses the various existing solutions and means of transport used for last-mile delivery, including traditional methods and new and emerging alternatives. Drones are identified as a technology with potential as a solution to the last-mile challenges.

The third section introduces drones, along with their various applications and associated technologies, to provide a framework for understanding and in-depth context on this emerging technology.

Lastly, the sections provide a detailed analysis of the various barriers as well as facilitators factors to the adoption of drone technology for last mile delivery in the B2C context.

2.2.The Last Mile Delivery Problem

2.2.1. Definition

Last Mile Delivery, in practical terms, involves cutting the delivery chain in half: "long-distance" delivery brings the goods to a depot that then redistributes the goods more efficiently over a shorter distance. The consumer may order a good that is geographically quite far away. A "traditional" delivery company will take care of covering most of the distance (by plane, truck, boat...) and will distribute the parcel in a place close to the customer. From there, other less cumbersome vehicles will take over to distribute the goods in a more efficient and agile way (Figure 1). It is this final step that is called the Last Mile Delivery. This final step in the logistics process where parcels are delivered from a distribution center or warehouse to their destination, is the most challenging logistic step regarding B2C transaction in term of complexity and cost (Mangiaracina, 2019).

2.2.2. Challenges

One of the main challenges of Last Mile Delivery is the high cost related to it. Recent research indicates that this phase contributes more than 50% of the entire cost of delivery, having a major effect on the profitability and overall effectiveness of logistical operations (Silva et al., 2023). This high cost comes from different factors. The cost in terms of fuel consumption, given the deliveries in urban areas, the vehicles drive at reduced speed, are brought to make frequent stops and restarts which leads to higher fuel consumption and contributes to increased emissions from delivery vehicles, exacerbating environmental pollution.

Frequent stops due to congestion of the road infrastructure result in idle time which is a waste of time and money for the companies. The last mile of deliveries mostly takes place in busy

urban areas where the road infrastructure is congested due to the complex traffic systems and the occupancy rate of the road infrastructure. Route optimization is made more difficult by the need for many stops to transport individual products to various locations. Due to congestion, high occupancy, and the associated labor costs, last-mile delivery efficiency decreases while costs increase (Janjevic et al, 2019).

The customer's wants and preferences complicate last-mile delivery even further. Customers of today want flexibility and convenience, as well as products to be delivered at a specific time and place that fits into their schedules. The increased demand for customized delivery options, like doorstep delivery, locker pickups, and delivery intervals, presents a problem for logistics companies: developing quick and adaptable delivery systems. Logistics firms are under more pressure to expedite their processes due to the requirement for deliveries on the same or next day, often at the expense of higher operational costs. If these standards aren't met, there may be unsuccessful deliveries (returns and refunds), which represent 1 in 5 sales (Altug et al., 2021), raising expenses and annoying customers.

The economic impact of last mile delivery is intense, influencing the various parties involved in the retail sector. The high costs of last mile delivery have a direct impact on margins for companies. According to a report by Capgemini, these high costs mean that current last mile delivery models are considered unsustainable by 97% of logistics executives (Capgemini, 2019).

Companies are covering these costs by including them in delivery charges or minimum order amounts for delivery. These direct or indirect costs to the customer can be a disincentive for companies, impacting their sales volume. As mentioned in the previous section, unsuccessful deliveries lead to additional deliveries, which again increase costs and therefore reduces the profitability of the delivery process.

Companies that apply and use inefficient last-mile delivery methods expose themselves to difficulties in terms of competition at a higher level of the economy. When a company fails to standardize its last-mile logistics, it risks losing customers and market share to other companies using faster, better-organized or even more cost-effective means. Competition is fierce in the logistics industry, driving constant innovation and the development of new technologies. Examples include autonomous cars, intelligent lockers and delivery drones. These technologies come at a high cost, which not every company can afford. In fact, small businesses are much

less inclined to make large investments in their logistics, which can lead to market consolidation (Filiopoulou et al., 2025).

The environmental impact of last-mile delivery is equally- important, especially in terms of urban sustainability. In general, large cities are becoming increasingly congested and busy, and the explosion of online shopping is leading to an ever-increasing number of delivery vehicles in urban areas. The result is greater air pollution, higher greenhouse gas emissions and noise pollution. The International Transport Forum published a report in 2021 indicating that more than a quarter of polluting emissions from urban traffic are due to freight transport. As explained above, these emissions are due to the frequent stops made by delivery vehicles, but also to the number of delivery vehicles clogging up the roads, creating traffic and having a negative effect on the environment and society in general. According to a study by the World Economic Forum in 2020, if logistics are not improved, there will be a 36% increase in the number of delivery vehicles in the top 100 cities by 2030, resulting in a 32% increase in emissions from urban deliveries.

The challenge for companies active in the logistics industry is to find innovative ways of reducing these polluting emissions, which have a negative effect on the environment. Today, a greener alternative is already in place: the use of electric vehicles to avoid dependence on fossil fuels. Companies such as UPS, DHL, PostNL and Hello Fresh are currently using electric vehicles to deliver last mile (Moolenburgh et al., 2020). Other means of delivery have also emerged in urban environments, such as foot deliverers, cargo bikes, smart lockers and electric scooters (Engesser et al, 2023).

There are many obstacles and downsides associated with last mile delivery, continuous innovation in the logistics industry, the high costs associated with innovation and the need to meet customer expectations, as well as sustainability and pollution issues. All these obstacles have a major economic and environmental impact. The profitability, the competitiveness and the urban environment are directly impacted by these economic and environmental challenges that the logistic industry is facing (Cardenas et al., 2017). To reduce these negative effects, there is a need to move towards innovative, green, economically profitable solutions, and all this in a cooperative process between the different players in the industry.

It therefore appears that it is essential to address last-mile challenges so that businesses remain competitive, profitable, and able to respond to evolving customer demands. These challenges play an important role in urban decongestion and environmental impact. Analyzing possible

last-mile transport modes is therefore essential to identify solutions that are effective, sustainable, and accessible for all market players.

2.3. Delivery Methods for the last mile

The last step of a parcel journey is the last mile, which is done with delivery vans or trucks. These are classic means, but they pose problems in terms of sustainability, congestion of road infrastructures and in terms of costs (Maestro et al., 2021).

Due to the emergence of the last mile delivery problem, solutions are analyzed to increase the efficiency of this step of the logistics process. The means of delivery must therefore adapt with the increase in consumer demand, their desire to be delivered faster, more secure and more efficient but also considering the many ecological and economic challenges that companies face (Amaya et al., 2025).

A new technology is smart lockers or smart boxes located in cities or neighborhoods. The principle is the following, when a customer places an order, the order is delivered in this locker. Once the order is in the locker the customer receives a notification that the package is available. By means of an access code, the customer goes to the locker, unlocks it, and retrieves his order (Figure 2). This technology allows flexibility for the customer who can pick up his order 24/24 7/7 when he wants, as well as a security guarantee, once the package in the locker no one can open it without the access code. This solution for the last mile allows to deliver many packages at a single place, hence reducing ecological and environmental impact of the delivery process (Hovi et al., 2024). With the same logic, picking points fall into the same bucket: instead of having your parcels delivered to your home, you can have them delivered to a relay point. The delivery person therefore drops off several parcels at the same location (a store, a gas station, etc.) and the customer can pick them up during opening hours. It is less flexible for the consumer, but there is a reduction of the ecological impact.

Another technology is the autonomous car. Autonomous cars are an important challenge of this decade for many companies such as Tesla or Amazon who have been testing autonomous cars for several years. The idea here is twofold when talking about this technology, using autonomous delivery vans that would be equipped with smart lockers so that the customer can pick up his package without human intervention of an employee of the delivery service company (Figure 3). The second opportunity is to use private autonomous vehicles that transport people and that could also transport parcels to increase the occupancy rate of the vehicles while reducing their number on the roads (Schlenther et al., 2020).

The delivery of parcels by robots is a technology studied as a last mile delivery solution. Startship technologies, an Estonian company active in countries such as Germany, UK or USA has developed autonomous delivery robots. By subscribing to a 10$ monthly subscription, Startship provides a robot delivery service to each of its users. However, the probability that the robot will reach its destination without error is also very high. The robots are also equipped with sirens to notify companies in the event of a malfunction. In addition, they are equipped with GPS, programmed maps, speakers and microphones for effective communication (Alverhed et al., 2024), Despite its many advantages, package delivery robots still require a lot of research and pose some safety concerns. The use of this service is therefore still under study in many countries due to the questions of legislative framework and safety, as these robots would use the sidewalks as normal pedestrians (Hoffman & Prause, 2018).

Finally, in recent years, drone technology has emerged as a promising solution for last-mile delivery due to the possibility of delivering faster, contactless, and potentially in a more sustainably. Drones can reduce delivery times by avoiding traffic jams in congested urban areas and can offer efficient delivery (Moshref-Javadi et al., 2021). However, challenges are present and need to be analyzed, although companies such as Amazon and UPS have conducted tests with promising results demonstrating the potential of this technology (Figure 4). This thesis focuses specifically on the application of drone delivery to last-mile logistics, in B2C context, aiming to assess its feasibility, benefits, and implications for the future of parcel distribution.

2.4.Drones for the Last Mile Delivery

Drones have existed and been used for decades for military applications such as surveillance or air attack. However, the role of UAVs in civilian applications has been spreading and increasing in recent years. Current use is still limited in many sectors but many pilot projects have been developed to use drones in sectors ranging from agriculture, mobility services, logistics services to emergency services. Drones therefore have great potential to change the way logistics services operate today. Indeed, during the COVID-19 crisis, technological advances in the use of drones were made. Face masks were delivered by drone to remote islands in Korea and medicines were delivered by drone to retirement villages in Florida (Merkert & Bushell, 2020).

Companies such as Dominos Pizza, DHL, Walmart and Amazon Prime Air made their first drone delivery at the end of 2016. For several years now, drone delivery projects have been developed to address the problem of last-mile delivery. These various trial projects have

demonstrated that the use of drones is a solution for reducing delivery times in urban environments (Goodchild & Toy, 2018).

However, drone delivery faces different obstacles and constraints that will be discussed later in this thesis. As a result, recent technological improvements have tended to focus on increasing load capacity, flight time and on-board navigation systems. The safety of UAVs is of paramount importance, and this calls for powerful, precise and safe navigation systems. Added to this is the need to improve the batteries used, so that deliveries can be made over longer distances, but also to create batteries capable of withstanding different climates (Goodchild & Toy, 2018).

An important current trend for the future is the study and development of drones capable of autonomous delivery. Autonomous drones are not piloted by a single operator; they take off, fly and land without human intervention. These drones are guided by algorithms and artificial intelligence and are packed with technologies such as sensing sensors (ultrasonic, vision sensor, infrared, LiDAR, and monocular vision). The goal behind this automation is to minimize the human cost of flying drones via operators, reducing the total cost of the last mile delivery process. In the U.S., Wing, an Alphabet subsidiary, has developed a successful autonomous drone delivery project that represents a starting point for the development of this technology (Hoffman & Prause., 2018).

Delivery drone technology offers several advantages and solutions to the problem of last-mile delivery, not least delivery time. Recently, a study demonstrated that the use of delivery drones can be up to 70% faster than the use of traditional delivery means (Hwang et al., 2018).

2.5.Use Case Definition

The following Use Case Typology Table categorizes various scenarios of drone utilization in last-mile delivery logistics, highlighting distinct examples and factors such as payload, urgency, and environmental context. By exploring this typology, we can discern which barriers and drivers are pertinent to particular use cases, thereby enabling a more targeted analysis of the adoption and integration challenges of drone technology within B2C last-mile delivery logistic in Belgium.

Use Case	Example	Payload	Urgency	Urban/Rural
1: B2C Parcel Delivery	Amazon Prime Air (Parcel delivery)	≤5 kg	Medium	Urban
2: Medical Emergencies	Helicus (Medical delivery)	Light & critical	High	Rural/Remote
3: B2B Component Transfer	Factory to warehouse	Medium (≤20 kg)	Medium	Industrial areas
4: High-Density Urban Logistics	Wing (Meal, groceries)	Small parcels	Medium	Urban
5: Rural Parcel Delivery	Remote village access	Mixed	Medium	Rural
6: Disaster Relief/Humanitarian	Post-earthquake supply drop	Essentials	High	Remote/Disaster

2.6.Barriers to Adoption of Drone Technology for the Last Mile

Several advantages of drone delivery for the last mile delivery problem were briefly mentioned, pointing to improved efficiency, possibility of reducing delivery time and the potential to reduce the environmental impact of the last mile delivery process due to the electric nature of drones, which makes them a greener alternative to fuel-based delivery vehicles. It is undeniable, however, that barriers to the adoption of such technology do exist and therefore act as a brake. The literature on drone delivery for the last mile logistics shows that there are different categories of barriers to drone delivery technology adoption such as regulatory, technical, economic and social barriers. Drawing from peer-reviewed articles and journals in logistics, transportation, and supply chain management this section aims to categorize these barriers, provide relevant examples, and identify which are considered most critical to the deployment of drone delivery systems.

2.6.1. Regulatory Challenges

Drone regulations are generally strict, as drones are flying objects that can be dangerous if mishandled. The rules governing the use of drones for logistical purposes therefore face

considerable legal constraints, which vary from continent, country and region. These regulatory challenges are not equally critical across all use cases, their impact is especially significant in urban or high-volume operations, but more manageable in rural or low-frequency scenarios. This section examines the barriers to adoption and highlights the challenges faced by players in the logistics sector.

2.6.1.1. Airspace Management and Safety Regulations

Air traffic management is complex, highly regulated and monitored to guarantee safety. Delivery drone technology therefore represents a major risk for low-altitude commercial flight zones or busy urban areas. Different countries and regions have different rules. These regulatory bodies define where a drone may or may not be operated. Maximum altitudes can be defined, as well as minimum distances from populated areas, and restrictions or interdictions to flight over certain places (Niu et al., 2024).

This challenge is particularly critical in: Use Case 1: B2C parcel delivery and Use Case 4: High-Density logistics, where drones must navigate dense, controlled airspace with limited flexibility.

In contrast, for Use Case 2: Medical emergencies in rural or remote areas, or Use Case 5: Rural parcel delivery, the less congested airspace can make regulatory compliance easier, especially if governments support such public-interest missions.

Additionally size and weight of packages is also subject to specific rules. In the USA it is the Federal Aviation Administration (FAA) that sets the rules. The FAA not only requires specific permission to fly a drone carrying freight, but also imposes strict operational guidelines. In addition, guidelines and protocols must also be in place for cyber-attacks. UAV communication and control systems must meet certain requirements to avoid hacks. This cyber threat must not compromise drone safety or integrity. These strict rules often make it difficult for businesses to develop drone delivery operations at scale (Smith et al, 20122).

2.6.1.2. Privacy and Confidentiality concerns

To carry out the deliveries, the drones are equipped with high-resolution cameras to be able to locate themselves in space. These cameras are also effective because they are used by supervisors who can verify that the delivery has been made. It is a problem in terms of confidentiality. Homes, properties, people or vehicles can be filmed without the consent of people and can lead to unauthorized surveillance and data collection. Regulation on privacy

protection and on this surveillance issue, is an important factor in public resistance to accepting the implementation of this technology (Finn & Wright, 2012).

This issue is especially sensitive in: Use Case 1: B2C parcel delivery and Use Case 4: High-density logistics, where operations occur over residential areas, raising alarm over constant aerial surveillance.

2.6.1.3. Legal Liability and Compliance

As regulations are not yet developed everywhere, or are not clear and precise in certain respects, determining responsibility in terms of accidents, inappropriate use or damage caused by drones is complex. This lack of legal clarity, but also the continuous evolution of this technology, can be a brake on investment in this technology and therefore block its adoption (Safie & Khairil, 2025).

This barrier is a key concern for: Use Case 1: B2C parcel delivery, Use Case 4: High-density parcel delivery and Use Case 3: B2B transfers where higher flight frequencies increase risk exposure.

2.6.2. Technical Challenges

Various technical constraints act as barriers to the implementation of delivery drones. These include battery limitations, sensitivity to weather conditions, and limited payload capacity, all of which influence different use cases to varying degrees. This section analyzes the specific technical challenges associated with the implementation of drone delivery operations for last mile and links them to relevant scenarios.

2.6.2.1. Battery Life

Drones' autonomy is not highly performant, drones empty their battery in an average of twenty-five minutes. Drones need to deliver and return to the depot and the current battery technologies limit the distance that drones can fly. The battery life is a crucial technology problem that needs to be addressed for the delivery drone technology to be adapted and implemented (Bhuiyan et al., 2024). This poses a particular challenge for: Use Case 1: B2C parcel delivery and Use Case 4: High-density logistics, where multiple short-distance deliveries are expected in quick succession. Battery life limits the number of deliveries possible per charge and prolongs downtime required for recharging, impacting profitability. Use Case 5: Rural parcel delivery is also affected by this constraint, as longer distances between destinations is requiring better

battery life. For the Use Case 2: Emergency medical deliveries, which typically involve a single priority delivery per flight, those constraints are more important. These missions can be optimized for direct routing and efficient battery management.

2.6.2.2. Weather Condition

Weather is another major disadvantage of using delivery drones. Indeed, drones should not be flown when it is raining or snowing, as this can damage the drones' electronic systems and create short circuits that render the drone inoperative. Drones can be optimally operated in temperatures between 0 and 40 Celsius, considered as 'normal' temperature (Gao, 2021). Indeed, the temperature influences the efficiency of the batteries. At very cold temperatures the battery can be drained up to 50% faster than in 'normal' temperature conditions. Commercial drones can withstand winds of up to 40kmh on average. These constraints have an impact on the efficiency, safety and reliability of delivery drones. The weather barrier requires technological and operational development (Villa et al, 2016). This barrier is a risk fall all use cases but particularly affect Use Case 2: Medical emergencies, where the urgency of deliveries often conflicts with non-ideal flying conditions, creating tension between need and feasibility. For Use Case 1: B2C parcel Delivery, while weather still poses a risk, urban infrastructure may allow for more flexible rescheduling or quick rerouting compared to remote areas.

2.6.2.3. Limited Carrying Capacity

The size of a drone varies enormously according to its use, from a few grams for civil recreational drones, to several kilos for professional drones, or even tens of kilos for military drones. Delivery drones are professional commercial drones weighing between 1.5kg and 5kg. These types of drones can transport parcels ranging from 2kg to 5kg in average, making them ideal for last-mile delivery (Eskandaripour & Boldsaikhan, 2023). Technological developments in terms of engineering and materials used need to be implemented to expand the use of drones for last mile delivery to the use of drones for long-distance delivery with much heavier loads (Zhang & Kovacs, 2012). Use Case 3: B2B Component Transfers is specifically impacted, where industrial parts may exceed the capacity of standard drones and Use Case 6: High-Density logistics, if delivery volume is high or package sizes vary significantly. However, Use Case 1: B2C parcel delivery often fits well within current payload capabilities, as many e-commerce orders are lightweight. Similarly, Use Case 2: Medical deliveries typically involve small but vital items such as blood bags, medicines, or lab samples.

2.6.2.4. Navigation and Anti-collision Systems

To operate delivery drones in complex environments such as urban areas, a wide range of on-board technology is needed such as sophisticated navigation and collision avoidance systems (e.g., LiDAR, ultrasonic, GPS). Drones must deal with obstacles such as buildings, trees, light poles, power lines and other vehicles in the air or on the ground or event people. Studies insist that drones must be equipped with sensors as well as artificial intelligence capable of making real-time decisions (Chen et al., 2024). Innovation and continuous development are needed to make software and algorithms safer and more efficient to avoid obstacles and make delivery drones reliable and safe (Floreano, 2015). This challenge is especially critical for: Use Case 1: B2C Urban parcel delivery and Use Case 4: High-density logistics, as these involve navigating dense, obstacle-rich environments. Use Case 2: Medical emergencies and Use Case 5: Rural Deliveries typically occur over less obstructed rural areas, reducing collision risks and simplifying navigation, yet still require reliable GPS and fail-safes for emergency response and public safety. In any case, and particularly in dense urban airspace, integration with unmanned traffic management (UTM) systems is essential to ensure safe coordination between multiple drones and other aircraft (Chen et al., 2024).

2.6.3. Economical Challenges

From an economic standpoint, several factors need to be considered when implementing a drone delivery system. Such technology represents a substantial initial investment, with related maintenance and operability costs, but also a return on investment (ROI). These barriers vary significantly depending on the scale, payload type, geography, and delivery urgency involved in each use case (Cikmak et al., 2023).

2.6.3.1. Initial Investment

Implementing a logistics system for delivering parcels by drone involves a very costly initial investment. The cost of drones, a drone with the necessary characteristics to carry out deliveries has a price ranging from 10,000eu to 50,000eu. Drones with state-of-the-art anti-collision systems, long-distance batteries and the ability to carry heavy loads are even more expensive (Otto & Gatz, 2018). The infrastructures for maintenance, ground control systems and drone charging are costs to be considered. The logistics industry is a market with enormous potential for delivery drones, but one that may prove elusive for small and medium-sized businesses in view of the initial investment. A study by PwC (2016) indicates that the global market for commercial drones could reach $127 billion by 2025. This initial barrier is more problematic for: Use Case 1: B2C urban parcel delivery and Use Case 4: High-density urban

logistics, as they requires to deploy a large fleet of drones for scalable coverage where achieving ROI requires deploying a large fleet of drones for scalable coverage which drastically raise startup costs. However for Use Case 2: Emergency Medical Deliveries, it is less problematice as they often receive public funding or donor investment, reducing the burden of capital expenditure (KOZIOŁ, 2022).

2.6.3.2. Operational and Maintenance Costs

Operational costs include insurance for delivery drones, training costs for ground operators (pilots) and maintenance operators, and regulatory costs such as obtaining the necessary certificates or permits (Otto & Gatz, 2018). The direct cost of maintenance, such as replacing parts of the UAV, as well as maintenance checks are part of the overall expenses. The total cost of owning such a system must be considered to ensure economic viability (Li & Kharchenko, 2024). These barrier are significant for uses cases that continuously operates drones such as Use Case 1: B2C urban delivery, Use Case 3: B2B Transfers and Use Case 4: High-density urban logistics.

2.6.3.3. ROI/Economic Viability

The concept is quite straightforward when it comes to economic viability: the total costs of implementing a drone delivery system must be lower than the benefits it delivers. Given the major economic problem of capital investment, factors such as operational volume, delivery density, and delivery type are crucial to the system's economic viability. Delivery drones may be a solution to achieve cost savings for the last mile delivery, but for specific scenarios only such as Use Case 1: Urban B2C parcel Delivery, where multiple light parcels can be delivered in a short time within a small radius. And Use Case 2: Emergency Medical Deliveries, where the value of time savings outweighs the cost, making ROI non-financial but mission-critical. In contrast Use Case 3: B2B Transfers or Use Case 5: Rural Deliveries, which entail extended distances or reduced delivery frequency, frequently lead to a slower return on investment owing to increased energy usage and a lower number of deliveries per route. Thus, businesses must align drone delivery models with appropriate scenarios to justify the investment.

2.6.4. Social Challenges

The implementation of drone delivery systems for the last mile presents not only technical and economic barriers but also social challenges. The acceptance of the public is vital in assessing the viability of drone operations, especially in densely populated regions. Social opposition frequently arises from apprehensions regarding safety, privacy, ethics, employment, and noise pollution. Elements that influence each use case in distinct ways.

2.6.4.1. Public Perception and Public Trust

To see drone delivery technology adopted, public acceptance is paramount. Indeed, public sentiment is rather mixed due to the risk in terms of safety (Hwang et al, 2018). There is a social anxiety linked to automation and the fact that there is no pilot on board the aircraft and the danger of collision. There are also full skies where many drones will be flying, making the risks ever greater. Strict security protocols and transparent operations are needed to give the public the confidence to accept this technology. This is most blocking for: Use Case 1: B2C urban parcel delivery and Use Case 4: High-density urban logistics, where drones operate in densely populated neighborhoods, making them highly visible and frequent. Use Case 2: Emergency Medical Delivery is generally more socially accepted due to its life-saving purpose, and Use Case 5: Rural delivery typically faces less community opposition due to lower population density (Maity, 2021).

2.6.4.2. Ethical Concern

Ethical questions arise when the adoption of drone delivery is raised. The public generally thought that the use of drones is for military surveillance purposes, and this fear of being monitored by cameras and having one's privacy violated is a brake. Drones, equipped with their own technology, have the potential to invade the public's privacy. Drones flying over homes, gardens or simply on public roads raise questions about the ethics of this technology. It is therefore essential to put privacy policies and strict ethical rules in place. Without such ethical and privacy policies, public acceptance will be difficult (Finn and Wright, 2016). Ethical resistance is most acute in: Use Case 1: B2C Urban parcel delivery, where drones fly over private homes, schools, or parks. Use Case 4: High-Density urban logistics, where flight frequency amplifies this issue. In Use Case 2: Medical Deliveries, drones are frequently perceived as beneficial instruments, with ethical issues being ignored by the public. This further emphasizes the contextual aspect of societal resistance.

2.6.4.3. Employment Impact

The implementation of such technology has a direct impact on employment in the logistics sector. Indeed, jobs linked to the traditional delivery system will shrink in number, which is a concern for both delivery drivers and unions. It is important to find solutions that will enable these current roles to be valued, and to switch to other roles in line with the implementation of a drone delivery system. Companies need to find strategies to counter or support these job losses to see this technology adopted (Kellerman, 2023). This concern primarily affects: Use Case 1: B2C Urban parcel delivery and Use Case 3: B2B transfers and Use Case 4: High-density urban delivery which are scenarios where drone fleets could take the place of human couriers operating on the ground or personnel responsible for delivery from warehouses to retail locations. In Use Case 2: Emergency Services and Use Case 5: Rural Access, drones are frequently employed to enhance current logistics rather than to supplant them, thereby reducing employment disruption.

2.6.4.4. Noise Pollution

A social barrier to be considered is the problem of the noise produced by drones, which is an obstacle to the adoption of this technology, especially in urban environments. Indeed, since cities are already noisy due to traffic in general, this noise in the air is a problem that needs to be resolved to ensure that autonomous delivery drones don't have a negative impact on city life. Public acceptance of delivery drones depends on the possibility of developing quieter drones and on finding strategy regarding drones routes and takeoff/landing locations to avoid this resistance from the public (Tan et al., 2024). The most impacted scenarios are: Use Case 1: B2C Urban Delivery, where drone traffic may pass over residential or commercial areas frequently and Use Case 4: High-Density Urban logistics, where noise can be amplified due to high drone density and fixed routing corridors. In rural or emergency situations (Use Cases 2 and 5), this issue is not as critical, since drones are either deployed rarely or function in areas with lower population density.

2.6.5. Identified Barriers

This section summarizes the significant barriers to the adoption of last-mile delivery drones identified in the literature review and supported by international comparative analyses. The focus is on the challenges most relevant to B2C last-mile parcel delivery in urban areas.

Three studies establish a comparative basis for the synthesis: Tadić et al. (2023) conducted in Serbia, Cikmak et al. (2023) in Turkey, and Sah et al. (2020) in the United States. Although there are variations in locations, methodology, and stakeholder viewpoints, a common conclusion arises: regulatory and technical impediments consistently emerge as the foremost challenges to the adoption of drone delivery for the last mile.

Regulatory challenges include the lack of aviation-specific laws, complex airspace management, difficulties obtaining flight permits, and legal uncertainties regarding incidents or cyberattacks. These issues are particularly critical in urban areas, where drone operations overlap with dense infrastructure and strict security zones.

Technical challenges also manifest themselves significantly, with limited battery life, short flight range, poor resistance to hard weather conditions, and the need for advanced navigation and collision avoidance systems. These obstacles are particularly significant for B2C deliveries, which require precision, speed, and reliability in a complex urban environment.

Social challenges include public trust, ethical issues surrounding surveillance, and noise pollution, especially when drones operate near residential areas. The impact of these factors varies depending on the cultural context and the perceived benefits of the service.

Economic barriers, such as high initial costs, operating expenses, and uncertain returns on investment, are often perceived as less urgent in the short term, especially for large companies. However, they remain relevant for smaller logistics providers and during the early stages of adoption.

Table 1 summarizes these challenges and analyzes their relevance to the main objective of the thesis: drone delivery for last mile in B2C urban environments.

Table 1: Identified Barriers

Category	**Barrier**	**Disadvantage**	**Importance for B2C Urban Parcel Delivery**
Regulatory	Airspace management and safety regulations	Complex air traffic management	Very high
Regulatory	Confidentiality concerns	Unauthorized surveillance and data collection	Very high
Regulatory	Legal liability and compliance	Unclear regulations and evolving technology	Very high
Technical	Battery life	Short drone battery life limiting flight distance	High
Technical	Weather condition	Drone operation issues in rain, snow, and extreme temperatures	Moderate
Technical	Limited carrying capacity	Limited payload capacity for delivery drones	Low
Technical	Navigation	Need for advanced sensors, cameras, and collision avoidance systems	Critical
Social	Public perception and public trust	Mixed public sentiment and social anxiety	High
Social	Ethical concerns	Fear of surveillance and privacy invasion	High
Social	Employment impact	Potential job loss in the traditional delivery sector	Moderate
Social	Noise pollution	Noise produced by drones affecting urban environments	High
Economical	Initial investment	High upfront costs for drone and infrastructure	High
Economical	Operational and maintenance costs	Ongoing costs for insurance, training, and maintenance	Moderate
Economical	ROI/Economic viability	High initial investment requiring high delivery volume	High

2.7. Facilitating Factors for Adoption of Drone Technology in Last-Mile Delivery

Although various obstacles and challenges hinder the adoption of drone delivery, the academic literature on last-mile drone delivery, from peer-reviewed journals specializing in logistics, transportation, and supply chain management, identifies several categories of facilitating factors. These factors are likely to support and accelerate the adoption of this technology and are therefore essential to overcome existing challenges. Several categories of factors are identified, such as environmental drivers, operational efficiency, and different market demands, which encourage and open the door to the adoption of last-mile delivery drones in B2C. This section considers these drivers within the context of multiple drone delivery use cases, while emphasizing their relevance to the thesis's main focus: B2C parcel delivery in urban settings.

2.7.1. Environmental Drivers

The ecological aspect and the global demand and awareness of the need for ever-greener solutions today is a facilitator for the adoption of delivery drone technology. The potential to reduce Co2 emissions, decongest traditional vehicle traffic and make better use of energy are all likely to encourage adoption (Rodrigues et al., 2022).

2.7.1.1. Demand for Sustainable Solutions

Drones are zero-emission electrical devices. This technology can reduce the logistical industry's currently large carbon footprint. Drones can cut emissions by 25% compared with traditional delivery methods and up to 60% compared to delivery trucks (Goodchild & Toy, 2018). Although drones are globally more eco-friendly, this reduction in emissions is most pronounced in urban environments because of the concentration of delivery vehicles in cities. Drone delivery is a solution for reducing greenhouse gases and air pollution, which is in line with the sustainability objectives that businesses want to tackle. This driver is particularly relevant to: Use Case 1: B2C Urban parcel delivery and Use Case 4: High-density urban logistics, where high vehicle traffic and emissions are a problem. It also applies to Use Case 5: Rural parcel delivery, where drones can replace long, fuel-intensive truck trips over poor infrastructure. However, for Use Case 2 (Medical emergencies) and Use Case 6 (Disaster relief), the environmental factor is secondary to speed and reliability. Similarly, Use Case 3

(B2B Transfers) may prioritize efficiency and integration over emissions reduction, especially in low-frequency or controlled industrial routes.

2.7.1.2. Decreased Traffic Congestion

As already mentioned, this technology has the potential to reduce congestion in delivery vehicles, especially in urban areas (Wang et al., 2023). Indeed, one of the challenges of the last mile is the frequent stops made by delivery vans and trucks. This reduction in traffic is an environmental benefit in terms of emissions but also simplifies mobility for road users. This is most beneficial in: Use Case 1: Urban B2C parcel delivery and Use Case 4: High-density urban logistics (e.g., food/groceries). By contrast, in rural or emergency operations (Use Cases 2, 5, 6), traffic congestion is not a pressing concern, and in industrial zones (Use Case 3), operations often occur off major public roads.

2.7.2. Operational Efficiencies Drivers

The implementation of delivery drones for the last mile can bring great operational efficiency on several levels Key factors include route optimization using AI and real-time data, hybrid delivery models (e.g., truck-drone combinations), and long-term reductions in operating costs. However, the extent to which these benefits apply varies significantly depending on the delivery use case.

2.7.2.1. Route Optimization and integration with other delivery means

With the evolution of technology such as artificial intelligence, increasingly powerful software and advanced algorithms combined with machine learning, optimizing the routes taken by drones can drastically increase their efficiency. These drones can analyze traffic in real time, whether on the ground or in the air, to find the most efficient route to reduce delivery time, distance and energy consumption (Wu et al., 2021). Additionally, the optimization of delivery routes can also be improved by combining drones with other delivery methods, traditional or not). A study has also shown that truck and drone coordination is more effective than delivery by truck (Ding et al., 2024). This hybrid model is a solution to the last mile problem as it lead to time reduction and energy consumption (Moeini et al., 2023). This driver is valid for Use Case 1: B2C Urban parcel delivery where high delivery volume and complex routing benefit greatly from an integration with other delivery means (e.g truck-drone model) (Ding et al., 2024). Use Case 4: High-density urban logistics, particularly meal or grocery deliveries that

require time-sensitive, high-frequency routing. Driver has less impact on Use Case 2: Medical Emergencies and Use Case 6: Humanitarian relief, where each mission is single-purpose, urgent, and route-agnostic. Use Case 5: Rural Parcel Delivery, where route optimization is constrained by long, sparse networks and limited infrastructure integration.

2.7.2.2. Long Term Cost efficiency

Implementing a drone delivery system represents a significant initial investment, but it becomes very beneficial in the long run, allowing for cost reductions. Drone delivery offers significant long-term cost reduction potential for B2C last-mile logistics. By minimizing reliance on human labor and fuel-dependent vehicles, drones offer a scalable and automated alternative that reduces operational expenses over time. Studies show that integrating drones into delivery systems can reduce delivery costs by up to 38% when used in combination with trucks (Moeini et al., 2023). Drones run on electricity, which is generally cheaper than fossil fuels, further reducing delivery costs per package (Goodchild & Toy, 2018). This advantage is more valid for 3 use cases: Use Case 1: Urban B2C parcel delivery where high delivery density enables scalable automation. Use Case 4: Urban logistics, with constant demand and short-distance repeatable routes. Use Case 3: B2B Transfers, especially when used in predictable, high-frequency factory-to-warehouse runs. However, less impactful for Use Case 2 and Use Case 6, which are less frequent and often government funded (cost efficiency is not the primary concern). Use Case 5 (rural delivery), where low delivery density and long flight paths may slow ROI or make per-package costs higher.

2.7.3. Market Demand

The existing literature indicates that market demand for delivery drones significantly enhances the adoption of this technology for last-mile logistics. This demand arises from three stakeholder groups: consumers, logistics firms, and drone manufacturers. Nevertheless, the intensity and significance of this factor differ among various drone applications and use cases.

2.7.3.1. Evolving Consumer Preferences for Speed and Reliability

Today's consumers want increasingly faster and more reliable deliveries. Online shoppers are willing to pay more to get faster and more efficient delivery, which is also pushing companies to innovate in delivery methods (Oyama et al., 2024). Consumers expect same-day or next-

day deliveries, especially in urban areas. Meeting customer demands builds loyalty and, of course, increases customer satisfaction. Therefore, evolving consumer preferences and this need for speed and reliability are important factors facilitating the adoption of done delivery for the last-mile delivery (D'Andrea, 2014). This driver is valid for: Use Case 1: B2C Urban parcel delivery, where customers expect rapid and flexible delivery to their doorstep. Use Case 4: High-density urban logistics, including food or grocery delivery, where the urgency of time is paramount and consumers are familiar with immediate services. However it is less important for: Use Case 2: Medical emergencies and Use Case 6: Disaster relief, where the "customer" is typically a public institution or a patient. Use Case 3 where consumer expectations are less time-sensitive or the delivery is not directed to private end-users.

2.7.3.2. Enterprises Integrating Drones into Their Logistics for Delivery

Logistics companies face intense pressure to improve operational efficiency while gaining a competitive edge. The integration of drones into logistics operations is increasingly viewed as a viable solution for streamlining delivery processes, reducing costs, and enhancing service speed. Companies that offer faster, more efficient delivery methods stand out from the competition. Businesses that adopt such technology can gain significant market share and become innovative in terms of current logistics solutions (Li & Kharchenko, 2024). The need for more efficient logistics solutions is a real incentive for the adoption of drones. This is highly relevant for: Use Case 1: B2C parcel delivery and Use Case 3: B2B Component Transfer, where logistics efficiency directly impacts business outcomes. Use Case 4: Urban logistics, where companies can scale drone delivery across frequent, short-range routes. It has limited relevance in: Use Case 6: Disaster relief and Use Case 2: Medical delivery, where public interest, not market competitiveness, drives adoption. Use Case 5: Rural delivery, where the logistics industry is less pressured by competitive delivery expectations.

2.7.3.3. Drone Manufacturers

The market demand from drone manufacturers is also an incentive. This growing interest in delivery drones offers manufacturers significant opportunities to invest in and improve drone technologies. As logistics companies push for faster, more efficient, and more environmentally friendly delivery solutions, manufacturers face increasing pressure to innovate in terms of safety, cost-effectiveness, and operational features to meet these evolving requirements. Manufacturers are not only addressing current demand but are also instrumental in shaping the

future of logistics through ongoing research and development (R&D) efforts and strategic alignment with the supply chain industry (Li et al., 2025). This demand is relevant across multiple use cases, especially Use Case 1, 3, 4 and 5, where business-led drone adoption requires rapid product evolution and customization. Use Case 2 and 6, where manufacturers work closely with public institutions to design drones suitable for medical or emergency logistics.

2.7.4. Identified Drivers

Delivery drones have several facilitators for the adoption of this technology in the logistics sector for last-mile delivery. While many of these facilitators apply across various drone use cases, this section highlights those most relevant to B2C parcel delivery in urban settings, which is the core focus of this thesis. These include the sustainability and ecological benefits of this solution. Indeed, the possibility of reducing polluting emissions such as Co2 by decongesting the streets or the fact that they are powered by electricity and not polluting fuels. These days, companies are realizing that sustainability is a necessity and soon a duty, and drones are an alternative solution to today's polluting traditional delivery methods.

A second driver is operational efficiency, thanks to the optimization of the routes used by the drones and the integration with existing means of delivery, which can change in real time to adapt to the environment and arrive faster. Cost efficiency is also a driver that can reduce long-term costs by up to 40% for the last-mile delivery process.

Consumers' changing expectations to get their orders faster and faster, the adoption of businesses needing faster and more efficient delivery methods to gain a competitive edge, and the opportunity within the manufacturers sector. These factors collectively form a strong foundation for the adoption of drones in last-mile delivery, though their impact varies depending on the use case.

Table 2: Identified drivers

Category	Facilitator	Advantage	Importance for B2C urban parcel delivery
Environmental	Demand for Sustainable Solutions	Reduced carbon emissions	High
Environmental	Optimization of Urban Logistics	Decreased traffic congestion	High
Operational Efficiencies	Optimization of drone routes, integration with other delivery means	Increased efficiency and quality of service	High
Operational Efficiencies	Substantial long-term cost reduction	Lower operating costs	High
Market Demand	Evolving consumer preferences for speed and reliability	Competitive advantage, enabling businesses to meet growing expectations for faster delivery options.	Critical
Market Demand	Enterprises Integrating Drones into Their Logistics for Delivery	Efficiency gains from quick delivery increases consumer satisfaction and loyalty, resulting in a stronger market position.	High
Market Demand	Drone Manufacturers	Encourages technological advancements, leading to improved drone capabilities and lower operational costs.	Moderate

3. Empirical analysis I: The Belgian Context

3.1. Introduction

This part of the empirical analysis aims to assess whether the barriers and drivers identified in the literature apply to the Belgian context for B2C last-mile drone delivery.

The first section explains the delivery drone projects existing in the world to understand how this technology is already used but also to draw lessons learned to identify key and important factors capable of influencing the Belgian market for the adoption of this technology for last mile delivery in B2C.

The following section compares the barriers and drivers identified with the Belgian context based on written sources such as reports and white papers, case studies, market research, trade publications or even government regulations and policies. The objective here is to consider regulatory frameworks, infrastructure or even public trust to understand how local factors could impact the barriers and drivers.

3.2.Example of Drone delivery projects for the Last Mile

3.2.1. Projects Overview

The use of drones in the logistics sector has been demonstrated in different countries around the globe, with a particular focus on the technology's potential for last-mile delivery. Several case studies are presented here to give an idea of what is currently being done.

Amazon has developed drone delivery projects. Amazon's Prime Air was announced in 2013, with the aim of delivering parcels to customers within 30 minutes and reducing the impact of delivery cost in the long term. Amazon was able to develop its project and carry out test flights thanks to FAA approval to carry out experimental delivery flights. It's important to point out that the implementation of this project has encountered several challenges, starting with the FAA's approval process, due to safety and regulatory issues, as well as public opinion regarding the arrival of potential delivery drones in the sky (Wang, 2023). Amazon is working every day to minimize these challenges and make drone delivery a reality. They work closely with the regulatory authorities to bring a safe and effective solution to market. In May 2024, the FAA granted new authority to expand drone delivery to new locations in the United States (McNabb, 2024).

Another company called Zipline specializes in the delivery of e-commerce, medicine and essential items. The company was founded in 2014 and has become a pioneer in its sector. The company has worked with the Rwandan government to deliver medicines, vaccines and blood bags to hard-to-reach places . They proposed two different use cases, one with a B2B focus and one with a B2C focus (Figure 5). Zipline is a fine demonstration that delivery drones can be a solution in places with poor infrastructure and complex accessibility. Success has also been achieved in reducing delivery times for these life-saving medicines with thwo different. Zipline has faced technical challenges due to the complexity of the locations to be delivered or the hot weather conditions and the apriori attitude of the communities. These challenges have been overcome through technological developments, notably with more powerful algorithms, even more extensive pilot training and community involvement (Zipline, 2016).

A successful implementation of drone delivery has been achieved by Alphabet, a Google subsidiary. Their service is called Wing and delivers food, medicine and essential goods to urban and suburban areas. This system has been implemented in Australia since 2019 and has been a success thanks to the Australian government's support for this innovation. Fast deliveries and meeting customer demands is a success. Challenges were encountered regarding privacy concerns and noise pollution. These have been overcome by adapting the regulations but also the way drones are operated (airandspace.si.edu, 2020).

3.2.2. Lessons Learned

These examples of drone delivery are relevant examples for the use of drones delivery for the last mile and provide a good guideline for companies wishing to implement this technology. One important lesson that emerges from Amazon and Alphabet is the importance of regulation. Alpahabet's speed of implementation thanks to the Australian government, but also Amazon's thanks to the FAA. Regulation must strike the right balance between providing security without hindering innovation. The FAA is a good example, adopting regulations little by little as tests are carried out and the results obtained.

Public acceptance is also important. The example of Alphabet and Zipline shows that care for the public contributed to the success. Alphabet had to make operational and regulatory changes in response to the public, while Zipline had to work with local authorities to build trust (McNabb, 2024,). This shows the importance of "socially accepted" in the implementation of this technology.

The technical challenges are present in the Zipline example, with its diverse terrain and complicated weather conditions. Technological evolution has been necessary for proper implementation. Manufacturers must consider the fact that drones can be subject to different weather, terrain or technical constraints. They need to innovate while adapting to technical challenges (Zipline, 2016).

Economic viability is a crucial point: drones can be cost-efficient in the long term, but as we've already said, the initial investment is substantial. Companies like Amazon and Google can meet this initial cost, while smaller companies will need to find the funds for such adoption.

These lessons form a useful benchmark for understanding how global trends may or may not translate into the Belgian context. The next section will assess how these barriers and drivers play out specifically within Belgium's regulatory, economic, and social environment.

3.3.Comparison of identified Barriers with Belgian Context

3.3.1. Introduction

To understand and explore the implementation of drone technology for last-mile delivery in a geographic area, Belgium in this case, it is crucial to understand the local contexts and their impact on adoption and implementation. This section analyzes the barriers and drivers identified in the literature review and those that are particularly relevant to Belgium. By studying regional dynamics, this section aims to define the unique challenges of the Belgian market, but also to provide information to stakeholders seeking to understand the complexities of deploying this technology.

3.3.2. Regulatory Challenges

Belgium is part of the European Union, and there are laws at that level which are applicable to Belgium, so it's important to review the European legislation applicable to Belgium. In fact, the EU has developed a framework of legislation concerning drone use. These rules and laws are defined by the European union safety agency (EASA). The aim is to bring about a more uniform regulatory framework between the countries of the European Union, with a view to bringing safety, efficiency and security to the EU.

Regulatory impact varies across drone applications. This thesis targets Use Case 1: B2C Parcel Delivery in urban/suburban areas, where frequent BVLOS flights over populated regions face stricter regulations due to higher risk. In contrast, Use Case 2: Medical Emergencies may obtain faster BVLOS approval due to urgency and public interest.

Key components of EASA Regulation:

The rules and procedures for unmanned aircraft operations are defined by law (EU) 2019/947. The aim of these regulations is to categorize operations according to the risks involved. There are three categories: Open, Specific and Certified (EUR-Lex, 2019).

Open Category: The risks are low. Safety is assured provided the operator complies with the drone operating rules. It is noted that this open category has three sub-categories, categories A1, A2, A3. The operator does not need any operational authorization to fly. The differentiation of subcategories is based on flight. In this sense, subcategory A1 can fly over people but not over assemblies of people. The A2 subcategory can fly close to people and the A3 subcategory flies away from people.

In addition, the ESEA has set up sub-categories whose characteristics are based on their weight, their various capabilities and the risk they generate. There are 7 classes in all, with classes C0 to C4 for Open category UAVs, and classes C5 and C6 for the Specific category UAVs. Within the Open category, A1 category UAVs are classified as C0 or C1, A2 category UAVs are classified as C2, A3 category UAVs are classified as C2, C3 or C4 (Figure 6).

Specific category: Riskier drone operations, riskier for people and for air traffic. As this risk increases, the operator must obtain an operational authorization to ensure a safe flight. This authorization is issued by the competent national authority where the operator is registered. This authorization is obtained by passing tests and evaluations to demonstrate the safe use of the drone.

Certified category: Operations where the risk is particularly high. In this category both license and authorization are required to ensure safety by the operator. Examples of drones in this category are future taxi drones or cargo drones delivering packages (EASA, 2019).

In 2021, regulation (EU) 2019/947 is amended by (EU) 2021/1166. This amendment postpones the date of application of the standard scenarios for both visual line-of-sight (VLOS) and beyond visual line-of-sight (BVLOS) operations (Figure 7). In other words, it adjusts the period during which operators of unmanned aircraft (UAS) can submit declarations compliant with certain operating scenarios. This amendment extends the effective date of certain rules for Class C5 and C6 UAS such as the aim is to give UAS operators more time to comply with the harmonized standards (EUR-Lex, 2021). On January 26, 2023, the EASA introduced U-Space. It's a solution for managing air traffic and integrating UAVs into it, while remaining secure, safe and respecting privacy in airspace. U-space benefits all operators, service providers, companies and citizens concerned using civil UAVs (Droneport, 2023). The main features of U-Space are as follows: Management of authorized flight zones, air traffic monitoring, geofencing, real-time tracking, automated flight authorization, drone identification and registration, and communication between drones and operators (EUR-Lex, 2023).

Belgian Implementation:

Belgium has adopted the rules mentioned above but added its own national rules to best suit our country. This is the Royal Decree on the use of Remote Piloted Aircraft Systems (RPAS) which has been in force since April 10, 2016 and which segments open category drones according to their weight and use. There are therefore 3 classes, class 1a, class 1b and class 2 (Figure 8).

Class 1a: High-risk operations. Drone must fly in daylight, weigh less than 150kg, the pilot must have the drone in sight, the drone flies up to 90m. For these operations a license issued by the Belgian Civil Aviation Authority (BCAA) is required after practical and theoretical tests.

Class 1b: Medium-risk operations. Drone must fly in daylight, weigh less than 150kg, the pilot must have the drone in sight, the drone flies up to 90m. For these operations a license issued by the Belgian Civil Aviation Authority (BCAA) is required after practical and theoretical tests.

Class 2: Low-risk operations. Drone must fly in daylight, weigh less than 5kg, the pilot must have the drone in sight, the drone flies up to 45m. For these operations a license issued by the Belgian Civil Aviation Authority (BCAA) is required after practical and theoretical tests.

In terms of privacy and data protection, the Belgian data protection authority (DPA), ensures that Belgium is well aligned with the general data protection regulation (GDPR). Indeed, drone operators must follow the rules of consent in terms of data collection and data use (Schrijver, 2015).

In addition, there are other rules specific to Belgium:

No-Fly zones: No-fly zones are listed on a map accessible on the Internet (Figure 9) and include airports, military installations and dense urban areas.

Maximum Altitude: Maximum altitude of 120m (Skeyes.be, 2019).

Belgian drone delivery legislation:

As far as regulations for delivery drones are concerned, they are very strict, which shows the questions that exist in terms of security, safety and privacy. Delivery drones do not fall into the Open category, but into either the Specific or Certified categories of European regulation. It is therefore necessary to carry out risk assessments and obtain operational authorizations from the BCAA that will judge the safety of the project. Belgium studies the authorizations for BVLOS flights on a case-by-case basis. For Use Case 1: B2C Parcel Delivery, these regulations are particularly restrictive due to urban overflight, BVLOS needs, and potential interaction with the public.

In Belgium, Helicus Aero Initiative (Use case 2: Medical delivery), a company aiming to deliver medicines and medical equipment by drone, has collaborated with the BCAA to define safe framework and protocols to obtain authorization for test flights. There is also ADLC and the Port of Antwerp for the Samplifly project received authorization from the BCAA to deliver

medical samples between the ports of Antwerp and Bruges. These authorizations are the result of the Specific Operational Risk Assessment (SORA) process. Samplifly can therefore carry out BVLOS flights, transporting up to 15kg of cargo, and perform night flights (Esa.int, 2023).

In Belgium, there are several key stakeholders involved in the possible implementation of a drone delivery system at the legislative level.

First, as already mentioned, there's the Belgian Civil Aviation Authority (BCAA), the body that lays down the specific regulations for drone use.

The European Union Aviation Safety Agency (EASA), which sets legislation at European level. They play a key role in harmonizing regulations across Europe and facilitating cross-border drone operations.

In terms of confidentiality, rules have been put in place for surveillance and photography in public places, to protect privacy. In terms of liability, a drone operator is responsible (Drone Laws, 2021).

In summary, Belgian drone regulations represent both a barrier and an enabler , as it is overseen by the EASA and additional national laws. The rules (EU) 2019/947 and (EU) 2021/1166 ensure safety, security and rules regarding airspace management, and the royal decree adds further security. While BVLOS operations and urban overflight are tightly controlled, particularly relevant for B2C parcel use cases, the existing framework has shown flexibility for high-impact projects (Helicus & Samplifly). Thus, Use Case 1 remains constrained, but not impossible, provided sufficient risk assessment, stakeholder coordination, and regulatory compliance are achieved.

3.3.3. Technical Challenges

The literature has shown that several technical barriers exist in terms of battery capacity, the maximum load the drone can carry and the navigation systems that must be able to ensure safe operations (Floreano & Wood, 2015).

In Belgium, these barriers are present. Cities such as Brussels, Antwerp or Gent are densely populated, with buildings close together and narrow streets. These conditions are conducive to higher accident risks. High urban density requires advanced navigation and anti-collision systems, which are currently existing for airplanes and are under development and test for drones. Indeed, for the first time, a drone flight took place in the controlled airspace of an

international airport, Brussels Airport, with active deconfliction between ATM (Air Traffic Management for conventional manned aviation) and UTM (for unmanned aviation). Skeyes and SkeyDrone exchanged data extensively, allowing the airspace to stay active for conventional manned aviation while safely incorporating a drone flight at the same time (Verwilligen, 2025).

These technical challenges are amplified in urban B2C parcel delivery (Use Case 1) due to the complexities of navigating dense cityscapes and ensuring precise deliveries while avoiding various obstacles. Unlike medical emergencies (Use Case 2) or disaster relief (Use Case 6), which often operate in less congested environments, urban B2C drone delivery faces heightened navigation risks, making advanced anti-collision systems and real-time data processing crucial.

In addition, Belgian companies such as Unifly, ADLC and Helicus are investing in research and development to improve drone autonomy, battery life, payload capacity and real-time data processing capabilities (Helicus, 2018). Now Helicus can deliver blood bags which is around 5Kg and Samplifly drones can carry a payload of up to 15 kilograms over distances of up to 60 kilometers (SGSCorp, 2024).

As far as the weather is concerned, Belgium doesn't offer a favorable setting due to heavy rain or strong winds. This calls into question the drone's stability and reliability, requiring advanced engineering solutions and robust design standards (PwC, 2018).

Despite these technical challenges, the advances being made in navigation systems, battery technology, and research initiatives signal a positive trajectory for the industry. With ongoing investment and innovation, it appears that the barriers to successful drone delivery operations in Belgium are surmountable.

3.3.4. Economical Challenges

The literature review has identified economic barriers such as the high investment required to purchase drones and the instrumentation needed to operate delivery drones for the last mile. Long-term economic viability is also raised, as is cost-effectiveness compared with traditional methods (Janjevic & Winkenbach, 2020).

The very high initial cost is a barrier in Belgium for small and medium-sized businesses. A commercial drone can cost between 5,000 and 50,000 euros per unit, to which must be added maintenance costs, control centers, recharging stations and the cost of training staff to operate

such a system (Drone Launch Academy, 2024). These economic challenges are particularly relevant for Use Case 1: B2C parcel delivery, which requires large-scale deployment of drones in high-density areas.

The economic viability of drones in Belgium is also questionable, given that the traditional means like vans or truck are most effective and cost-efficient. Moreover, Belgian regulations currently prohibit delivery drones, which is a major limitation to the implementation of this system in companies. Achieving economies of scale and cost reductions through global adoption is therefore not possible now (Riedel et al., 2023).

To overcome this economic barrier, it is necessary to find investment and funding. Belgium has various grants and incentives to support technological innovation. Government grants and incentives include Innoviris, the Brussels R&D institute, which offers various funding programs to support technological innovation. VLAIO in Flanders and SPW in Wallonia also offer funding for technological research. The forementioned Helicus company, which focuses on medical logistics, transporting medical equipment and drugs, has obtained funding from Innovaris and VLAIO (Ayming Balgium, 2025). Helicus, aligned with Use Case 2: Medical Emergencies, operates under a public interest mandate and was able to secure public funding and regulatory support. In contrast, Use Case 1 requires a viable commercial model, and without market liberalization or incentive mechanisms for urban B2C delivery, private companies in Belgium will struggle to justify the cost. Belgian companies such as Unifly and Helicus did international partnerships to finance their drone projects, as grants and incentives are often not substantial enough. As an example, Unifly has partnered with DJI and Frequentis, and Helicus with Airbus and Matternet.

3.3.5. Social Challenges

Public acceptance of delivery drones is a major barrier according to the literature review. Ethical, noise pollution and safety issues are challenges for the implementation of this technology.

A study conducted by the EASA on the social acceptance of urban mobility in the air shows that Belgians are not against the idea at first sight, but there are significant social barriers. The problem of privacy and being watched by cameras that can constantly observe what citizens are doing is not well seen. Belgian laws are strict when it comes to privacy and cameras in public places. These laws are a barrier to a drone delivery system (EASA, 2021). Privacy concerns are heightened in urban/suburban B2C parcel delivery (Use Case 1) due to frequent

drone flights over residential areas, increasing potential surveillance risks. Conversely, socially beneficial use cases like medical emergencies (Use Case 2) and disaster relief (Use Case 6), operating in less populated zones, encounter less privacy resistance.

Noise pollution is a problem for the acceptance of delivery drones. The Belgian regulations in place for drone use take care of this by imposing maximum flight distances from dwellings, as well as times when drones can be flown (EUR-Lex, 2019). Noise pollution is a greater concern for frequent urban drone operations, especially in B2C delivery (Use Case 1) and high-density urban logistics (Use Case 4). Rural deliveries (Use Case 5) and medical emergencies (Use Case 2), operating in less populated areas, pose less significant noise disruption.

Safety is a crucial issue to consider, as drones can injure and damage property. The density of cities in Belgium and their occupancy increases this risk. Here again, Belgian regulations try to keep the risk to a minimum, with their strict rules on flying being a barrier to delivery drones. Urban safety is critical for B2C deliveries (Use Case 1) due to proximity to structures and people, while B2B transfers (Use Case 3) benefit from controlled industrial settings. In contrast, medical emergencies (Use Case 2) and disaster relief (Use Case 6) experience easier safety management thanks to their lower-frequency flights in simpler environments.

To raise public awareness, Belgian companies and the government are investing in campaigns to raise awareness of drones and their uses as well as their benefits and safety measures towards drones. DroneDays was organized by Brussels Capital Region, where industry professionals were on hand to give demonstrations and workshops on drone technology. The Mobility FPS has launched campaigns to inform the public about drones, with brochures, websites and social networks. The Belgian Civil Aviation Authority (BCAA) has also launched drone training programs to familiarize the population with this new technology.

3.4.Comparison of Facilitating Factors with Belgian Context

3.4.1. Introduction

The barriers have been analyzed and to effectively evaluate the implementation of delivery drones for the last mile in B2C in Belgium it is also essential to identify the factors that facilitate its adoption. This section examines the different positive factors highlighted in the literature and their specific relevance to the Belgian context. By studying regional dynamics, this section aims to define the unique opportunities of the Belgian market, but also to provide information to stakeholders seeking to understand the complexities of deploying this technology.

3.4.2. Environmental Drivers

Various environmental benefits for the use of delivery drones for last mile delivery have been identified in the literature review, such as the demand for more sustainable solution to reduce carbon emissions compared with current delivery methods and the optimization of urban logistics by reducing traffic congestion (Goodchild & Toy, 2018).

Belgium, like every other country in the European Union, has environmental objectives and wants to reduce its impact on the environment to become more sustainable, which makes it a rather favorable framework for the implementation of delivery drones. In addition, since 2023, parcel delivery companies with more than 250 employees have been required to demonstrate their environmental efforts. Petra De Sutter, Minister of Postal Services, launched this proposal, which was subsequently accepted by the Belgian government (Brussels Times, 2023). Drones and their potential to reduce environmental impact are therefore in line with Belgium's objectives.

Big cities such as Brussels, Antwerp and Ghent are faced with traffic congestion (McNally, 2019). Implementing a delivery drone can reduce this problem, as well as the pollution associated with the many traditional delivery vehicles. This can help solve the logistical and environmental problem of last mile delivery.

In the Belgian context, the environmental driver is particularly relevant to Use Case 1: B2C Parcel Delivery in Urban/Suburban Areas, where congestion and emissions from vans are a growing concern. Urban municipalities like Brussels are actively exploring low-emission logistics zones, and drones may complement efforts to reduce traffic in narrow streets and improve air quality. Here, the drone’s role in supporting sustainability policies becomes a strong justification for adoption.

In Belgium, the already mentioned Samplify project has been developed to transport chemicals between the ports of Bruges and Antwerp. This shows that Use Case 3: B2B Component Transfer also benefits from this driver. The aim is to offer a fast, reliable and, above all, more sustainable solution than traditional means of delivery. The company wants to solve the problem of road congestion and reduce CO2 emissions with drones capable of transporting up to 15kg of goods over 60km. This project is in the test phase and is specific to the transport of chemical samples (Samplifly, 2024).

The environmental driver is less decisive for Use Case 2: Medical Emergencies and Use Case 6: Disaster Relief, where the primary motivation is urgency and life-saving potential rather than emissions reduction. Therefore, while the environmental argument is valid across multiple cases, it carries the most strategic weight for urban B2C and industrial B2B applications within Belgium's policy and infrastructure landscape.

3.4.3. Operational Efficiencies

This facilitator encompasses the ability to optimize the efficiencies of delivery through effective route planning and integration with logistics systems, so that the last mile realized by delivery drones is not only more efficient but also lost costly through substantial long-term cost reduction.

Belgium has a well-established and well-developed logistics infrastructure, ranging from large-scale logistics to last-mile delivery logistics. The country's strategic location and existing transport networks are therefore favorable factors for new innovative parcel delivery solutions, including delivery drones that can be integrated with the already existing logistics network (Embracing Belgium, 2025).

Belgium has several smart city projects. Projects such as Citymesh's SENSE Project or Pix4D's aim to integrate drones into smart city projects, whether for logistic purpose, emergency missions or urban planning, infrastructure maintenance and environmental monitoring. Drones therefore have a role to play, as they are aligned with the goal of improving urban logistics and reducing the environmental impact of cities.

Drones also have the potential to reduce last-mile delivery costs. A study by VVA Brussels comparing the cost effectiveness of drones with electric vans provides interesting information. The study compares three types of deliveries: biomedical samples (Use case 2), food (Use case 4), and parcels (Use case 1). In this thesis, the scope is B2C parcel deliveries. The cost assessment analysis indicates that e-vans are the most economical vehicles for same-day deliveries, with a delivery cost of around EUR 0.14, whereas the estimated cost for drones is EUR 0.59 (Figure 10). Nonetheless, in the case of express delivery within 30 minutes from the time of order, drones gain a competitive edge. The analysis reveals that in this scenario, the cost per delivery for each drone is anticipated to be EUR 1.00, whereas the cost for the e-van increases to EUR 4.35. Drones offer greater efficiency for urgent deliveries as they can fly straight to their destinations, bypassing traffic and minimizing delivery times. Conversely, e-vans become less economically viable in these scenarios due to the requirement for quicker,

less efficient routes and a reduced number of parcels transported per journey, which increases their delivery costs (Tavares, 2019). The findings from the analysis suggest that drones are unlikely to fully take over last-mile parcel deliver, instead, they are might be used to serve a specific type of delivery or be integrated with other mean of delivery.

Overall, the Belgian logistics ecosystem offers favorable conditions for drone integration, but the efficiency gains are most compelling for use cases involving urgent, high-frequency delivery within constrained urban infrastructure.

3.4.4. Market Demand

The literature has shown us that the market demand for delivery drones for last mile delivery is directly correlated with the considerable development of online shopping and consumers' desire to have their goods delivered as quickly as possible. Consumers are looking for same-day or next-day delivery, pushing companies to find solutions to meet these demands (Goodchild & Toy, 2018). In addition to consumer market demand, there is also the market demand for logistics companies and for drone manufacturers that are driver to the implementation of drone delivery for last mile.

Online shopping in Belgium has been growing for several years, with a market worth $6 billion in 2017 and $9 billion in 2024 (Statista, 2024). Added to this growth in online shopping is the need for fast delivery, as demanded by customers. These demands are driving the search for innovative delivery methods such as drones.

Belgium is a country where competition in terms of logistics is fierce, driving companies to continually innovate to gain a competitive edge (Oryx Logistics, 2024). This competition is an advantage for the adoption of drone delivery technology, as companies seek to reduce their costs, the carbon footprint of last-mile deliveries and delivery times. Several Belgian companies are looking into drone technology, such as Bpost, which in collaboration with Apple Express has launched pilot projects in Canada for the delivery of parcels and medicines (The Brussels Times, 2022). Moreover, as mentioned earlier, Belgium is supporting technological development and innovative projects. Public and private investment is a real push for delivery drones. These incentives are positive for the logistics company and encourage the adoption and implementation of such last-mile delivery systems.

Finally, this market demand driver, due to the desire of consumers and logistics companies to integrate drones, results in a positive market demand for manufacturing drones and an interest

in investing in this technology. As an example ADLC startup secures 2 millions euros in seed funding to expand its services. The funding round was spearheaded by Galactic Beacon Ventures, with contributions from LRM, the Port of Antwerp-Bruges, and NXT II. The startup intends to utilize the investment to expand its drone logistics services on a global scale, reflecting an increasing interest in the incorporation of drone technology within industrial logistics.

Regarding the use cases, B2C Parcel Delivery (Use Case 1) is primarily driven by the consumer market, with online shopping growth and demand for faster service encouraging drone adoption in Belgium. B2B Component Transfer (Use Case 3) also benefits from logistics sector interest, particularly in industrial areas, demonstrating efficiency improvements. In contrast, Medical Emergencies and Disaster Relief (Use Cases 2 and 6) are driven by public need and governmental support, not market dynamics. In summary, market demand is a major facilitator for drone integration in Belgium, but its influence is strongest for B2C and B2B commercial scenarios.

3.5.Synthesis of Findings on comparison with Belgian context

3.5.1. Interpretation of barriers within the Belgian Context

Belgium therefore faces obstacles to implementing drone delivery for the last mile in B2C parcels, but there are also opportunities. Legislative obstacles are significant, specifically related to BVLOS flights, which demonstrates a need for management and implementation of security protocols. These are especially critical for Use Case 1: B2C Parcel Delivery in urban/suburban areas, where flights are frequent, commercial, and occur over populated zones. However, the establishment of U-Space zones allows for standardized guidelines and heralds clearer legislation. Technical challenges such as batteries, navigation systems, and maximum parcel weights are present, but technological investments are promising to overcome them. Regarding economic obstacles, the initial investment is significant, but financing and partnership options exist in Belgium for innovative projects. Social challenges exist, and public awareness must be raised to find solutions to problems related to privacy and noise pollution. The analysis of these obstacles shows that even if there are more significant obstacles such as legislation, there is potential collaboration to innovate and implement drone deliveries for the last mile in B2C in Belgium.

Table 3: Comparison of barriers and the Belgian context

Category	Barrier	Disadvantage	Belgian Context	Importance for B2C urban parcel delivery
Regulatory	Airspace management and safety regulations	Complex air traffic management	Rules (EU) 2019/947 and (EU) 2021/1166	Very High
Regulatory	Privacy/confidentiality concerns	Unauthorized surveillance and data collection	Privacy GDPR-aligned laws in place to avoid unauthorized surveillance and data collection	Very High
Regulatory	Legal liability and compliance	Unclear regulations and evolving technology	All drone operators are liable for any damage they cause, and insurance exist	High
Technical	Battery life	Short drone battery life limiting flight distance	Battery life restricts drone range and frequency, especially in dense urban areas with high delivery volumes	High
Technical	Weather condition	Drone operation issues in rain, snow, and extreme temperatures	Frequent adverse weather in Belgium complicates drone reliability	High
Technical	Limited carrying capacity	Limited payload capacity for delivery drones that limit the kind of object being deliverable	Projects existing in Belgium with a payload capacity of 15kg sufficient for many standard B2C parcels	Low
Technical	Navigation	Need for advanced navigation systems and anti collision avoidance systems	Requires advanced systems currently under development to operate safely in dense cities. Innovation research and companies are working on these technologies. High risk of accidents due to densely populated areas with close buildings and narrow streets.	Very High
Social	Public perception and public trust	Mixed public sentiment and social anxiety	EASA study showing a good acceptance	High

Social	Ethical concerns	Fear of surveillance and privacy invasion	Legislation in place to protect privacy	High
Social	Employment impact	Potential job loss in the traditional delivery sector	N/A	Moderate
Social	Noise pollution	Noise produced by drones affecting urban environments	Noise issues lead to regulations on flight distances and times, complicating delivery operations.	High
Economical	Initial investment	High upfront costs for drone and infrastructure	High purchase, maintenance, training, and infrastructure costs, particularly for SMEs. Need for significant investment and funding, despite available grants and incentives. Traditional delivery methods are more cost-effective	Very High
Economical	Operational and maintenance costs	Ongoing costs for insurance, training, and maintenance	Training and technical certification required; maintenance infrastructure not yet widely deployed	High
Economical	ROI/Economic viability	High initial investment requiring high delivery volume	Cost per delivery higher than e-van for regular delivery; more viable for urgent express use cases	High

3.5.2. Interpretation of drivers within the Belgian Context

In Belgium, various factors are facilitating the implementation of last-mile delivery drones for B2C parcels (Use Case 1). Indeed, environmental drivers align with national sustainable development objectives, making drones an interesting and viable solution for reducing carbon emissions and decongesting road networks.

Operational efficiency drivers, such as route optimization and integration with Belgium's robust logistics network, are promising for frequent, small-package deliveries typical of B2C models. Long-term cost efficiency is still debatable; under certain specific conditions, drones are more profitable (urgent delivery), but for normal deliveries, drone delivery is more expensive in Belgium than traditional methods.

Finally, changing consumer preferences are driving market demand for this technology, forcing logistics companies to innovate and integrate drone technology for faster service, and therefore for drone manufacturers to invest in developing the technologies. These factors reveal a promising landscape where collaboration and investment can facilitate the successful implementation of drone delivery in the competitive Belgian market.

Table 4: Comparison of drivers and the Belgian context

Category	Facilitator	Advantage	Belgian Context	Importance for B2C urban parcel delivey
Environmental	Demand for Sustainable Solutions	Reduced carbon emissions	Aligns with Belgium's goal to reduce environmental impact of deliveries and become more sustainable Regulations requiring large delivery companies (+250 employees) to demonstrate environmental efforts support drone adoption.	High
Environmental	Optimization of Urban Logistics	Decreased traffic congestion	Samplify project that provides a sustainable solution for transporting chemicals between Bruges and Antwerp, reducing CO2 emissions. Drones can reduce traffic congestion in cities like Brussels, Antwerp, and Ghent	High
Operational Efficiencies	Optimization of drone routes, integration with other delivery means	Increased efficiency and quality of service	Belgium's well-developed logistics network supports integration of delivery drones. Institutions like Innoviris and VLAIO support research and financial backing for drone projects Companies/ Startups collaborate with BCAA and the government to ensure safe drone operations.	High

			Projects like Citymesh's SENSE and Pix4D integrate drones into urban logistics and infrastructure maintenance.	
Operational Efficiencies	Substantial long-term cost reduction	Lower operating costs	Drones become more cost-efficient only under specific scenarios (e.g., urgent 30-minute delivery).	Moderate
Market Demand	Evolving consumer preferences for speed and reliability	Competitive advantage, enabling businesses to meet growing expectations for faster delivery options.	E-commerce growth and urban demand for same-day delivery are major drivers in Belgium.	Very High
Market Demand	Enterprises Integrating Drones into Their Logistics for Delivery	Efficiency gains from quick delivery increases consumer satisfaction and loyalty, resulting in a stronger market position.	Fierce competition in Belgium's logistics sector pushes companies to adopt cost-effective, fast, and environmentally friendly delivery methods.	High
Market Demand	Drone Manufacturers	Encourages technological advancements, leading to improved drone capabilities and lower operational costs.	Belgian startup ADLC received major funding to expand logistics drones; R&D support from Innoviris, VLAIO, and international partnerships (e.g., Helicus).	High

3.5.3. Interview guide

Based on the literature review and the findings of the comparison with Belgian context, a semi-structured interview guide (Annex 2) was developed. The goal of these interviews was to validate, qualify, or invalidate what was written in scientific articles through discussions with experts active in the drone sector. Different profiles were interviewed and are listed in the next section. While the central focus of this thesis is the adoption of drone technology for B2C parcel delivery in last-mile logistics, some of the interviewed experts operate primarily in adjacent domains, such as medical drone logistics or industrial applications. To address this, the interview questions were designed to be broad enough to capture sectoral expertise but always directed toward relevance for B2C urban delivery scenario.

4. Empirical Analysis II: Validation and Experts Insights

4.1.Introduction

The purpose of this section is to compare the findings found in the literature review section with the information gathered during interviews with experts. It is crucial to carry out this synthesis to understand the complexities, trends and nuances that are the barriers and drivers to the adoption of this technology. A comparison will be made of the barriers identified in the literature and those mentioned by the interviewees. This allows for the discovery of commonalities as well as specific challenges encountered in Belgium. Similarly, the facilitators will be analyzed and compared to understand the emerging convergences and divergences. Through this process, the findings will be synthesized to construct a comprehensive framework that captures the interactive dynamics between barriers and drivers of drone technology adoption.

4.2.People contacted for Interviews

Various experts from various sectors related to drone technology were interviewed as part of this thesis and are listed in the table below. Among them were representatives from a software company specializing in autonomous traffic management (Unifly), a startup focused on industrial drone logistics (ADLC), and an incubator dedicated to the development of artificial intelligence systems in the drone sector (ID2MOVE). Interviews were conducted with a government agency responsible for mobility and aviation policies (FOD Mobiliteit), as well as with an expert from academic institutions engaged in drone research (UHasselt & ULiège).

Data was also obtained from consulting firms specializing in the implementation of drone technology (PimConsult) and from a company specialized in medical delivery with drones (Helicus). While these discussions provided significant insights, many other companies were approached, including drone manufacturers, courier services, and aviation authorities, but many did not respond. These collective contributions enriched the analysis of the drivers and barriers to drone adoption for last-mile delivery.

Table 5: List of people contacted and interviewed

Name	Function	Company Name	Interviewed (Y/N)	Interview Date	Transcript in Annexes
Mario Cools	**Transport and mobility professor**	**UHasselt and Uliège**	**Y**	**23/08/2024**	**1**
Grégoire Moreau	**Chief executive officer**	**ADLC**	**Y**	**26/02/2025**	**2**
Emilien Watelet	**Director**	**ID2MOVE**	**Y**	**28/11/2024**	**3**
Patricia Van Acker	**Head of unmanned aicraft systems**	**FOD Mobiliteit**	**Y**	**04/12/2024**	**4**
Jürgen Verstaen	**Chief executive officer**	**Unifly**	**Y**	**18/03/2025**	**5**
Mikael Simam	**Chief executive officer**	**Helicus**	**Y**	**11/04/2025**	**6**
Didier Van Nes	**Chief executive officer**	**PimConsult**	**Y**	**07/04/2025**	**7**
Simon Devoldere	Common Information Service manager	Skeyes	N	/	/
Hendrik-Jan Van der Gucht	Managing Director	Skeydrone	N	/	/
Rob de Roo	Researcher	VIVES	N	/	/
Bernard Piette	Managing Director	Logistics in Wallonia	N	/	/
Anthony Bievelez	Project Manager	Skywin	N	/	/
Arnaud Collette	Press officer	Skywin	N	/	/
Kris Rottier	Founder	Drone Future	N	/	/
Ward Decaluwe	Chief executive officer	Droneport	N	/	/
Adrien Fita Cordina	Technical Advisor for the Aero-Thermo-Mechanical Service	ULB	N	/	/
Nicolas	Rousseau	Belgian Drone Federation	N	/	/
Mark Vanlook	Digital Business Director	Syntra PXL	N	/	/
Contacted via info email adress	/	Antwerdronecompany	N	/	/
Contacted via info email adress	/	Bpost	N	/	/
Contacted via info email adress	/	Altigator	N	/	/
Contacted via info email adress	/	Drone Matrix	N	/	/
Contacted via info email adress	/	SGS	N	/	/
Contacted via info email adress	/	DHL	N	/	/
Contacted via info email adress	/	Skyebase	N	/	/
Contacted via info email adress	/	Airobot	N	/	/
Contacted via info email adress	/	Antwerp drone pilot	N	/	/
Contacted via info email adress	/	Sky-Hero	N	/	/
Contacted via info email adress	/	Sabca-UAS	N	/	/
Contacted via info email adress	/	AW-Drones	N	/	/
Contacted via info email adress	/	Airmes.io	N	/	/

4.3. Company description of people interviewed.

1. **Jurgen Verstaen - Unifly NV:** *Unifly is a European software company that provides a platform for drone telematics services for unmanned traffic management. The company provides mapping and location data to connect authorities with pilots for the safe integration of drones into the airspace and unmanned aviation.*
2. **Grégoire Moreau – ADLC:** *A Drone Logistics Company (ADLC) is a start-up from the Beacon community that develops and designs industrial express delivery by drone. ADLC's mission is to provide safe and sustainable services and to integrate drone transport into its business operations.*

3. **Emilien Watelet – ID2MOVE*:*** *ID2Move is an incubator designed to support the development of artificial intelligence technologies and autonomous systems, with a special focus on drones. Adapted to the needs of start-ups and SMEs, ID2Move facilitates relations with the academic world.*
4. **Patricia Van Acker – FOD Mobiliteit:** *FOD Mobiliteit, also known as the Federal FPS Mobility and Transport, is a government agency in Belgium responsible for formulating and implementing policies related to mobility, transport, and aviation*
5. **Mario Cools – UHasselt & ULiège:** *Belgian universities*
6. **Mikael Simam – Helicus:** *Helicus is a Belgian company focused on developing drone logistics solutions, particularly for the transportation of medical supplies and equipment.*
7. **Didier Van Nes – CEO at PimConsult:** *PimConsult is a Belgian consulting firm that specializes in providing strategic advice and solutions for companies looking to implement drone technology in their operations. The company focuses on areas such as regulatory compliance, operational efficiency, and integration of unmanned aerial systems (UAS) into various industries.*

4.4.Barriers to Adoption: Insights from Experts

4.4.1. Introduction

This section compares the barriers found in the literature with the opinions of experts active in the field in Belgium. This analysis aims to better understand the current delivery drone landscape and its implications for the various stakeholders in the sector within the scope of B2C urban last-mile parcel delivery (Use Case 1). While the interview questions were focused on B2C delivery, several experts interviewed operate primarily in adjacent sectors such as medical logistics or B2B use cases. To ensure analytical consistency, when an insight originates from a non-B2C context, this is briefly noted to clarify its applicability. This approach ensures that findings remain aligned with the thesis scope while benefiting from cross-sector expertise.

4.4.2. Regulatory Challenges

4.4.2.1. Air Management and Safety Regulations

Interviews have demonstrated that regulatory environment associated with drones' operation represent the foremost obstacle to the widespread adoption of drone delivery systems in Belgium. Jürgen Vertstaen from Unifly, a company specializing in unmanned traffic

management, explained the complexity of air traffic management and the strict safety regulations that create hurdles for drone operations. Indeed, there are many challenges surrounding Beyond Visual Line of Sight (BVLOS) flights, although they are now authorized in Belgium, these authorizations are subject to strict requirements and risk assessments (SORA) and are therefore evaluated on a case-by-case basis. Emilien Watelet of ID2MOVE also pointed out that these authorizations issued by the DGTA can take more than 12 months to be processed, which hinders companies' willingness to invest in this technology.

However, the current regulations around BVLOS operations are still evolving. Patricia Van Acker from the Fod Mobiliteit emphasized that Belgium is relatively advanced in permitting BVLOS operations, partly due to pilot projects undertaken in areas like the Port of Antwerp (Samplifly). Indeed, Belgian legislation is evolving with U-space that aims to create a structured environment where multiple drones can operate safely, especially in urban settings characterized by high air traffic density. The U-space framework present in Antwerp now offers an opportunity for organized drone operations, although a robust national strategy remains to be implemented.

Didier Van Nes from PimConsult and Patricia Van Acker both agree that the legislation lacks the necessary structure to ensure safe drone operations in urban areas where populations are dense and air traffic is important. Dider also emphasized the importance of establishing defined safety standards that align with traditional air traffic regulations. Mickael Shimam, CEO of Helicus, also mentioned the limitations of Belgian legislation that restricts flight tests and the need for its simplification.

Additionally, Mario Cools, professor of transport and mobility at UHasselt, indicated that the complexity also results from the different flight bans, whether military or civilian, which is a hindrance to drone operations in urban environment. The relationship between regulatory bodies and drone operators needs strengthening, as pointed out by several interviewees, to foster clearer communication regarding permissible operational practices and risk management strategies. Finally, all interviewees agree that Belgium is working on the regulation, follows European directives and is motivated to ensure that legislation is favorable to delivery drones for last mile delivery in B2C.

4.4.2.2. Privacy and confidentiality concerns

Privacy was a concern raised by several interviewees, particularly with the issue of unauthorized surveillance mentioned by Patricia Van Acker, Mikael Shimam and Mario Cools. Mikael added that current regulations in Belgium need more comprehensive guidelines, emphasizing that challenges related to privacy legislation must be addressed to strengthen public trust and acceptance. Didier Van Nes and Grégoire Moreau did not consider the privacy issue as a major issue, arguing that proper authorizations and safety measures mitigate these concerns. Generally speaking, the barrier is seen as existing but surmountable, Belgium having clear GDPR rules, the application of rules for drone delivery for the last mile in B2C is a matter of time.

4.4.2.3. Legal liability and compliance

Legal liability surrounding drone operations is also a topic worth investigating. Emilien Watelet points to a certain lack of clarity and ambiguity regarding legal liability in the event of accidents involving operators. Mikael indicates that this complexity regarding liability issues creates uncertainty for companies wishing to invest in this technology, but it also has an impact on public perception. Interviewees pointed out the need for clearer liability frameworks to encourage the acceptance of drones in logistics. Patricia specifically mentioned that current legislation holds operators liable and underscores the necessity of insurance coverage to protect against potential damage. There is a strong call for regulatory harmonization at both national and European levels to facilitate clearer pathways for drone operations.

4.4.3. Technical Challenges

4.4.3.1. Battery life

Battery issues are unanimously not a problem given current technology and the continuous battery capacity improvement. For B2C deliveries in dense urban areas, where distances are shorter, current battery technology is considered sufficient to support short-range operations. However, as Mickael pointed out in earlier discussions, endurance becomes more critical in longer-range or high-frequency delivery models, which may be relevant in future scale-ups.

4.4.3.2. Limited carrying capacity

Grégoire Moreau indicates that current technology must evolve to allow deployment in urban environments, due to the operational standards that drones must meet to enable air delivery but also to increase payload capabilities which can be up to 50kg limiting the type of object to be delivered or the number of parcels delivered per flight.

4.4.3.3. Navigation systems

Emilien points out that the urban environment is a real challenge in terms of navigation for drones: the density of buildings, the population, the numerous obstacles are a problem for their detection and avoidance. Patricia also explains that drones in urban environments fly between 60 meters and 120 meters altitude which operate in controlled airspace, which increases the risk of conflicts with manned aircraft. The need for advanced anti-collision systems, including airspace integration with conventional aircraft, is urgent for urban B2C delivery use cases. Mikael acknowledged that we need more advanced anti-collision technology and system automation suitable for drones. While some countries have made leaps in drone safety technology, Belgium still needs to keep pace. There's a pressing need for a unified approach to integrating these technologies to ensure seamless operations and safety in various environments. These insights are crucial for B2C use where safe and efficient navigation in cities is non-negotiable.

4.4.3.4. Weather conditions

Grégoire, Emilien and Mario explained the impact that adverse weather has on drone operations. While current technologies can perform delivery operations, variable weather conditions limit the ability to apply these operations in all environments. There is therefore a need for innovation to enhance the robustness of drones. While this affects all drone use cases, it is especially relevant for B2C operations aiming for daily, high-frequency flights.

Jürgen is optimistic about the advancement of technology and its rapid progress, while Didier and Mikael were more critical, pointing to the lack of clear rules and standards that prevent the mass production of the technology or its integration into the airspace. This opposition highlights an important point in the industry: finding the balance between innovation and safety. Finaly, the different interviews suggest that the economic aspect is closely connected to the technical one, in the form of high costs for sophisticated technologies, which limit the access for SMEs. In summary, expert views confirm that while technical challenges are not insurmountable, they remain significant for B2C urban parcel delivery.

4.4.4. Economical challenges :

4.4.4.1. Initial investments

The initial investment barrier was acknowledged in most interviews but also refuted. Didier and Mario mentioned the significant cost of purchasing the drone itself and the necessary

infrastructure and equipment, which are significant barriers for SMEs. Mario indicated that this investment can be justified for specific industries, such as use cases like medical logistics, for hard-to-reach locations However, in the B2C parcel delivery context, especially in Belgium's already efficient logistics market, this high upfront cost limits adoption. Grégoire and Mikael confirmed that the initial investment is very costly but is a barrier that can be overcome with a coherent business model suitable for B2C delivery. Conversely, Jürgen explained that commercial drones for delivery can cost between €10,000 and €50,000, which is similar to the price of a traditional delivery van. Hnece, he did not see it as a significant barrier.

4.4.4.2. Operational and maintenance costs

Aside from the initial investment, ongoing operational and maintenance costs pose a significant challenge for companies considering drone delivery. Jürgen noted that drones can reduce delivery times and therefore provide an economic advantage. However, maintenance, infrastructure, necessary equipment, permit costs, and insurance costs present recurring expenses that weigh more heavily on smaller logistics providers, particularly in the B2C segment. Grégoire highlighted the requirement for certified pilots and technical personnel under current regulations, which significantly raises the cost structure. However, Emilien is positive and indicates that although operating costs are significant upfront, the long-term efficiency gains are worthwhile in terms of profitability. This perspective tempers the concerns of others by suggesting that operational costs can be seen as an investment rather than a barrier.

4.4.4.3. ROI and Economic Viability

The interviews offered different perspectives regarding the economic viability of drone delivery for last-mile delivery. Mario and Didier are skeptical about the investment required to achieve a return on investment especially for routine B2C deliveries, where cost margins are thin and expectations are high They noted that ROI is more realistic in niche markets or high-urgency use cases, such as medical deliveries, which are less constrained by price sensitivity. This demonstrates that not all use cases are ready to adopt this technology.

Mikael asserts that the evolution of consumer and business preferences, and the need to innovate to remain competitive, will change the dynamics of ROI through the growing acceptance of drone delivery. Patricia confirms this idea: although current business models for last-mile drone delivery may currently seem uncertain, growing demand in various sectors could ultimately foster a more stable economic environment for drones.

In conclusion, the economic barrier is particularly significant for B2C parcel delivery, where scale, cost, and customer expectations converge. While technology and demand trends may reduce this barrier over time, in the current Belgian context, it remains a key challenge, especially for SMEs.

4.4.5. Social challenges:

4.4.5.1. Public Perception and Public Trust

Public trust and acceptance of drone delivery systems is essential for the implementation of this technology. Jürgen has seen that public opinion has evolved and continues to evolve, with more people seeing the usefulness of drones, whether in emergency services, agriculture, defense, or even logistics. Challenges persist, however, given that the public often tends to associate drones with surveillance and a lack of privacy. Emilien notes that this fear of the unknown has tended to lead to negative public perceptions and therefore a fear of adopting this technology. Grégoire explain that pilot projects like the ADLC one at the Port of Antwerp (primarily B2Bl use but relevant as a public demonstration), are helping to dispel myths and build public confidence, as these tests demonstrate the effectiveness of drones and that operations are controlled and safe. In B2C parcel delivery, where drones would be more visible and frequent, managing public perception is particularly crucial. Experts agree that demonstrating safety and transparency is essential to gain public trust.

4.4.5.2. Ethical Concerns

Significant barriers to the adoption of last-mile delivery drones are privacy and ethical concerns. Mario Cools points out that the overflight of private property by delivery drones raises questions about surveillance and public consent. These questions reflect society's unease about privacy in an increasingly technological world. Patricia points out that the ethical discourse on drone use is complicated by legal frameworks regarding data collection and surveillance. Existing regulations on traditional surveillance are not fully adapted to drone technology, potentially leading to privacy violations and creating legal ambiguities for operators. Mikael emphasized the need for transparent and clear regulations and procedures to respect citizens' privacy. He points out that drones must be equipped with technology that can limit the use of cameras to only necessary situations. For example, his company, Helicus, which delivers to the medical sector, doesn't use cameras, just sensors. While his example stems from non-B2C use, it highlights practices that can be adopted in B2C scenarios to enhance public

comfort. All interviewees mentioned the need for transparency of drone operations and its privacy regulations and its impact that will promote public acceptance.

4.4.5.3. Employment impact:

The impact on employment was not perceived as a barrier by most interviewees. However, Didier expressed his apprehension about the automation of deliveries, which could lead to job losses in the so-called "traditional" delivery sector. He mentioned that drones can reduce delivery costs but also replace manual delivery roles. All other experts see an opportunity to create new jobs in logistics management or technical support. Grégoire indicated that drones will not entirely replace jobs, but they will complement current logistics functions, allowing workers to focus on more complex tasks and therefore increase productivity. This contrast in vision between Didier and the other experts shows that it is necessary to mitigate the negative effects of automation while promoting job creation in the drone sector.

4.4.5.4. Noise Pollution

Drone noise was identified as a social barrier, particularly in dense B2C delivery environments where frequent operations are expected. According to Patricia, although drones make less noise than a delivery van, the number of drones in urban areas can be problematic, especially in dense and already noisy areas. Jürgen argues that this pollution must be managed to ensure public acceptance. Mikael shares solutions such as the need to develop quieter technologies and optimize flight plans to minimize disruption. These strategies are essential for B2C adoption, where high delivery volumes in populated areas require minimal disruption to everyday life. Finding a solution to noise concerns is essential to be able to offer drone operations that are non-disturbing to the public and experts are confident it will be managed.

These discussions demonstrate that it is feasible to overcome these social barriers by addressing a multi-dimensional approach, such as ethical considerations, public education, and professional transitions. Integrating the perspectives of all parties is necessary to have a constructive dialogue on the implementation of drone delivery.

4.4.6. Findings from Experts:

This section synthesizes the barriers identified throughout the thesis by presenting a comparative table that consolidates insights from literature, Belgian policy context, and expert interviews. The goal is not only to summarize known challenges but to evaluate how industry

experts validate, contradict, or nuance these barriers, particularly within the scope of B2C parcel delivery in Belgium. The table below provides a comprehensive comparison of major barrier categories, highlighting those most critical from a practical standpoint. This analysis connects theoretical findings with real-world insights, guiding strategic recommendations.

Table 6: Comparison of barriers with experts' insights

Category	**Barrier**	**Disadvantage**	**Belgian Context**	**Experts Insight**	**Importance for B2C urban delivery**
Regulatory	Airspace management and safety regulations	Complex air traffic management	Rules (EU) 2019/947 and (EU) 2021/1166, introduction of U-space	Experts note complex BVLOS approval processes (often >12 months) that hinder investment. U-space seen as a way to simplify future operations..	High
Regulatory	Confidentiality concerns	Unauthorized surveillance and data collection	Privacy legislation in place to avoid unauthorized surveillance and data collection	Experts highlight that public trust is critical; transparency and clear policy frameworks are essential to mitigate concerns.	High
Regulatory	Legal liability and compliance	Unclear regulations and evolving technology	All drone operators are liable for any damage they cause, and insurance exist	Experts call for harmonized, clearer liability rules to increase legal certainty and reduce risk for operators.	High
Technical	Battery life	Short drone battery life limiting flight distance	Battery life restricts drone range and frequency, especially in dense urban areas with high delivery volumes	Experts agree battery life is improving and not a critical limitation for short-range urban B2C delivery.	High
Technical	Weather condition	Drone operation issues in rain, snow, and extreme temperatures	Changeable weather (heavy rain, strong winds) affects drone stability and reliability.	Weather conditions are cited by experts as an operational challenge, affecting delivery reliability.	High

Technical	Limited carrying capacity	Limited payload capacity for delivery drones that limit the kind of object being deliverable	Projects existing in Belgium with a payload capacity of 15kg sufficient for many standard B2C parcels	Experts agree that limited payload capacities hinder the types of products that can be efficiently delivered but is not a blocking barrier.	High
Technical	Navigation	Need for advanced sensors, cameras, and collision avoidance systems	Requires advanced systems currently under development to operate safely in dense cities. Innovation research and companies are working on these technologies. High risk of accidents due to densely populated areas with close buildings and narrow streets.	Experts state that advanced navigation systems are under development for the drones. Anticollision systems, systems communicating with aircraft exist but not at the drone level and therefore there is a pressing need for a unified approach to integrating these technologies to overcome this barrier.	Very high
Social	Public perception and public trust	Mixed public sentiment and social anxiety	Study showing a good acceptance	Experts conveyed that while there's growing public acceptance, negative perceptions related to safety and privacy persist and stakeholders should promote and be transparent about drone operations.	High
Social	Ethical concerns	Fear of surveillance and privacy invasion	Legislation in place to protect privacy	Experts highlighted the need for drone operators to address ethical concerns regarding privacy actively but also to have clear and	High

				transparent regulation framework.	
Social	Employment impact	Potential job loss in the traditional delivery sector	N/A	Many experts believe that while traditional jobs might be threatened, new roles will also emerge within the drone sector, requiring workers' reskilling. Making this barrier surmountable.	Moderate
Social	Noise pollution	Noise produced by drones affecting urban environments	Noise issues lead to regulations on flight distances and times, complicating delivery operations.	Experts suggest noise management must be prioritized through less noisy technologies and appropriate air routes to mitigate public concerns about urban noise.	High
Economical	Initial investment	High upfront costs for drone and infrastructure	High purchase, maintenance, training, and infrastructure costs, particularly for SMEs. Need for significant investment and funding, despite available grants and incentives. Traditional delivery methods are more cost-effective	Experts point out that the daunting initial finances may deter SMEs, though innovative financing models could mitigate this.	High
Economical	Operational and maintenance costs	Ongoing costs for insurance, training, and maintenance		Experts suggest long-term gains possible, but financial viability still hinges on volume, automation, and regulation.	High
Economical	ROI/Economic viability	High initial investment requiring high		Experts note ROI is unclear for general B2C delivery, but more	Moderate

		delivery volume		favorable in express/urgent segments.	

The expert interviews corroborated the barriers identified in existing literature, notably in areas such as regulatory complexity, technical challenges within urban settings, and economic considerations. These discussions introduced additional nuances, for example, advancements in battery technology have mitigated previous concerns regarding battery life as a technical constraint. Similarly, issues such as privacy and noise, while acknowledged, are perceived by experts to be manageable through policy adaptation and technological advancements.

The most persistent and critical challenges remain regulatory bottlenecks (especially for BVLOS approval in dense urban areas) and economic scalability for SMEs. ROI remains difficult to justify for routine B2C deliveries under current cost structures. Still, experts expressed optimism, especially in light of growing public interest, pilot programs, and improving drone technologies.

This section underscores the notion that while barriers persist, many are transitional and likely to evolve with strategic investment, regulatory clarity, and enhanced public engagement. The expert feedback helps prioritize where attention should be focused to unlock viable paths forward for B2C last-mile drone delivery in Belgium.

4.5.Facilitators for Adoption: Experts Insights

4.5.1. Introduction

Drone technology is evolving rapidly, offering promising solutions for the logistics sector, particularly for last-mile drone delivery. Despite the barriers to adoption, key drivers that can encourage the implementation of such a system in Belgium were discussed with experts. The following sections examine these facilitating factors based on expert perspectives, with a particular focus on Use Case 1: B2C parcel delivery in urban settings. While some examples are drawn from other sectors, the analysis here focuses on how relevant they are for B2C applications.

4.5.2. Environmental drivers

4.5.2.1. Demand for Sustainable Solutions

These days, the topic of sustainable development is on everyone's agenda, and concerns about global warming are driving the need for solutions, particularly in the logistics sector. These issues are driving the adoption of delivery drones. Drones, being electric and producing zero emissions during operation, are seen as aligned with these demands, especially for short-range urban B2C deliveries. Patricia explained that consumer preferences and regulations are pushing the logistics sector to adopt more environmentally friendly practices. Interviewees indicated that drones could be a viable alternative to traditional delivery methods, especially in urban environments where the need to reduce emissions is greatest. Jürgen explained that the European Green Deal, which was approved in 2020 and is a set of policy initiatives by the European Commission with the overarching aim of making the European Union climate neutral by 2050, is something that will push companies to demonstrate their commitment to sustainable development. Emilien and Grégoire indicated that last-mile delivery drones fit very well with this desire to reduce environmental impact. While Mario agreed that drones is a greener solution that traditional van, he expressed uncertainty about their overall effectiveness, citing alternatives like electric vans and bike deliveries for last-mile logistics. While all experts acknowledged the ecological potential of drones, their effectiveness may depend on context, such as delivery size, distance, and urban layout.

4.5.2.2. Optimization of Urban Logistics

In terms of urban logistics, the reduction of traffic congestion and the possibility of reducing CO2 emissions mean that last-mile delivery drones have significant potential. Emilien, Jürgen, and Grégoire indicate that the use of drones for last-mile delivery is a way to reduce the use of traditional delivery methods (vans, trucks) helping to resolve last-mile inefficiencies and mitigate congestion, critical factors for B2C parcel delivery Experts noted that drones can bypass road networks entirely, allowing for more direct, faster delivery. This independence from traditional infrastructure is especially advantageous for time-sensitive B2C operations in cities. Mikael and Didier, however, pointed out that these environmental benefits must be analyzed to conduct a lifecycle assessment of this technology, given the current issue of battery manufacturing, which is not environmentally friendly at all. However, being a zero-emission vehicle on paper, the drone meets the logistics' desire for sustainability. Therefore, the dual

objective, focused on immediate ecological benefits and long-term sustainability, constitutes a convincing argument in favor of the adoptability of drones for the last mile. Overall, the expert consensus is that environmental drivers are strong facilitators for drone adoption in urban B2C delivery use cases.

4.5.3. Operational Efficiency Drivers

4.5.3.1. Optimization of Drone Routes and Integration with Other Delivery Means

Operational efficiency is one of the most commonly cited advantages of drone technology for logistics, particularly for Use Case 1: B2C parcel delivery. Grégoire and Emilien indicated that logistics performance can be improved by optimizing delivery routes. Drone operators, aided by algorithms, can effectively reduce delivery times and improve the efficiency of the drone delivery system which is ideal for dense urban areas where B2C deliveries are most common.

All interviewees unanimously discussed the opportunity to use drones and integrate them with existing delivery systems (hybrid delivery models), allowing logistics providers to leverage existing infrastructure while maximizing the benefits of drone technology. All mentioned a hybrid model, not the last mile from the warehouse to the home, but rather the drone arriving at a hub with different lockers where multiple packages can be dropped off. This type of model and integration can yield operational capabilities that enhance quick and effective response to changing delivery requirements, further highlighting the previously mentioned environmental efficiencies. Didier highlighted the importance of partnering with local businesses and municipalities to optimize the integration of drones into existing delivery systems. As such, these hubs with lockers installed in high-traffic areas can improve consumer accessibility but also simplify and speed up the delivery process.

4.5.3.2. Substantial Long-Term Cost Reduction

The economic aspect of this technology for last-mile delivery is a very important point regarding its viability. While Jürgen mentioned that commercial drones are not that expensive (10k-50k euros), Didier clearly states that the initial investment cost is significant and can pose a problem for the adoption of the technology. He also indicates that the ability of drones to reduce costs in the long term thanks to the operational efficiency they bring should not be overlooked. The speed provided by drones, but also the possibility of reducing the use of

expensive delivery means, are factors that will lead to a reduction in costs over time. Mikael evokes a similar point of view, indicating that by adopting this technology in their logistics, companies have an increasing growth potential. Discussing the pilot projects existing in Belgium and the growth of the drone sector, Mikael and Grégoire are optimistic about the financial feasibility and the fact that drone operations are becoming more economically viable. In summary, experts agree that operational efficiency is a powerful driver for drone adoption in Belgium's B2C logistics. The effectiveness of this driver is especially pronounced in hybrid models and time-sensitive delivery contexts, where drones offer clear advantages in flexibility, speed, and cost over time.

4.5.4. Market demand drivers

Market demand is differentiated by three different identified markets, all three of which play a crucial role in the adoption of the technology: consumers, companies integrating drones into their logistics and drone manufacturers.

4.5.4.1. Evolving Consumer Preferences for Speed and Reliability

For the consumer market, the growth of online shopping and changing consumer expectations are a real driver for the use of last-mile delivery drones for B2C. Mikael and Patricia shared that consumers are increasingly looking for fast, same-day delivery, as well as reliable delivery, especially relevant in urban B2C scenarios where doorstep drop-offs and parcel security can be challenging. This consumer demand for fast delivery means that industry players must respond to it to remain competitive.

Emilien indicated that this consumer pressure is a push for the adoption of this technology, given that speed and reliability are paramount to them, and therefore, businesses benefit from it. Patricia noted that consumers also need safe delivery. This shift in preferences shows that if service quality requirements are met, public acceptance is greater for innovative delivery systems.

4.5.4.2. Enterprises Integrating Drones into Their Logistics for Delivery

In today's increasingly fast-paced world, businesses must improve their operational efficiency and meet consumer demands. Jürgen and Emilien indicated that companies must find solutions to streamline their delivery processes. Mikael indicated that drones are a viable option for businesses that want to remain competitive, reduce costs, and have a lesser environmental impact. Jürgen explained that route optimization and reduced delivery times offer operational efficiency that can improve businesses' service levels. Grégoire emphasized the flexibility of drone systems, which can adapt to fluctuating demand and urban delivery constraints—a major advantage in B2C parcel networks. This aligns with prior findings that drones may be most viable when integrated with hybrid delivery systems (e.g., hubs or lockers), especially in cities. In general, insights from experts validate that enterprise-level demand is most robust in urban logistics, where competitive pressures are intense and the infrastructure is conducive to scalable drone deployment.

4.5.4.3. Drone Manufacturers and Innovators

The third component focuses on the market demand driver which includes manufacturers and innovators developing drone technologies. This segment focuses on corporations involved in the designing and improving processes of drone technology. As technology progresses, Mario, stressed that there is an imperative need for manufacturers to improve the product’s functionality, safety, and dependability.

According to Jürgen, market opportunities act as an incentive for drone constructors to innovate continuously. Navigation systems, and collision avoidance system accuracy improvements are essential for more widespread filming and usage of drones for delivery services. This view is also supported by the literature that drone delivery systems require active partnership strategies between manufacturers and logistics since both need to work closely with each other to effectively meet the market supply needs.

Furthermore, the information from the interviews underscored that collaboration between the two sectors can potentially drive new solutions required by the industry. From the information collected it became clear that the manufacturers are fully aware of the need to form strategic alliances with the players from the logistics industry. As far as drone integrating companies is concerned, the cooperation provides crucial information and feedback that allows refining the

drone design and functions. This interaction between drone manufacturers and logistics providers enables the development of advanced, efficient drones.

4.5.5. Findings from Experts:

This section summarizes the facilitating factors for last-mile drone delivery identified through expert interviews, which complement the drivers previously discussed in the literature and within the context of Belgium. The table below presents a comparative analysis of these factors, aligning expert perspectives with national dynamics. While some insights are derived from broader industry experiences, each is contextualized in relation to Use Case 1: B2C parcel delivery, which is the focus of this thesis.

Category	Facilitator	Advantage	Belgian Context	Expert insight	Importance for B2C parcel delivery
Environmental	Demand for Sustainable Solutions	Reduced carbon emissions	Aligns with Belgium's goal to reduce environmental impact of deliveries and become more sustainable Regulations requiring large delivery companies (+250 employees) to demonstrate environmental efforts support drone adoption.	Experts agree that the demand for sustainable logistics is growing. They highlight that drone delivery reduces carbon footprints and meets consumer preferences for eco-friendly options, making it a strategic choice for companies pursuing sustainability goals.	High
Environmental	Optimization of Urban Logistics	Decreased traffic congestion	Samplifly project that provides a sustainable solution for transporting chemicals between Bruges and Antwerp, reducing CO2 emissions.	Experts confirm drones reduce traffic and delivery delays in dense cities. Urban logistics optimization is a strong B2C driver.	High

			Drones can reduce traffic congestion in cities like Brussels, Antwerp, and Ghent		
Operational Efficiencies	Optimization of drone routes, integration with other delivery means	Increased efficiency and quality of service	Belgium's well-developed logistics network supports integration of delivery drones. Institutions like Innoviris and VLAIO support research and financial backing for drone projects Companies/ Startups collaborate with BCAA and the government to ensure safe drone operations. Projects like Citymesh's SENSE and Pix4D integrate drones into urban logistics and infrastructure maintenance.	Experts support that integrating drones can enhance service efficiency and lead to faster deliveries while improving overall quality. Especially in an hybrid mode where drones will deliver parcels to a hub/lockers.	High
Operational Efficiencies	Substantial long-term cost reduction	Lower operating costs	Belgian delivery drone projects see opportunity to reduce cost for the last mile delivery	Experts concur that adopting drone technology can lead to significant long-term cost savings. They point out that while initial investments might be high, operational efficiencies gained, such as reduced fuel and labor	Moderate

				costs, will justify the investment as drone technology matures.	
Market Demand	Evolving consumer preferences for speed and reliability	Competitive advantage, enabling businesses to meet growing expectations for faster delivery options.	The rise of online shopping n Belgium drives customer demand for innovative, fast, and reliable delivery solutions, particularly in urban areas.	Experts confirm rising consumer expectations are a strong push for drone-based services, particularly in fast-paced urban settings.	Very High
Market Demand	Enterprises Integrating Drones into Their Logistics for Delivery	Efficiency gains from quick delivery increases consumer satisfaction and loyalty, resulting in a stronger market position.	Fierce competition in Belgium's logistics sector pushes companies to adopt cost-effective, fast, and environmentally friendly delivery methods.	Early adopters can lead the market. Experts say integration supports differentiation and meets urgent demand for speed and sustainability.	High
Market Demand	Drone Manufacturers and Innovators investment	Encourages technological advancements, leading to improved drone capabilities and lower operational costs.	Belgium's diverse logistics sector, combined with governmental support for technological innovation, makes it an attractive location for drone manufacturers.	Experts stress that R&D funding drives innovation. Collaboration with logistics providers refines product design and supports scalable urban B2C adoption.	High

The interviews with experts validated that the primary facilitators influencing B2C drone adoption in Belgium are motivated by sustainability objectives, operational advancements, and consumer expectations for fast and reliable delivery. Experts highlighted hybrid delivery models, route optimization, and the utilization of real-time data as essential factors for enhancing drone deployment in urban settings. While concerns about cost persist, especially for smaller operators, long-term ROI is considered achievable as the ecosystem matures. In summary, the interviews confirm that Belgium presents a promising environment for the

adoption of B2C drone delivery, contingent upon ongoing investment and the development of infrastructure to facilitate integration, especially within high-density logistics corridors.

5. Conclusion

5.1. Restatement of the research problem

This thesis explored the various barriers and factors facilitating the integration of drone technology for last-mile delivery for B2C in Belgium. The objective and main question was to identify the important barriers and the drivers to the adoption of this technology. The study for this thesis was conducted through a literature review and an empirical analysis of the Belgian context, subsequently integrating the perspective of an industry player. This approach allows for a nuanced understanding of the subject and the various barriers and drivers.

5.2. Summary of key findings & interpretations

The outcomes of this thesis highlight a rather complex interaction between barriers and drivers that can influence the implementation and adoption of this technology for the last mile for B2C in Belgium. The work carried out demonstrates several categories of barriers which are the following:

Regulatory Challenges: The main and most significant obstacle for the adoption of delivery drones for the last mile is the regulatory challenges. There are strict European and Belgian rules regarding airspace management, privacy and BVLOS flights. Despite the fact that initiatives such as U-space seek to streamline processes, delays in approval and inconsistent standards continue to obstruct implementation. These obstacles are particularly significant in B2C urban scenarios, where flying over densely populated regions is essential.

Technical limitations: Various technical limitations include battery life, payload capacity, navigation systems, and weather, making it the second most important barrier. Although progress is being made and batteries are no longer an issue, it is essential that innovations accelerate to address operational constraints identified such as the pressing need for integrated anti-collision technologies that are crucial for B2C parcels delivery. Furthermore, experts are clear that technology does not solve everything and that it must interact with regulatory frameworks to ensure safe and efficient operations.

Economic Challenge: There is a double perspective with this barrier. The primary economic obstacle is the initial investment required to acquire the technology and infrastructure, especially for SMEs. Added to this are operational costs such as maintenance, insurance, and training, which are additional costs that are a barrier to the adoption of drone delivery for the last mile. However, it is feasible to achieve long-term efficiency and cost savings, particularly through the implementation of hybrid delivery models. Therefore, the economic feasibility depends on the context and is most favorable in urban B2C scenarios.

Social Challenges: It is essential to have public acceptance and trust. Issues such as privacy, noise pollution, ethics, and the impact on employment are currently holding back efforts even if there is a certain level of optimism regarding the utility of drones in logistics. Public education must be carried out with awareness campaigns to build confidence in drone operations, their safety and respect of privacy.

However, several drivers have been identified to encourage the adoption of drone technology for last-mile parcel delivery in B2C:

Environmental benefits: With the demand for sustainable logistics solutions due to the issue of global warming, delivery drones are a potential solution. Reducing Road congestion and reducing CO2 emissions have been identified as environmental benefits for adopting this technology. This, combined with consumer preferences and regulations, is driving the adoption of environmentally friendly practices, supported by initiatives such as the European Green Deal, which aims for climate neutrality by 2050, and is driving the adoption of this technology. Indeed, the increasing importance of sustainable development and the optimization of urban logistics are drivers for the integration of drone systems. However, experts emphasize the need for a thorough life cycle analysis due to the environmental impact of battery production. Ultimately, while drones offer immediate environmental benefits, their long-term sustainability must be carefully considered. These benefits are especially applicable to urban B2C deliveries.

Operational efficiency: The potential of drones to optimize logistics operations by ensuring faster deliveries and integrating with existing delivery systems has proven crucial. Experts emphasized integrating drones into existing delivery infrastructure, including hybrid models using platforms equipped with lockers to simplify parcel drop-off. This approach allows logistics providers to quickly adapt to changing demand while benefiting from greater environmental efficiency. Experts view this as the most realistic implementation path.

Market demand: The market demand driver applies to three market demands: consumers, companies integrating drones into their delivery logistics, and finally, drone manufacturers. The demand for fast, same-day deliveries, combined with security, underscores the need for improved service quality. Organizations are progressively attracted to the incorporation of drones in logistics to enhance operational efficiency and reduce costs, whereas manufacturers are motivated to innovate and partner with logistics providers to improve designs and satisfy the increasing market demand. Demand is strongest in the B2C segment, particularly for rapid delivery in cities.

Despite the presence of considerable obstacles, the recognized factors demonstrate substantial potential to revolutionize the logistics industry. These findings are particularly pertinent to B2C parcel delivery within densely populated urban areas. Other applications may encounter varying dynamics influenced by urgency, location, or type of cargo.

5.3.Limitation of the study

Although this thesis aims to be as comprehensive as possible, it is important to acknowledge several limitations. First, the research is based on a sample of seven experts, who may not represent all perspectives on the subject. Increasing the sample would allow for a better understanding of the drivers and barriers encountered by stakeholders.

At a methodological level, relying on qualitative data can introduce biases related to the experts' opinions, given that these opinions are based on their professional lives and their own experiences. Added to this is the fact that drone technology is advancing rapidly, potentially rendering some conclusions outdated due to technological advances and changes in rules and regulations.

Furthermore, this research does not consider cost-benefit analysis of drone use cases. For some applications, cost-effectiveness and return on investment may be crucial factors affecting adoption, and the lack of this perspective limits the practical applicability of the findings.

Finally, the experts' opinion focused on Belgium, and the results may therefore have limitations when applying them to other countries with different economic and legal contexts.

5.4.Recommendations

Based on the findings of this thesis, several recommendations can be made to enhance the adoption and integration of drone technology for last-mile delivery in Belgium:

Regulatory Simplification: It is crucial for regulatory bodies to streamline the approval processes associated with drone operations. This could involve establishing clearer guidelines and reducing the waiting times for permits, especially for Beyond Visual Line of Sight (BVLOS) operations. Engaging industry stakeholders in discussions about regulatory needs can help create a more adaptive regulatory framework that keeps pace with technological advancements.

Public Engagement and Education: To address social perceptions and build public trust, stakeholders should implement comprehensive public engagement campaigns. These campaigns can focus on educating the public about the benefits of drone technology, addressing concerns related to privacy and noise pollution, and showcasing successful pilot projects. Transparency in operations and community involvement will be key to enhancing public acceptance of drones.

Investment in Research and Development: Continued investment in R&D is essential to overcome the technical limitations identified, such as anti-collision systems and the integration of drones in controlled airspace. Collaboration between academia, industry, and government can help accelerate innovation in drone technology. This will not only address existing constraints but also facilitate the development of advanced navigation systems that ensure safe operations in urban environments.

Financial Incentives for SMEs: Economic constraints pose significant barriers for small and medium-sized enterprises (SMEs) in adopting drone technology. Introducing financial incentives, such as grants or subsidized loans, can help lower initial investment costs. Additionally, providing training programs for SMEs regarding the efficient use of drones can enhance their operational capabilities.

By addressing these areas, Belgium can pave the way for the successful integration of drone technology in last-mile delivery for B2C, ultimately fostering a more efficient, sustainable, and innovative logistics ecosystem.

5.5.Recommendations for Future Research

To complement the work carried out, future research can address the identified gaps listed below:

1. Consumers' attitudes: Conduct a quantitative study on the consumer point of view, particularly in terms of confidentiality and reliability of the service, to have data on the population's adoption.
2. Stakeholder Diversity: Increasing the number of people interviewed but also diversifying the type of people interviewed allows for more objective and more solid results allowing for a complete understanding of perspectives, needs and concerns.
3. Comparative studies: Study the barriers and drivers in different countries and see their impact on technology adoption. This can highlight certain best practices.
4. Longitudinal studies: Investigate companies that conduct drone delivery over several months. This provides empirical data on the technology's effectiveness, demonstrating the successes and challenges encountered in various environments.
5. Cost-Benefit Framework : Integrate a cost-benefit analysis that will systematically assess the trade-offs of each drone use case, both in economic terms and by taking into account social, operational, and environmental impacts. This analysis provides more data-driven decision-making regarding the adoption of delivery drone technology.
6. Employment impact: Thoroughly study the impact of the integration of delivery drone technology on employment to assess the impact of automation on traditional delivery jobs.

Additionally, future research should further explore community engagement strategies that influence public perception, examine the effectiveness of evolving regulatory adaptations, and analyze how business models can adapt to support the sustainability of drone delivery solutions.

5.6.Concluding Remarks

To conclude, this thesis investigated the challenges and enablers surrounding the adoption of drone technology for last-mile B2C parcel delivery in Belgium. Based on the literature, the Belgian context, and expert opinions, this study confirmed that while the regulatory framework is the most important, technical, economic, and social factors are also significant challenges in urban environments with dense populations.

At the same time, several drivers offer promising avenues for implementation and integration. Environmental requirements, improved operational efficiency, and growing consumer expectations are creating favorable opportunities for integrating drones into last-mile logistics. Experts have particularly highlighted the hybrid delivery model, where drones deliver packages to platforms or lockers instead of delivering them directly to homes, considering this to be the most realistic and scalable approach in the B2C context.

All experts consulted agree that drone delivery will be implemented in Belgium in the future. However, the timeline is uncertain, with forecasts ranging from five to ten years depending on regulatory advances, technological maturity, and the evolution of the business model. It is essential to note that the findings presented here primarily reflect the reality of B2C parcel delivery. While some observations may be relevant to other use cases, such as the medical sector or B2B logistics, these contexts have specific operational and economic conditions that require separate analysis.

Finally, the successful implementation of drone delivery will require an effort between regulators, businesses, manufacturers, and the public. Belgium has a solid foundation, but to fully leverage the benefits of drone technology, it is necessary to accelerate the clarification of regulation, support innovation, and engage its citizens. With appropriate harmonization, drones can help reshape last-mile delivery into a more sustainable, efficient, and consumer-centric system.

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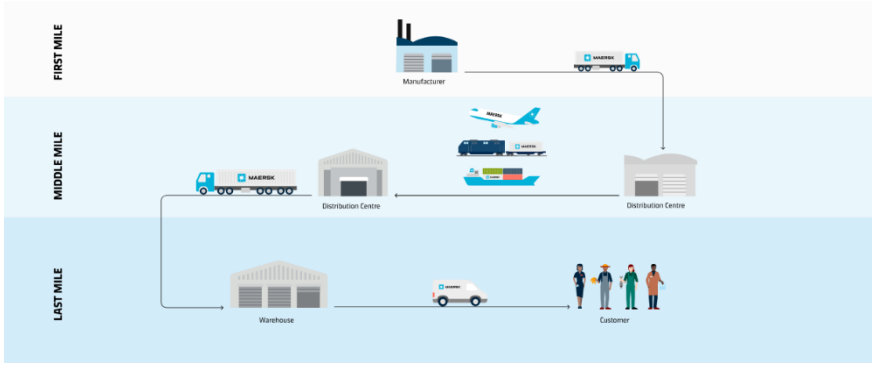
7. Annexes

7.1. Annex 1: Figures

Figure 1: Parcel Journey: From First Mile to Last Mile



https://www.maersk.com/logistics-explained/transportation-and-freight/2025/02/07/last-mile-delivery

Figure 2: Smart Lockers

https://www.intelligentparcellockers.co.uk/

Figure 3: Autonomous delivery van

https://newsroom.fedex.com/newsroom/asia-english/fedex-tests-autonomous-delivery-vehicle-in-china

Figure 4: Amazon prime air drone

https://eu.usatoday.com/story/tech/2013/12/01/amazon-bezos-drone-delivery/3799021/

Figure 5: Zipline delivery models

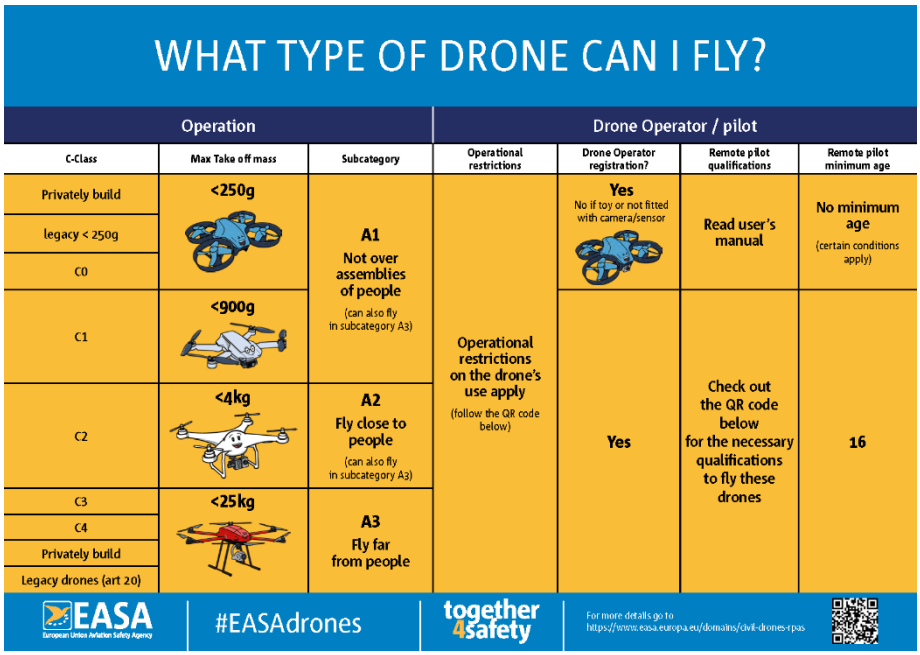
ZIPLINE'S DELIVERY DRONES

Source: *Zipline.*

	PLATFORM 1	PLATFORM 2
Delivery Focus	Enterprise, business and government	Home delivery
Payload	4 pounds	6–8 pounds
Service Range	120+ miles roundtrip	10 miles service radius, or 24 miles one way
Cruise Speed	60 miles per hour	70 miles per hour
Delivery Area	About two parking spaces	Areas as small as a patio table or the front steps of a home
Loading System	Orders packed by Zipline staff at distribution hubs	Easy-to-use loading portals to send orders
Delivery Mechanism	Parachute-controlled floating delivery from 60–80 feed above ground level	Droid-in-drone tethered delivery from more than 300 feed above ground level
Integration	Hub-and-spoke model via stand alone hubs	Hub-and-spoke model or long distance with dock-to-dock network charging

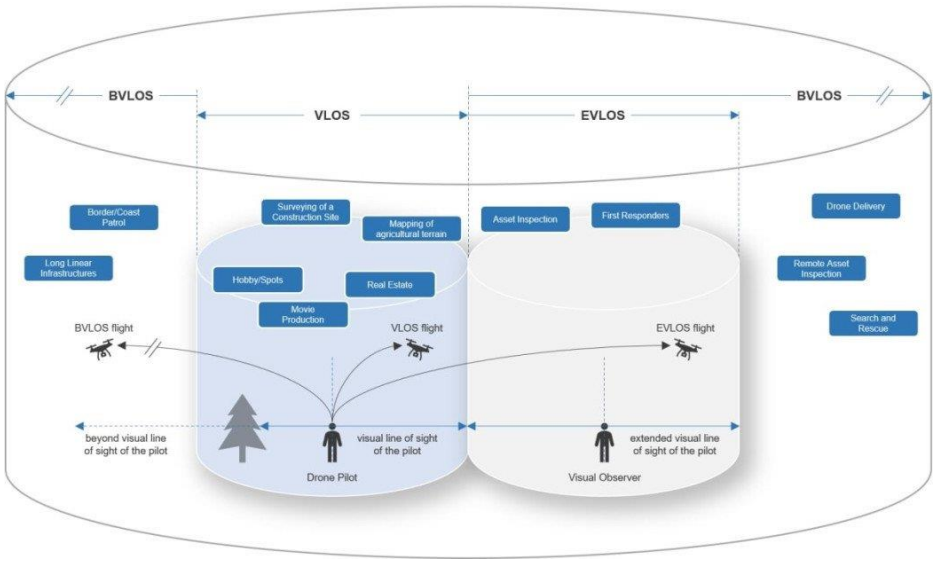
https://insideunmannedsystems.com/zipline-keeps-working-on-changing-delivery-for-good/

Figure 6: Open category classification



https://www.easa.europa.eu/en/domains/drones-air-mobility/operating-drone/open-category-low-risk-civil-drones

Figure 7: VLOS / EVLOS / BVLOS definition



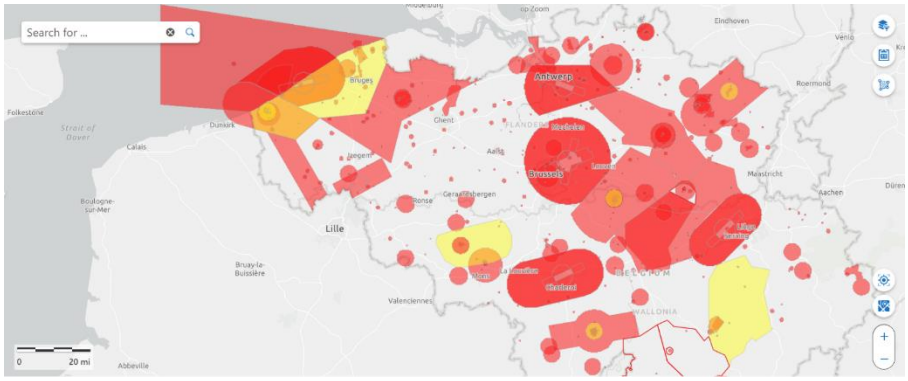
https://www.flyeye.io/drone-acronym-vlos/

Figure 8: BCAA Drone Operation Requirements in Belgium

	TYPE OF OPERATION				
	Private use	Model aircraft [1]	Class 2	Class 1b	Class 1a
Max height	10m (32.8ft)	Check AIP for terrain restrictions	150ft (around 45m)	300ft (around 90m)	300ft (around 90m)
Max. weight	< 1kg (2.2lbs)	1kg - 150kg (2.2lbs - 330lbs)	< 5kg (11lbs)	< 150kg (330lbs)	< 150kg (330lbs)
Remote pilot's age	All ages	All ages	At least 16yo	At least 18yo	At least 18yo
Remote pilot qualification	None	None	Theorical training + Practical skill test	Theoretical exam + Practical skill test	Theoretical exam + 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

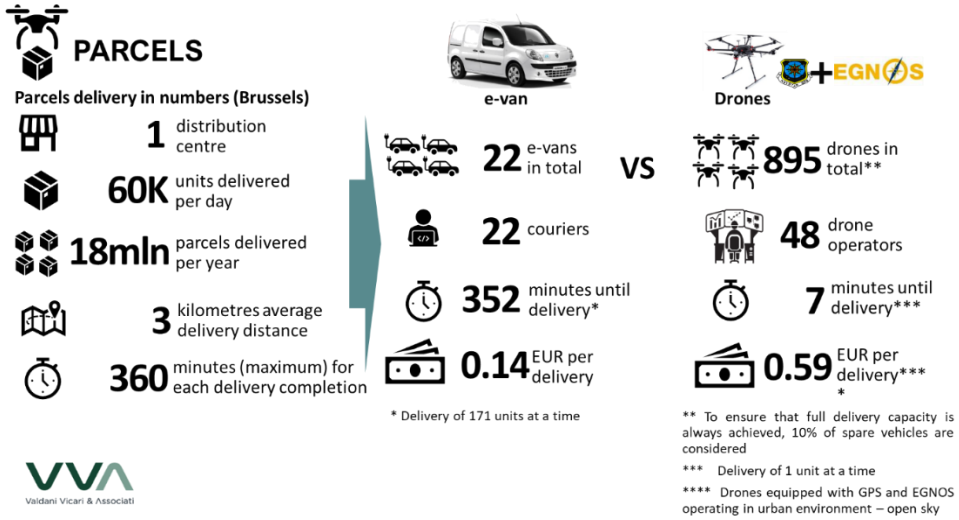
https://uavcoach.com/drone-laws-in-belgium/

Figure 9: Belgian No Fly zone



https://map.droneguide.be/

Figure 10: Result of VVA study



https://www.unmannedairspace.info/commentary/comparing-the-cost-effectiveness-of-drones-v-ground-vehicles-for-medical-food-and-parcel-deliveries/

7.2.Annex 2: Interview guide

Semi-Structured Interview Guide for Experts on Drone Delivery Adoption in Belgium

- Briefly introduce yourself and the purpose of your research.
- Explain the structure of the interview.
- Obtain consent to record the interview.

Introduction Questions:

1. I am studying the opportunity for drone delivery, specifically for last-mile delivery in B2C in Belgium. Does this align with an opportunity you foresee in the future, or would it not be the first application area you would think of?
2. Do you believe this will be implemented soon in Belgium, and why or why not?
3. Based on this response, I would like to ask what the barriers are.

Section 1: Identifying Main Barriers

General Barriers

- What do you think are the main barriers to the adoption of delivery drones for last-mile logistics in B2C parcels in Belgium?
- Based on your answer, here are the barriers I identified from my research.
  - Regulatory: Complex air traffic management and strict safety regulations.

        - Technical: Battery life, weather conditions, limited carrying capacity, navigation issues, anti-collision system.
        - Economic: High initial investment, operational and maintenance costs, ROI/economic viability.
        - Social: Public perception and trust, ethical and privacy concerns, employment impact, noise pollution.
    - The literature has shown that regulatory is the most important barrier followed by social and technical, while economical is the least blocking barrier to the adoption. Do you agree with these? Why or why not?
    - Are there any additional barriers you think should be considered for Belgium?

Section 2: Discussing Specific Barriers

1. Regulatory Challenges
    - What are the main regulatory obstacles to the adoption of delivery drones in Belgium?
    - I found that complex air traffic management and safety regulations are significant barriers. Do you agree? Why or why not?
        - Rules (EU) 2019/947 and (EU) 2021/1166
    - What about privacy concerns and legal liability issues? How do these impact the adoption of delivery drones?
        - Privacy legislation in place to avoid unauthorized surveillance and data collection.
    - Are there other regulatory barriers specific to Belgium that you believe are important?
    - For you how blocking is the regulatory barrier in Belgium? The literature has shown obstacles that seem to be surmountable for Belgium, given the existing pilot projects and authorizations to fly BVLOS.
2. Technical Challenges
    - What are the main technical obstacles to the adoption of delivery drones in Belgium?
    - I found that battery life, weather conditions, advanced sensors, cameras, and collision avoidance systems are significant barriers, do you agree and is it true for Belgium?

- Do you agree that the high urban density in cities like Brussels poses navigation challenges for drones? Why or why not?
- For you how blocking is the technical barrier in Belgium?

3. Economical Challenges
    - What are the main economical obstacles to the adoption of delivery drones for the last mile in B2C parcel in Belgium?
    - What do you think about the high initial costs of purchasing drones and related infrastructure (maintenance, training, insurance) as a barrier, especially for SMEs in Belgium?
    - Do you agree that the long-term economic viability of drones compared to traditional delivery methods is a concern? Why or why not?
    - Are there additional economic barriers specific to Belgium that should be considered?
    - For you how blocking is the Economical barrier in Belgium?

Social Barriers

4. Social Challenges
    - What are the main social obstacles to the adoption of delivery drones for the last mile in B2C parcel in Belgium?
    - I have found in the literature that perception issues, including concerns about privacy, noise pollution, safety, and employment impact the adoption of delivery drones. What is your opinion on these obstacles for Belgium.
    - Are there other social barriers specific to Belgium that you think are important?

Section 3: Identifying Main Facilitators

General Facilitators

- What do you think are the main facilitators for the adoption of delivery drones for last-mile logistics B2C parcel in Belgium?
- Based on your answer, here are the facilitators I identified from my research. Do you agree with these? Why or why not?
    - Environmental: Environmental objectives, traffic congestion reduction, specific projects like Samplify.
    - Operational Efficiencies: Logistics infrastructure, research institutions, regulatory collaboration, smart city projects.

        - Market Demand: Growing online shopping market, competitive logistics sector, central location in Europe
    - Are there any additional categories of facilitator you think should be considered?

Section 4: Discussing Specific Facilitators

Environmental Facilitators

1. Environmental Benefits

- What are the main environmental drivers for the adoption of delivery drones for last-mile logistics B2C parcel in Belgium?
- I have found in the literature that global demand for greener solutions, CO2 reduction and traffic decongestion are drivers. Do you agree for Belgium?
- How do you see the role of environmental objectives in facilitating the adoption of delivery drones in Belgium?
- Are there other environmental benefits or projects, regulation, incentive in Belgium that you believe are important?

2.Operational Efficiencies

- In term of operational efficiencies, which driver do you see to the adoption of drone delivery for last-mile logistics B2C parcel in Belgium??
- How do you see Belgium's logistics infrastructure supporting the integration of delivery drones?
- Do you agree that institutions like Innoviris and VLAIO play a significant role in supporting drone projects? Why or why not?
- I found that regulatory collaboration and smart city projects are facilitators. Do you agree with this assessment? Are there additional operational facilitators specific to Belgium?

3.Market Demand

- What are the main drivers related to market demand for the adoption?
- How does the growing online shopping market in Belgium drive the demand for innovative delivery solutions like drones?
- Do you agree that the competitive logistics sector in Belgium pushes companies to adopt cost-effective, fast, and environmentally friendly delivery methods? Why or why not?

- Are there other market-related facilitators specific to Belgium?

Section 5: Validation and Insights

Validation of Findings

- Based on the barriers and facilitators identified in my research specific to Belgium, do you agree with these findings? Are there any that you believe are overstated or understated?
- Can you propose any new barriers or facilitators specific to Belgium that should be considered?
- What future trends do you foresee in the adoption of delivery drones in Belgium?

Conclusion

- Thank the interviewee for their time and insights.
- Ask if they have any additional comments or suggestions.
- Confirm how they would like to receive a summary of the interview or any follow-up information.

7.3.Annex 3: Interviews Transcript

Transcript 1: (In French)

Mario Cools –Transport and mobility professor at UHasselt and ULiège

Martin: On va directement alors rentrer dans le dans le vif du sujet rapidement de voir un peu mon interview interview guide donc voilà il est un peu elle est séparée en fait en deux grosses section non vraiment identifier les barrières et identifier quels sont les facilitateurs ah ben voilà l'implémentation d'une telle technologie en Belgique donc je vais directement commencer par ma première question donc voilà comme on dit comme ça je peux rebondir ma première question ça va être d'après vous pour le les droits de livraison pour le Last mile en logistique quels sont les principales barrières à l'heure actuelle il y a des drones tu as vu ça ça le prend pas

Martin: D'après vous pour le live en logistique quels sont les principales barrières à l'heure actuelle

Mario: pour le Last miles ça c'est déjà une hypothèse que vous faites donc on parle bien des drones aériens qu'on soit bien d'accord là-dessus parce que parfois les robots comme fournis

par Colruyt leur test avec les robots automatiques ils appellent ça drone aussi. pour moi c'est peu probable que ce soit une solution last miles ça peut être une solution logistique mais il y a quelques restrictions en tout ce qui est législation aérienne surtout vu que dans les zones urbaines et Bruxelles par exemple il y a une grande no fly zone déterminée par le temps donc dans beaucoup d'endroits ce n'est pas possible car il y a des restrictions militaires plutôt qui limite l'utilisation des drones et à la fois il y a la vie privée dans laquelle on a besoin d'une acceptation de chaque maison sur lesquelles on survole. donc pour être efficace ça doit rentrer dans l'efficacité avec les avions et le management aérien et un espace qui est déjà bien occupé point donc un il y a d'abord l'aspect légal et deuxièmement il y a la crainte en cas d'accident.C'est pour ça que dans les cas il y a le plus de marché qui est exploré en Europe c'est plutôt le transport de médicaments urgent dans lequel la on peut éviter par exemple c'est un accident en centre-ville. est-ce que ce sera vraiment pour de la cour de distance et je ne pense pas non plus je pense que la solution des vélos est une solution plus durable mais ce sera surtout pour des moyennes à longue distance dans lequel un drone peut être efficace surtout si on doit circuler dans lequel les livraisons pour certains le poids n'est pas très important. mais donc réglementation et sécurité sont les restrictions les plus importantes d'après moi et également en prenant en compte que l'espace n'est pas une capacité imiter non plus. je crois que c'est très important d'avoir un cadre spécifique mais c'est très compliqué par exemple j'ai un collègue qui a des drones pour capter l'isolation des bâtiments il peut survoler avec des caméras infrarouge pour constater là où il y a nécessité d'isolation mais c'est la mère de total pour avoir l'acceptation car pour chaque vol il faut une acceptation individuelle pour pouvoir survoler la maison. même s'il y a la possibilité juridique de le faire ce n'est pas non plus harmonisé que ça facilite la vie donc dans le cas où c'est permis c'est encore une documentation énorme qu'il va falloir suivre et donc ça ça peut être aussi une limite ce sera pas une contrainte bloquante mais ça ne va pas du tout faciliter.

Martin: moi d'après la littérature ce que j'ai trouvé c'est qu'il y a en effet le régulateur il a législation il y a aussi la barrière technique également la barrière économique en termes d'investissement initial en terme de maintenance en terme de coopérationnel.

Mario: Alors ça ça va dépendre sur quel marché on va se focaliser par exemple si on est sur des marchés là où ce sont des médicaments ou des organes ou la vitesse est super urgente à partir de ce moment-là il a vraiment un marché là où il y a des fournisseurs qui dominent vraiment. dès qu'on a au-dessus d'un certain poids les certificateur de avoir une des certifications spécifiques très pointue et ça évidemment ça ne facilite pas la vie non plus.

Martin: et alors moi la dernière barrière que j'avais identifié c'est la barrière sociale en effet la peur de respect de la vie privée.

Mario: en effet il y a le respect de la vie privée il est aussi la peur en terme d'accident et ça c'est quelque chose qui est pas très facile à régler je ne sais pas exactement sur quelle hauteur on peut voler au-dessus de maison donc ça va aussi dépendre point l'acceptation va aussi être lié au fait que on commence à des solutions de mobilité avec drone aussi je crois que les deux peuvent faciliter ou bloquer l'autre donc je ne sais pas encore ce sera quoi la solution qui sera développée en tant que solution la plus rapide. Amazon fait ça dans des lieux qui ne sont pas habités évidemment.

Martin: Pour terminer ce point-là moins la littérature elle a montré que c'est la législation qui est le plus important suivi par ce qui est technique et puis la barre économique et enfin la barrière sociale est-ce que vous êtes d'accord avec ce classement que le régulateur est le plus problématique à l'heure actuelle là où l'appareil économique est la moins importante

Mario: oui mais avec la législation il y a l'aspect sécurité une des raisons qu'il y a beaucoup de règles c'est pour assurer la sécurité donc la sécurité c'est à la fois législaiton mais aussi social donc ça va dans les deux volets donc c'est un peu plus autour de ça qu'il y a un souci.

Martin: alors moi en fait comment j'ai classifié ça d'après la littérature en régulatori je comprends tout ce qui est complexe air trafic management and strict safety regulation là où le social ça sera plus de la perception du public la pollution par le bruit, l'impact sur l'emloyabilité. ethical and privacy concern. Donc voilà la séparation dans ma législation il y a la sécurité qui est compris là où dans le social ce sera plus la perception du public.

Mario: là alors dans ton mémoire tu dois bien spécifier qu'il y a cette distinction et je pense qu'en Belgique il y a beaucoup de no fly zone à cause du l'OTAN.

Martin: là je vous ai donc demandé c'était quoi les plus grosses barrières et donc là j'aimerais bien creuser par barrière j'ai des sous question on va peut-être se recouper un peu sur ce qu'on a déjà parlé mais commençons par la première barrière donc la législation. quels sont les obstacles principaux en termes de législation pour les drones autonomes de livraison en belgique?

Mario: alors je pense qu'il y a trois grands types de législation on va tout d'abord avoir la législation avec aviation la réglementation de l'armée avec le temps et tout ce qui est réglementation avec la vie privée je pense que c'est les trois grands types de législation qui sont là et en secondaire de ça ça va être tout ce qui est certification par exemple dès qu'on a un certain poids il faut une certification spécifique pour faire voler ce drone ainsi que tous les permis qu'il faut obtenir pour pouvoir faire voler des drones.

Martin: d'après vous est-ce qu'il y aura une barrière en termes de régulation que vous pourrez ajouter à laquelle vous penserez peut-être.

Mario: oui alors celle de l'OTAN qui est vraiment spécifique à celle de Belgique.

Martin: pour clôturer cette partie sur la législation j'aimerais vous demander d'après vous à quel point cette barrière elle est bloquante pour l'adoption des tournées de livraison en belgique.

Mario: vu l'expérience qu'on a ici avec les drones qu'on a pour regarder la personne inutile des bâtiments je pense pas que ça va être rapidement arrangé. peut-être que la législation elle-même va être facilité mais ce n'est pas vraiment ce que je pense quand je fais la comparaison avec les véhicules autonomes la notre ministre fédéral a complètement bloqué le fait de pouvoir continuer avec ça. donc si je prends le parallèle je ne pense pas qu'on a le climat politique actuel pour le faire. le problème c'est que si on attend c'est que c'est les autres qui vont déterminer les standards au niveau européen. Moi je pense la technologie va être développée ailleurs pour réduire un risque un minimum et là la gestation pourra suivre en Belgique car je pense qu'ici en Belgique à l'heure actuelle les opérations sont freinées drastiquement.

Martin: Je sais pas si vous avez entendu il y a drone futur c'est une start-up qui a eu les autorisations pour commencer à faire des tests de livraison de colis type online shopping à Mechelen. j'ai l'impression qu'il y a des choses qui commencent à se faire il y a l'entreprise unifly aussi qui eux transportent des sample des médicaments entre deux laboratoire c'est aussi en face de test donc j'ai l'impression que des projets voient le jour et que les investissements sont faits mais comme vous dites dans des endroits bien définis là où les risques peuvent être réduits au maximum.

Mario: Oui comme un Saint-Trond ils ont créé Droneport donc il y a la volonté d'aller plus loin, il y a cette volonté mais je suis curieux de comment ça va évoluer. J'aimerais voir si dans 10 ans on aura des drones taxi et j'aimerais bien aussi savoir comment ça va se passer alors qu'il y aura le premier accident qu'est-ce qui va se passer comment les gens vont réagir.

Martin: D'après vous quelles sont les barrières techniques les plus importantes pour l'adoption d'un tel système en Belgique je sais que vous avez déjà mentionné le carrying capacity.

Mario: Tout ce qui va être quand même compliqué pour moi je pense c'est tout ce qui est météo et alors les fortes rafales de vent ça va être le plus dramatique parce que faire des vols dans les bonnes conditions météorologiques c'est pas trop compliqué mais s'il y a des vents qui montent très fort qui peut être très dangereux pour tout ce qui est drone encore plus pour ce qui est l'aviation du poids de la drone donc voilà ça dépend encore de quel type de drone on est en train de parler peut-être on va aussi prévoir des plages horaires pour faire fonctionner ses drone comme en pratique avec l'aviation avec les avions ultra léger eux ça dépend de certaines météo ils ne peuvent pas voler dans toutes les conditions météorologiques peut-être qu'on pourrait imaginer quelque chose qui soit un petit peu pareil pour les drones

Martin: et aussi problème de batterie et les capteurs qui sont sur ce genre de drone et système anti-collision est-ce que vous pensez que pour la Belgique c'est une barrière d'adoption la technologie qui est disponible à l'heure actuelle

Mario: si on regarde l'évolution des batteries je pense que ça a pas trop poser problème la technologie de batterie va assez vite donc je pense pas que ce soit problématique peut-être un des trucs ça va être vers l'environnement tout ce qui est pollution sonore ça peut être un des cas délicat et donc là peut-être qu'il faut une technologie qui soit moins bruyante. il y a aussi la question de combien de drone pourrons voler si demain il y a toutes les 30 secondes un drone mais qui arrive c'est toute notre histoire aussi.

Martin: j'ai identifier aussi que à l'heure actuelle les drones ont besoin de connexion 5G en Belgique est incomplète est-ce que vous pensez que c'est quelque chose qui peut être en blocage que les vôtre vu sur cette couverture de la 5G et ce problématique ou pas?

Mario: là je prends souvent de parler avec tout ce qui est transport de personnes quand je prends le train le 1 seul vers Bruxelles là j'ai vraiment des soucis de connexion pour un quart du trajet dans lequel je n'ai pas de connexion 4G. en effet la couverture 5G va prendre du temps et tout ce qui est véhicule autonome ou drone autonome il va falloir des connexions partout alors oui ça arrivera à la grande question c'est quand.

Martin: Pour vous c'est pas rire technique si vous dirigez à quel point le bloc l'adoption est-ce que pour vous ce serait plus important que la régulation moins importante à quel point les barrières techniques sont bloquantes.

Mario: en terme de drone opéré ça va aller potentiellement plus facile je pense que elles sont pas très très importante des barrières techniques car je pense que la technologie existe elle est là maintenant de nouveau le problème c'est de pouvoir réduire les risques au maximum donc d'après moi la barrière technique elle n'est pas vraiment un gros bloqueur pour l'adoption de drone de livraison. les drones doivent utiliser un système GPS pour ce géolocaliser et donc qu'est-ce qu'on fait le jour où les États-Unis disons mais hors fonctions les GPS il faut des systèmes de sécurité et avec la situation géopolitique ça n'aide pas énormément.

Martin: pour aborder la barre économique maintenant je voulais voir avec vous d'après vous quel serait le plus gros obstacles économique pour l'adoption de cette technologie.

Mario: le coût de l'infrastructure est pas trop élevé d'après moi mais c'est surtout il faut faire une comparaison avec d'autres moyens je pense qu'il y a d'autres moyens qui sont beaucoup moins coûteux et donc c'est pour ça que à l'heure actuelle ce serait applicable ou la rapidité est vraiment très importante c'est pour ça que je donne un exemple des médicaments et des organes de l'urgence de la rapidité très importante et donc on est prêt à y mettre le coût.

Martin: moi si je peux voir c'est que c'est un coup élevé ce genre de système à mettre en place il faut acheter les drones qui ont un coup plutôt important c'est drone qui peuvent coûter entre 10 et 60000 € étant donné que ce sont des drones commerciaux il a également la maintenance il y a l'entraînement pour les opérateurs il y a les assurances à prendre en compte et donc j'identifié qu'un drone de livraison sur le long terme ça devient intéressant par rapport au moyen traditionnel de livraison et donc j'aurais voulu savoir votre avis à ce niveau-là est-ce que sur le long terme c'est quelque chose qui peut être économique en plus viable que ce qu'on peut avoir à l'heure actuelle.

Mario: purement économique je ne pense pas je pense pas que ce soit plus viable et plus rentable sur le long terme mais encore comme je reviens ça dépend du domaine d'application là où pour un domaine médical la vitesse est cruciale et donc il y aurait un marché. De nouveau lit à l'urgence on peut imaginer un système de drone dans des endroits vraiment très difficile d'accès là où de nouveau le drone de livraison aurait un marché en effet.

Martin: est-ce qu'il y aurait une autre barrière économique qui vous viendrait en tête ?

Mario: oui la même incertitude que il y a pour les véhicules électriques quelle est la durée de vie des batteries un certain moment il faut changer les batteries qui est une partie essentielle du coût total du drone donc est-ce qu'on a déjà assez de connaissance là-dessus ça je ne suis pas capable de vous le dire.

Martin: d'après vous en terme de barrière sociale quels sont les social les plus importantes vous avez déjà mentionné qu'il faudrait que les habitants acceptent que il faut passer au-dessus de raison on a parlé de la pollution par le bruit quels autres barrières vous aurez en tête?

Mario: en effet il faut que les personnes trouvent que la solution est assez sécurité car si j'ai peur des drones et il aura un blocage et là ce sera impossible d'avoir ce genre de système. et donc de nouveau il faut voir qu'est-ce qui va être livré avec des drones parce que si on commence à tout livrer avec des drones là il y aura un problème par contre de nouveau si on livre des médicaments ou des organes là les gens accepteront au niveau social ce sera plus facile d'être accepté.

Martin: Oui tout à fait parce que l'idée ici de ce mémoire c'est plus accès à voir son paquet qui se fait livrer chez sois.

Mario: oui alors là la volonté d'accepter les restrictions ce sera beaucoup plus compliqué parce qu'il existe déjà des alternatives pour se faire livrer. et puis il est aussi la question de ou le drone va livrer est-ce qu'il livre dans le jardin est-ce qu'il livre dans la rue c'est assez complexe.

Martin: on a que la partie barrière on peut regarder les facilitateurs alors d'après vous qu'est-ce qu'ils vont être les drivers pour l'adoption de cette technologie en Belgique?

Mario: alors le fait tout d'abord qu'on a des investissements qui existent en Belgique pour supporter ce genre de projet donc dès qu'on assistement pour les entreprises qui facilite la recherche industrielle et la mise en application de solution technologique et donc cela ça facilite l'implémentation.

Martin: alors moi ce que j'avais identifié dans la littérature on avait tout d'abord en facilitateur environnemental avec l'idée de décongestionner l'écran de villes et l'impact carbone j'avais ensuite l'opération l'efficacité opérationnelle c'est-à-dire comme vous dites avec le fait que la Belgique investisse dans ce genre de projet avec des infrastructeurs logistiques ou les projets Smart City qui vont être un driver à l'adoption de cette technologie.

Mario: alors moi je suis un petit peu surpris avec le le facilitateur environnemental.

Martin: l'idée de l'environnemental c'est que c'est drone ils ont l'avantage environnemental car ce sont des drones électriques en comparaison avec d'autres méthodes de livraison traditionnelle et le fait que cela peut décongestionner les villes grâce au fait qu'ils veulent et compter congestionne avec les vannes traditionnels de livraison.

Mario: alors oui avec des méthodes de livraison traditionnelle en effet mais il y a d'autres solutions pour de livraison il y a des camionnettes électriques il y a des cargo bike ça va fortement dépendre sur quelle base on va comparer et aussi quels sont les émissions par kilo transporter et si on prend en compte la production des batteries aussi et l'utilisation minière pour avoir les minéraux pour créer ces batteries alors là je me demande si le driver écologique et environnemental en est vraiment un. On peut parler aussi de la décision d'avoir signé pour le fait qu'on soit tous en full électrique pour 2035 c'est une des pires décisions que l'Europe est prise point tout d'abord c'est pas la mesure qui va faire réduire les émissions de CO2 la solution première ce serait de réduire la taille des voitures. deuxièmement maintenant les batteries sont créées en Chine toutes n'importe quelle marque donc déjà tout notre industrie dépend de la Chine ce n'est pas la meilleure idée.

Martin: Je vais aussi identifier la demande de marché avec le fait que la commande de plus en plus de ce jour internet ils ont cette volonté de vouloir être livré le plus rapidement possible mais aussi le fait qu'on a un une compétitivité pour les entreprises logistiques.

Mario: la demande ne marche pour moi elle est pas spécialement facilitateur en tout cas pas spécifiquement pour les drones de livraison parce que oui les gens commandent de plus en plus sur internet mais de nouveau je pense qu'il y a d'autres moyens de livraison qui passeront avant.

Martin: pour venir sur ce qu'on a dit juste avant pour vous entre le driver environnementale il y en a vraiment zéro pour vous ça peut pas être un driver cet aspect environnemental.

Mario: ça dépend avec quoi on compare mais si on compare avec les manières traditionnelle. pour moi je dirais alors que des cargo bike vont être plus efficace mais alors si on parle de rapidité mais alors le coup sera plus élevé et aussi. les coups de livraison seront énormes et je ne pense pas que les consommateurs seraient prêt à payer beaucoup plus cher à l'heure actuelle.

Martin: Est-ce que vous êtes d'accord que le virus et flayo joue un rôle important pour supporter les projets de drone ou vous avez pas vraiment de vue là-dessus.

Mario: je sais qui s'intéresse à ça mais tu ne ferais rajouter de gestic in Wallonia aussi dans ta liste.

Martin:Pour vous les procès Smart cities faites-vous comment en facilitateur en driver pour l'adoption de ce genre de technologie.

Mario: alors oui c'est plutôt un branding plutôt qu'un raisonnement ce mot Smart City est-ce que ça facilite ceux qui veulent se mettre dans ce marché des drones bien sûr ils doivent le vendre comme un espèce Marchetti mais c'est plutôt parce que c'est le mode d'actualité qui va bien et dans tous les cas chaque commune a son propre degré selon les villes intelligentes. alors oui c'est un facteur mais à prendre avec des pincettes.

Martin: En terme de demande de marché pour vous quels vont être les drivers les plus importants liés à ce à ce se facilitateur là?

Mario: pour des produits dans laquelle la vitesse est vraiment importante en termes de congestion donc la vitesse de livraison doit être vraiment importante comme je dis pour des pharmacies c'est clair pour des produits online shopping peut-être pour certains sous catégories de produits mais pas pour tous les produits de manière générale. pour moi pour les produits pour lesquels il est nécessaire d'être rapide il y a un marché sinon non.

Martin: vous voyez la chose par produit moi je veux la chose un peu différente je voyais que depuis le covid les gens commencent sur Internet et donc j'avais mis que voilà la demande de marché le fait que les gens veulent plus commander sur internet et de manière et recevoir de sa manière plus rapide je l'avais vu comme un driver pour l'adoption de son genre de technologie.

Mario: alors oui justement moi je le vois mais à l'inverse je dis plutôt le contraire le fait qu'il y a cette forte augmentation de demande du commerce fait que les online shopping eux-mêmes peuvent plus facilement consolider et travailler avec des opérateurs pour consolider leur livraison et diminuer leur coût opérationnel fortement.

Martin: est-ce que par contre vous êtes d'accord pour dire que cette compétitivité est le fait de devoir toujours être plus rapide est-ce que au niveau logistique ça c'est un driver qui va pousser les entreprises à innover et trouver des nouveaux moyens pour livrer de manière plus rapide?

Mario: alors ça oui par contre là clairement oui mais ce sera pas spécifiquement les drones la solution mais en effet les entreprises de logistique doivent innover et doivent trouver des moyens de livrer plus rapide à moindre coût oui.

Martin: Pour clôturer basé sur les barrières et les facilitateurs que j'ai identifié je pense que pour les barrières vous étiez plutôt d'accord avec ce qui a été dit vous avez apporté des amis

traditionnel par contre pour les drivers pour vous l'environnemental c'est pas quelque chose que vous mettrez rien en driver pour le drone et surtout pas dans un milieu urbanisé comme le nôtre.

Mario: Ouais voilà et donc pour clôturer moi je pense qu'à l'heure actuelle des drones de livraison pour du commerce dans des zones urbanisées comme chez nous ce n'est pas quelque chose qui va voir le jour rapidement ce n'est pas pour un futur proche.

Transcript 2:

Grégoire Moreau – CEO at ADLC

Grégoire Moreau:
I'll introduce myself now. I'm Grégoire Moreau, from Brussels. I studied at PL in computer science. A bit about the company: one of my co-founders is also in aeronautics, and we both went to Vlerick to pursue a master's in innovation, where we started working on drones because at the time, new regulations were coming into effect.

So, during that year, we were involved with the regulations that came into effect across all European countries. We saw a lot of opportunities and the school found a marketplace. It was a serial entrepreneur in the drone industry who became our mentor.

Originally, we focused on transport because it was becoming feasible, and we had the Bill of Lading, I suppose you know what that is.

Martin:
Yeah.

Grégoire Moreau:
We saw a lot of opportunities early on, and at first, we thought we could expand the business to B2C, but we quickly shifted focus.

Martin:
Uh-huh.

Grégoire Moreau:
We quickly pivoted to something else, focusing more on B2B. We looked for industrial users. We found a case in the green panel through contacts and worked on it for a few years.

Since the company's creation, it's been operating in a way that, in the Antwerp port, cargo ships need inspectors to board, take samples, and transport them to a laboratory.

The port of Antwerp is large. It takes time to transport these samples to a laboratory, which could be several kilometers away. Currently, the company we work with uses external express transport services to deliver the samples by van.

Grégoire Moreau:
But that's time-consuming and not very reliable. Their idea was to see if drones could be used for this.

We saw right away that this could be interesting because there's the express delivery side, which has value—saving minutes on deliveries could add value and potentially generate extra revenue for the service. So we focused on this, though there were many regulatory challenges.

Martin:
Yeah.

Grégoire Moreau:
But then, the new regulation came into effect on January 1, 2021. It allowed many things but as you probably know, we fall under the specific category for drones.

Even though the regulation was in place, we still needed to prove that we could be authorized to perform these operations.

So, we worked for a long time to find a drone that could make deliveries and meet the regulations. This was something we had to do together. For example, typically, we were transporting 15-kilogram cargo. Before the new regulation, drones capable of carrying 15 kilograms were 3 to 4 meters in size.

Martin:
Yeah.

Grégoire Moreau:
With the new regulation, we need to stick to 3 meters, and it's mandatory. The same applies

for flying BLOS. It requires redundancy and several systems on board for safety and approval.

So, we had to choose a drone that complied with the regulation. To be honest, we initially chose one manufacturer who went bankrupt, so we switched to another German manufacturer who made a drone with a wingspan of 2 meters that now works well.

At the regulatory level, we did a lot of work to get real BVLOS approved. In practice, about 95% of BVLOS you see on social media are fake BVLOS with ground observers.

Grégoire Moreau:
So, we're doing real BLASO, with drones flying in the port of Antwerp and pilots in a control room 15-20 km away from the drone.

We also operate in controlled, non-segregated airspace, and I think we're the first in the world to do that. We're flying over Antwerp city without blocking airspace. It's quite important, but it's going to be crucial for future delivery services.

We also have the added challenge of transporting dangerous products, where we're not the first to transport medical samples, which are theoretically dangerous, but we're transporting petrochemical products, which are much more dangerous because they can pose a danger on their own, not just through human contact.

Martin:
Yeah.

Grégoire Moreau:
This sparked a major discussion with another DGTA team, and we believe we're one of the first companies in the world to be authorized to transport these products. The final approval for all of this, allowing us to fly between locations B and G in the port of Antwerp, was granted in June 2024, and we've been flying daily since October, providing express transport services for SGS.

Grégoire Moreau:
So, as a company, we always aim to do more industrial transport, B2B. One area we're focusing on a lot is maritime and offshore transport, especially because we just completed a funding round with a maritime investor. This also ties into the economic aspect of transport

because, for now, we're replacing vans, and there's a lot of competition on price when compared to vans. It's difficult to justify adding extra costs to deliveries.

But in maritime transport, we're replacing helicopters or boats, and here, the drone can reduce the price of delivery by a factor of 10. In this case, the drone offers a real price advantage, whereas, on land, the main advantage we offer companies is speed.

Martin:
Right.

Grégoire Moreau:
The problem is that speed is hard to sell. We're talking about minutes that save money, and typically, this is a major challenge in medical transport. Medical samples are often semi-urgent but not always critical.

Martin:
Yeah.

Grégoire Moreau:
And once there's a van involved, which can take multiple parcels at once, then the drone is no longer competitive. It's possible to do transportation on a smaller scale or for innovation projects, but a real operational service is difficult to justify.

So, at this stage, we are trying to find cases where the service makes sense, which is why we focus a lot on the short distance.

Grégoire Moreau:
Something else I want to mention is that we also want to move closer to cities—not for B2C deliveries but for B2B transport, like DHL for businesses.

For example, between the city of Antwerp and the port of Antwerp, we think companies would be willing to pay a reasonable amount for that service. Maybe not an enormous amount, but something significant enough to make it a profitable service.

Martin:
Right.

Grégoire Moreau:
But this is also made possible by the developments in regulations in Belgium. The core of what we're going to do in the next few years is to expand what we're doing here in Antwerp, but to other locations. We're already in discussions with Rotterdam, and potentially even internationally on other continents.

Martin:
Okay.

Grégoire Moreau:
But these discussions are slower.

Martin:
I imagine so. But will it always be under the name of Simply, or will that change for locations outside of Antwerp?

Grégoire Moreau:
Ah, it's not entirely clear. Simply was initially the name of the project with SGS. Now, it's more like an umbrella project. The name Fly is something that SGS is marketing independently to other companies in Antwerp and abroad. So, the service will still likely be known as Simply when referring to our transport services for SGS, but we, as a company, are ADLC (Drone Logistics Company), and that's how we operate.

Martin:
Perfect, thanks for that introduction. So, I'll move the interview forward by asking the first real question to set the context: My focus is on last-mile delivery in B2C. My question is: Do you think this could become an opportunity in the near future, or do you think other application areas will take priority over last-mile delivery in urban areas?

Just to clarify, throughout the interview, we'll likely touch on things you already mentioned in your introduction, so I just want to make sure you're aware of that.

Grégoire Moreau:
Yes, I understand. To be honest, right now, we're focused on other use cases, but we're not ruling out last-mile delivery.

Martin:
Yeah, I was going to ask, what do you think would make last-mile delivery less of a priority for you?

Grégoire Moreau:
Sure. I'll list a few factors that are more complicated. We have the regulatory aspect, the public acceptance, the economic aspect of drones delivery but also the lack of funds to develop such projects.

Martin:
Right. So after hearing your perspective, I'll compare it with the list of barriers I've identified and we can dive deeper into each of those barriers.

Grégoire Moreau:
Sure. So, let me start by saying how we might imagine entering the last-mile delivery space, even if we're not fully focused on it right now. We think it would require a partnership with a big company that already handles a high volume of B2C last-mile deliveries, such as Uber or something like that.

This is because it seems like a B2C last-mile delivery model, where consumers pay at the time of delivery, is a model that could work, but it requires quite a complex operational model.

Grégoire Moreau:
For us, at least, it seems like it would require significant rethinking of the operational model, and that makes it a bit more challenging. That's why we think a hybrid model—using hubs for short distances—seems to be a more feasible and viable model for the moment.

Martin:
Right, I've seen similar hybrid models proposed. But for you, what are the main barriers to adopting drone delivery for last-mile logistics?

Grégoire Moreau:
Sure.

Martin:
Could you list them for me?

Grégoire Moreau:
Yes. First, the regulation. It’s not the most important issue, but it is something that’s currently blocking the process.

You’ve probably heard a bit about the regulation. It’s based on risk analysis, particularly for last-mile deliveries in more urban areas. It’s always complicated because of the density of people on the ground, which increases the risk, and therefore the cost of the required technology. We’ll likely need more expensive drones for that.

Grégoire Moreau:
This requires a lot of work on the operator's side to make it feasible. I don’t know if you’ve already had discussions with authorities regarding this?

Martin:
Not yet.

Grégoire Moreau:
In the specific category, we need to perform a SORA (Specific Operations Risk Assessment). This is a list of ground risks, which we assess, and then apply mitigations. The matrix tells us the specific levels of safety required. Right now, in Europe, 90% of operations fall under the lowest category, but the challenge is when we want to enter urban areas, which require much higher levels of safety.

This brings us into the unknown territory. Authorities may not have the capacity to make decisions on their own without expert input.

Grégoire Moreau:
Another issue is the operational complexity. The systems we need aren’t yet fully standardized, and this causes delays and a case-by-case approval process with the authorities.

Grégoire Moreau:
The second problem is the integration of BILAS (Built-in Load And Safety). Right now, the systems we have in place for certain areas, like Antwerp, work, but other regions or cities don’t have the same systems for urban drone delivery.

Grégoire Moreau:
So, in cities, the system doesn’t quite make sense, because it’s not just about who can fly

where, but also about how we can manage this more complex traffic. Right now, there are companies working on solutions for this, but most of them aren't focused on cities.

Grégoire Moreau:
In the case of Antwerp, the systems are set up so drones can avoid collisions, but cities lack such frameworks. If we don't have this kind of infrastructure, it's impossible to operate drones safely in urban environments. In many places, there are no airports nearby that could act as a reference for drone operations.

Martin:
Yes, I see.

Grégoire Moreau:
And since aviation doesn't require transponders in non-controlled airspace, there's no way to track planes or helicopters that may be in the area. If we can't avoid them, it becomes unsafe for drones to operate, which is a major issue.

Grégoire Moreau:
And another key aspect is how we handle risk management. In the traditional aviation model, you prepare for operations by understanding all the risks in advance and then execute the plan. But for last-mile deliveries, where drones travel on unpredictable routes, this becomes very difficult. We'll have to figure out how to handle this in real time, which is another challenge.

Martin:
Sure.

Grégoire Moreau:
So that's the third regulatory challenge: how do we operate drones on unknown routes in real-time, and how do we get approval to do so?

Martin:
Right, this all ties into regulation.

Grégoire Moreau:
Exactly. The final regulatory challenge is the issue of privacy. Drones typically have cameras onboard, which could raise concerns under the GDPR. There are still some gray

areas about what data can be collected, and how, when drones are flying over people's properties.

Martin:
Yeah, that's one of my concerns too.

Grégoire Moreau:
Yes, privacy is always a tricky issue. But I believe it can be addressed through the right processes, like ensuring data isn't stored unless it's necessary or deactivating cameras when they aren't needed. It's all about having the right procedures in place, and that can be verified.

Martin:
Right, that makes sense.

Grégoire Moreau:
The real barrier to large-scale drone operations in urban areas is public acceptance, which is still largely tied to privacy concerns. People are concerned about drones flying over their heads, and they often take their concerns to politicians. The main issue in many places, though, is noise. That's the barrier.

Martin:
Right.

Grégoire Moreau:
In regions where drone delivery is already operational, like in Australia, the acceptance issues seem to reduce over time as people get used to it. The key point is that drones will need to establish trust with the public. If it's a company people know, they're less concerned about privacy. The problem lies more in the noise they create, especially when drones are flying at lower altitudes.

Martin:
Yeah, I can see that being an issue.

Grégoire Moreau:
But for us, the noise isn't as much of a problem because we're not flying drones at low altitudes where people are located. Our drones typically fly at around 10 meters from the

ground and deliver inside buildings. You won't even notice the drone if you're inside with headphones on.

Martin:
Right, that's an interesting point.

Grégoire Moreau:
In a city, the noise wouldn't be a problem either if the drones are flying at 80 meters. Cities are already noisy, and the drone would be far enough above to not disturb people. The issue arises only when the drone lands near someone, which brings up both noise and safety concerns.

Martin:
Exactly.

Grégoire Moreau:
In terms of technological challenges, I don't think there's much left in the way of barriers. Battery life and weather conditions are typical concerns, but they aren't game-changers. The technology to make this work already exists, and while the systems aren't perfect, they're good enough to support a delivery model.

Martin:
Right, that makes sense.

Grégoire Moreau:
We have drones that can fly in various weather conditions, and while smaller drones may struggle in worse conditions, they can still manage in many cases. For B2C last-mile deliveries, we're usually working with shorter distances, so battery life and weather aren't huge problems.

Martin:
Got it.

Grégoire Moreau:
What's more important is how we handle the operational side. For instance, when we're running hundreds of flights a day, we need to make sure everything runs smoothly. There's a huge cost associated with this, especially when factoring in the time of the pilot. For example,

we calculate that for every 15-minute delivery, we're adding roughly €10 to the cost of the flight just for the pilot's time.

Martin:
Yeah, I see how that could add up.

Grégoire Moreau:
Exactly. But the biggest issue is still the upfront investment. Drones are expensive, they have a limited lifespan, and once they reach a certain number of flight hours, they can't be used anymore. This deprecation adds to the cost per flight, making it harder to justify the business model for last-mile delivery.

Martin:
That's true.

Grégoire Moreau:
Then there are the costs associated with infrastructure. We need charging stations and facilities for drones to land, which are expensive to set up. If we're doing thousands or millions of flights, we can offset the cost of infrastructure, but for smaller operations, it's a significant expense.

Martin:
Right.

Grégoire Moreau:
The biggest factor for us, however, is the pilot. Right now, a single pilot can monitor several drones, but they have to stay focused on every mission to be ready to intervene if something goes wrong. This raises a question about how many drones one pilot can manage at once, and whether they can stay alert enough to prevent accidents.

Martin:
That's an interesting challenge. How many drones can a pilot really manage?

Grégoire Moreau:
Right now, there aren't many pilots who can handle multiple flights simultaneously. We're working on software to help, but this is more of a long-term project. The European regulations don't yet provide a clear framework for this, but it's not forbidden either.

Martin:
Interesting. It seems like there's a lot of potential in this area, but there are still many challenges to overcome.

Grégoire Moreau:
Exactly. Once the economic model is proven and more companies can afford to build their own drones, the industry will likely see competition, and that will bring down costs. This will help make drone delivery more feasible for last-mile logistics.

Martin:
Right, that makes sense. So, in terms of barriers, if you had to rank them, would you say the economic barrier is the largest?

Grégoire Moreau:
Yes, the economic barrier is definitely the most significant one. After that, I'd say regulatory issues come next, followed by technical challenges, and then the operational challenges. The operational ones can be overcome with time and preparation, but the economic and regulatory barriers are the real hurdles.

Martin:
Got it. Thanks for your insights, Grégoire. This has been really helpful!

Martin:
We're running out of time, so I'll quickly move on to the next topic: facilitators. If I asked you to list the main facilitators, what would they be? From what I've identified, you can agree, disagree, or nuance, but here's what I came up with. First, environmental factors, like objectives for reducing traffic congestion, potentially reducing traffic emissions compared to traditional delivery methods. I also identified operational efficiency in terms of logistics infrastructure. The fact that there are research institutes investing, the presence of regulatory collaborations with state entities, and Smart City projects, which could help facilitate adoption. Lastly, the demand from the market, with the growing commerce market and a highly competitive logistics sector. I think this all suggests that innovation in logistics is needed.

Grégoire Moreau:
Yes.

Martin:
From what I could find, these are the key points.

Grégoire Moreau:
Okay, for me, the most important is market demand. Because logistics, as it has been for a long time, is still a problem. Last-mile delivery is always an issue. There's no good solution for it yet. That's why we end up with situations where people are in illegal situations—they're not authorized to operate but are under such pressure on prices and operational models that it doesn't work well.
So, drones are well-positioned for last-mile delivery because we're talking about the final stretch with a not-too-heavy package, and the drone can technically be an ideal solution for this delivery. Plus, all deliveries eventually end up as last-mile, so we're talking about a huge volume of potential deliveries. All the forecasts on future drone delivery potential are based on this huge last-mile volume and the billions of potential revenue from it.

Martin:
Right.

Grégoire Moreau:
So, from the demand side, logistics is definitely there.
Regarding environmental factors, we're using electric drones.

Martin:
Right.

Grégoire Moreau:
In our case, we've calculated that we avoid 85% of CO2 emissions, considering both battery production and drone production.

Martin:
Ah, considering the production too?
Okay, interesting.

Grégoire Moreau:
Yes, we checked. This is because the drone is much lighter than a car. And when we're

talking about transporting 10 kilos, the van is really carrying 10 kilos on board, so the drone is much more efficient.

Martin:
Got it.
You haven’t made a comparison in terms of capacity between what a van can carry and what the drone can?

Grégoire Moreau:
We haven’t done that, but the reason we don’t is that it’s not a meaningful model. The drone will always lose out in this comparison because I’d have to say, "Okay, I need to make 150 flights to replace one van," and practically, no one is going to pay me for 750 flights. So, the calculation we make for 85% efficiency is compared to the same routes a van would take.

Martin:
Got it.

Grégoire Moreau:
It’s comparing the same route for the van. One flight replaces one van journey, but it’s based on the actual route we’re replacing.

Martin:
Okay, understood.

Grégoire Moreau:
So, environmental factors are crucial. Electric drones have a big advantage, especially the smaller ones, which use smaller batteries. It’s easy to say that logistics companies are interested in that, but it’s harder for them to pay for it. A few years ago, it may have been easier, but now, it’s not really a topic that comes up when we try to sell our service.

Martin:
Right.

Grégoire Moreau:
It’s more of a "nice-to-have" now, but we have found an agreement on that front.

Martin:
Right, okay.

Grégoire Moreau:
Operationally, drones will save time, that's for sure. The goal is to fly in a straight line, or nearly straight. If needed, we can avoid obstacles, so we'll be much faster. The real question is about the price.

Martin:
Right.

Grégoire Moreau:
In B2C, the client may be willing to pay a premium for very fast delivery. They might want to have it delivered in the next few hours, or even in the next 10 minutes.

Martin:
Right.

Grégoire Moreau:
But that's rare. Fast deliveries are often requested when people are hungry or in urgent situations, but even then, we're usually not talking about a 5-minute difference. The client may be willing to pay an extra €3 to save 5 minutes on the delivery, but that's still a hard sell. It's complicated, but drones are definitely interesting because they can be much faster. I think the value of speed is more significant in B2B applications, where there's a real need to save those minutes.

Martin:
Got it. So, on the operational side, in Belgium, are there any subsidies or state support? Is there a real investment from state entities to make this happen?

Grégoire Moreau:
In terms of last-mile, we haven't tried, but I'm almost sure that there is.

Martin:
Right.

Grégoire Moreau:
As a company, we've received funding from the city of Antwerp, from Vlayos (Flemish Innovation Agency), and from the European Space Agency.

Martin:
Got it.

Grégoire Moreau:
Although, it's not exactly Smart City level.

Martin:
Ah, okay.

Grégoire Moreau:
But they see it as an innovative project with a positive impact. We're in the Port of Antwerp, and there's definitely a lot of positive attention for them, with no real negative aspects. But I think, if we're talking about Smart Cities, there's a lot of interest and there are definitely funds and subsidies available as long as it's presented the right way.

Martin:
Right.

Grégoire Moreau:
The key is to show how we can reduce road traffic and similar benefits. But of course, there's always the concern about noise from drones and people being afraid of them, especially in cities. I'm not sure this would be very popular in all cities if the city itself is funding it.

Martin:
Okay, understood.

Grégoire Moreau:
In Antwerp, I'm almost sure it would work, but in Brussels, I think it would be much more complicated. That's more of a political issue.

Martin:
Right, I can imagine.

Grégoire Moreau:
Yes, Brussels would be more challenging.

Martin:
Alright, thanks again! Just one last question to wrap things up.

Grégoire Moreau:
Sure.

Martin:
Do you think it's feasible in the near or medium-term future? What's your vision? Do you think it will happen within 100 days? Or are you not sure?

Grégoire Moreau:
I'm almost sure it will happen because, as I said, for me, the biggest roadblock is the economic side. It won't be easy for us, but for big tech companies like Wing (which is owned by Google) or Amazon with their infinite resources, they'll continue to invest until their drones are cheap enough and until they have all the technology and approvals to operate on a large scale.

Martin:
Right.

Grégoire Moreau:
Once they have a system where one pilot can oversee multiple drones, at that point, the model will be financially viable. The regulatory side is already in progress, and while there are still some blockers, authorities are slowly working on it, but it's happening. I think the U.S. may actually move faster because they're bypassing some of the complex European processes.

Martin:
Right.

Grégoire Moreau:
In the U.S., they're working directly with operators to verify their internal procedures without having to go through a complicated framework. Some U.S. operators are already authorized to operate in certain areas, and as long as no accidents occur, this will expand.

Martin:
Right.

Grégoire Moreau:
The two other factors I mentioned were operational and technical, but for me, it's really just about investment. So, it's a matter of time—how quickly can we get there?

Martin:
Got it.

Grégoire Moreau:
I think I would have been more ambitious a few years ago, but the issue this year is more about the financial side of the industry. Many startups need substantial funding, and raising money has been quite difficult this past year, which delayed things. Many companies failed in the process.
So, I think we're looking at a medium-term future, not in one or two years, but maybe in five years, we'll see companies reach a critical mass and start expanding everywhere.

Martin:
Right, okay.

Grégoire Moreau:
I hope that's us too, but we'll see.

Martin:
I hope so too. Thanks again for your time, Grégoire.

Grégoire Moreau:
You're welcome.

Martin:
If I need more help or contacts for interviews, I'll reach out. I still need a few more interviews to complete my research, and it's been a bit challenging.

Grégoire Moreau:
Sure, I can help with that.

Martin:
Great! Thanks again, I really appreciate it.

Transcript 3:

Emilien Watelet – Director at ID2MOVE

Martin Balgobin (BE):
Mais c'est ça que j'allais faire. Oui, oui. C'est exactement ça que j'avais commencé par une courte présentation. Moi, en fait, je suis consultant chez PC depuis 2 ans maintenant, mais à côté de ça, je n'ai jamais terminé mon petit mémoire que je traîne depuis plus de 2 ans maintenant. Enfin voué à le terminer en parallèle de mon boulot.

Emilien Watelet:
Ouais.

Martin Balgobin (BE):
Et j'ai envoyé l'invite avec mon adresse PC parce qu'avec mon adresse privée, je n'arrive pas à faire d'enregistrement du meeting. C'est une explication rapide pour parler un peu plus de cette thèse, enfin de ce mémoire.

Emilien Watelet:
OK.

Martin Balgobin (BE):
Je travaille sur un mémoire, le sujet c'est les drones de livraison pour le "last mile" et ma question de recherche est : Quels sont les obstacles critiques et les facteurs facilitateurs dans l'adoption et l'intégration de la livraison par drone pour la logistique du "last mile"? C'est le programme, alors je voulais expliquer comment j'ai structuré l'interview. J'ai fait ma revue littéraire et j'ai déjà identifié des barrières.

Emilien Watelet:
Vaste programme.

Martin Balgobin (BE):
J'ai identifié des facilitateurs et comment j'ai structuré ça, c'est vraiment selon les obstacles et les facilitateurs. Je commencerai par poser des questions sur les obstacles et je vous demanderai de lister quels sont les obstacles pour vous à l'adoption du drone en Belgique, pour comparer avec mon listing. Ensuite, l'idée est que nous allions plus en détail dans chaque sujet. Évidemment, quand je vais lister les obstacles, vous pouvez les nuancer ou ajouter à ce que je n'aurais potentiellement pas trouvé.

Emilien Watelet:
OK, d'accord.

Martin Balgobin (BE):
Ça va être la structure et ma première question serait de vous présenter, on parle pour la Belgique.

Emilien Watelet:
On parle pour la Belgique.

Martin Balgobin (BE):
Oui, donc on parle pour la Belgique effectivement.

Emilien Watelet:
OK.

Martin Balgobin (BE):
Oui, c'est ça que je disais, ma première question va être ce que vous faites chez D to Move.

Emilien Watelet:
Voilà.

Martin Balgobin (BE):
Je sais que c'est un incubateur, financé par l'USB de ce que j'ai vu. Donc voilà.

Emilien Watelet:
Parfaitement.

Martin Balgobin (BE):
Petite présentation de vous, votre rôle, ce que vous faites ?

Emilien Watelet:
Ouais. Avant cela, il y a un historique. Je pense qu'il est nécessaire pour comprendre le pourquoi du comment.

Martin Balgobin (BE):
Ouais.

Emilien Watelet:
Initialement, D to Move était un département de Cap Inove, le centre d'accompagnement pour l'innovation, un label reconnu au niveau européen, créé à Nivelle en 1983 par des professeurs de l'ULB de la Solvay Business School frustrés de ne pas trouver d'accompagnement pour les spin-offs universitaires. Ils ont tout l'accompagnement technique mais pas business, donc sur un terrain au sud de la capitale appartenant à l'université, ils ont créé Cap Inove, qui a rapidement évolué pour accompagner toutes les entreprises à orientation innovante.

Martin Balgobin (BE):
Hum.

Emilien Watelet:
En 2017, un plan stratégique pour les 5 années suivantes est décidé pour focaliser sur des thématiques importantes pour la région du Brabant wallon et la Wallonie, l'agroalimentaire et les technologies agricoles d'une part, et une vision prospective de systèmes autonomes en 2019. A cause de circonstances chanceuses, le bâtiment en face de Cap Inove appartenant à Peugeot est racheté et mis à disposition pour aménagement moyennant une charge, grâce à un partenariat public-privé avec l'ULB, l'intercommunale du Brabant wallon, et un fond privé.

Martin Balgobin (BE):
OK.

Emilien Watelet:
En 2019, I Love est lancé comme centre d'excellence, mettant à disposition des infrastructures pour d'autres. Les systèmes autonomes se divisent en systèmes aériens, soit les drones, systèmes au sol, et systèmes aquatiques. L'idée est que la technologie utilisée sur un drone aérien soit applicable aux autres types.

Martin Balgobin (BE):
Ouais.

Emilien Watelet:
Depuis 2019, encore aujourd'hui, je suis arrivé en 2020 pour l'internationalisation du réseau et la dynamisation des partenariats. J'ai pris la tête de D to Move en 2021. La grande valeur ajoutée est la zone de test aérien à Nivelle, internationalement diversifiée, permettant le survol de divers environnements industriels, agricoles, urbains, militaires, etc., dans une bulle de 600 hectares.

Martin Balgobin (BE):
Mais.

Emilien Watelet:
Nous facilitons les tests de hardware, software, capteurs et applications avec des scénarios adéquats. Mise à disposition d'un petit centre de prototypage, et services techniques, législatifs et business. Nous travaillons aussi bien avec de petits indépendants qu'avec de grandes sociétés, qu'elles soient dans le domaine des drones ou non.

Martin Balgobin (BE):
OK oui, donc c'est complet ce que vous faites là-bas.

Emilien Watelet:
Oui, c'est assez complet, ça amène beaucoup de diversité dans le boulot, ce qui est très

chouette. Il y a une quarantaine de centres reconnus au niveau européen, et nous sommes les seuls à travailler sur les 3 niveaux de drones, avec la plus grande diversité de survol.

Martin Balgobin (BE):
Oui.

Emilien Watelet:
Nous avons aussi des zones de test intérieur avec des caméras de capture de mouvement pour l'analyse de mouvement.

Martin Balgobin (BE):
Ouais OK.

Emilien Watelet:
Zones aquatiques, terrestres, et aériennes. Voilà un peu le topo.

Martin Balgobin (BE):
OKOK, une petite question pour terminer.

Emilien Watelet:
Oui.

Martin Balgobin (BE):
Par rapport à DronePort, par exemple, êtes-vous en avance, ou travaillez-vous avec eux ?

Emilien Watelet:
Alors, on travaille avec eux, ils sont notre équivalent flamand, avec seulement 3 zones de test en Belgique, la troisième étant en mer du Nord, et beaucoup plus spécifique. DronePort est bien connu, et nous faisons des échanges de clients, car nous avons des zones de survol complètement différentes.

Martin Balgobin (BE):
OK.

Emilien Watelet:
Ils peuvent travailler de manière plus simple pour les vols longs, mais doivent changer de zone pour un autre type de tests. Nous sommes leur équivalent, mais avec une autre approche.

Martin Balgobin (BE):
OKOK, parfait, merci pour cette intro. Je vois qu'on n'a que 45 minutes.

Emilien Watelet:
Je suis pas bloqué à 17h30, donc nous pouvons déborder si nécessaire.

Martin Balgobin (BE):
OKOKOK, ça va. Je vais commencer par les obstacles. Quels sont selon vous les principaux obstacles à l'adoption des drones de livraison pour la logistique du "last mile" en Belgique ?

Emilien Watelet:
La réglementation ? L'acceptation sociale ? Les sociétés qui vont faire le "last mile" ? Peut-être le prix.

Martin Balgobin (BE):
Le prix, OK. Parmi ce que j'avais listé : réglementaire.

Emilien Watelet:
C'est la chose la plus retardée à cause des délais.

Martin Balgobin (BE):
L'aspect technique aussi. Autonomie de batterie, conditions météorologiques, capacité de charge, aspect économique et aspect social.

Emilien Watelet:
D'accord.

Martin Balgobin (BE):
La littérature montre que l'aspect réglementaire est l'obstacle le plus important, suivi des obstacles sociaux et techniques, alors que l'aspect économique pour la Belgique serait a priori le moins bloquant. Quel est votre avis sur cette hiérarchie d'obstacles ?

Emilien Watelet:
Le légal en premier, c'est certain. C'est là que ça bloque, à cause de la réglementation européenne qu'on appelle la réglementation européenne du drone.

Martin Balgobin (BE):
OK.

Emilien Watelet:
C'est comme du gruyère, donc il y a beaucoup de trous à combler, mais rien n'est complété au niveau national. Le problème est double : européen et belge. J'ai pas peur de le dire, le dernier ministre fédéral de la mobilité avait peu d'intérêt pour le drone, donc ça n'a pas bougé les 5 dernières années. On parle de nouvelles propositions de loi pas avant 2027, donc ces conditions ne seront pas résolues à court terme. Acceptance sociale, même problème.

Martin Balgobin (BE):
OK.

Emilien Watelet:
En termes de tests, pour le médical ça va, mais pour le reste, c'est plus compliqué. La plupart des gens ne les voient pas et ne les entendent pas, mais on travaille pour diminuer l'impact sonore, visuel, etc. Donc l'acceptation sociale serait un frein, quoi. Les tests fonctionnent mieux sur grands sites industriels privés, zones spécifiques ou en milieu urbain avec composante sécuritaire ou santé publique.

Martin Balgobin (BE):
Hein ?

Emilien Watelet:
Pour moi, techniquement, il n'y a pas de gros problème. Suffit de regarder aux États-Unis, en Chine, il y a des drones pour la livraison "last mile". En Europe aussi, avec des sociétés comme Manon en Irlande. Ils font 3000 livraisons par jour dans la banlieue de Dublin de colis allant jusqu'à un kilo et demi. Techniquement, ça fonctionne, et l'acceptation sociale semble bien aussi.

Martin Balgobin (BE):
Hum.

Emilien Watelet:
Les drones peuvent porter de 50 g à 80 kilos maintenant. Nous avons un fabricant de drones hélicoptères qui peuvent porter 200 kilos. Techniquement, ça existe, mais ça fait du bruit, donc on revient aux deux premiers cas. La contrainte actuelle en Belgique serait les conditions météo, avec des rafales de vents et pluies battantes. Mais ça évolue rapidement.

Martin Balgobin (BE):
Ouais, exact.

Emilien Watelet:
Le côté commercial peut être mis en dernier ou avant dernier. Si le business model est viable et qu'il y a un réel gain de temps ou d'argent pour l'utilisateur final, l'intermédiaire passera la crainte. Mais en Belgique, les distances sont courtes. Les livraisons en vélo sont même plus économiques et faciles que l'intégration du drone. Peut-être opportunité d'aller directement au drone, mais la configuration belge avec des villes rapprochées rend la situation moins attrayante par rapport à l'Amérique.

Martin Balgobin (BE):
Ouais OK, parfait. Maintenant, nous allons creuser dans chacun de ces obstacles, au niveau réglementaire, vous avez mentionné le manque d'action du gouvernement.

Emilien Watelet:
Voilà.

Martin Balgobin (BE):
A part ça, quels sont les principaux obstacles réglementaires ? J'ai trouvé la gestion du trafic aérien et la sécurité. Quels sont les obstacles concrets ?

Emilien Watelet:
Pour moi, l'obstacle principal, c'est la DGTA, la Direction Générale des Transports Aériens. Elle est liée à une décision ministérielle. Ce sont eux qui donnent ou non les autorisations de vol. Si la DGTA dit OK pour un vol de livraison par drone et que les conditions de base sont remplies, ça ira plus vite.

Martin Balgobin (BE):
Hum.

Emilien Watelet:
Il y a des délais d'attente au-dessus de 12 mois pour le traitement d'un dossier. L'équipe est réduite, ce qui contribue à l'attente. La DGTA a la réputation d'être sévère et stricte, ce qui a du sens pour des questions de sécurité, mais très peu de dossiers sont acceptés. Le dernier grand dossier accepté concernait la pulvérisation, ce qui était pour eux le dossier de l'année.

Martin Balgobin (BE) :
OK.

Emilien Watelet :
Légèrement, là. Il y a très peu de place pour la flexibilité et l'expérimentation au niveau belge. Pour moi, le frein par rapport à la sécurité est un des points, et la gestion de l'espace aérien en est un autre.

Martin Balgobin (BE) :
Hum.

Emilien Watelet :
Mais si on voulait vraiment, ces points-là pourraient être mis de côté.

Martin Balgobin (BE) :
Donc, en fait, c'est vraiment au cas par cas ? OK, parce que j'avais vu que Drones Futures allait lancer des tests de livraison. Je ne sais pas si vous en avez entendu parler ?

Emilien Watelet :
Oui, il y a des procédures. Vous avez vu sur leur site web des dessins, peut-être.

Martin Balgobin (BE) :
Oui, ce n'est pas très clair.

Emilien Watelet :
Moi non plus, je n'ai jamais rien vu voler. Ils font de la publicité parce qu'ils prévoient quelque chose. J'en entends parler depuis un an, mais je n'ai jamais vu de drone, à part des dessins et belles vidéos 3D.

Martin Balgobin (BE) :
OK.

Emilien Watelet :
Mais concrètement, je n'ai jamais rien vu de leur part. Alors oui, ils ont un plan d'action en gants, mais rien de concret à ce niveau. Quoi qu'il en soit, il existe des procédures d'analyse de risque et de demande d'autorisation connues au niveau européen, comme les SORA et PDRA. Chaque SORA est analysé au cas par cas. Drone Futur pourrait attendre jusqu'à 18 mois pour une réponse.

Martin Balgobin (BE) :
OK.

Emilien Watelet :
Tout ça pour dire que si Drones Futur accomplit cela demain, une autre entreprise voudrait faire la même chose et devrait remplir exactement le même dossier. Le délai d'attente pour que le dossier soit traité pourrait ne pas être plus court. C'est vraiment du cas par cas.

Martin Balgobin (BE) :
OKOK. Et si c'était accepté ? En termes de responsabilité légale, s'il y a un accident impliquant des civils, que dit la législation actuelle ? La littérature montre que c'est assez compliqué d'obtenir des autorisations pour les vols hors de la ligne de visée (Beyond Visual Line of Sight).

Emilien Watelet :
C'est ça, B-VLOS. Actuellement, les directives européennes reprennent d'autres réglementations existantes. La RGPD s'applique clairement aux drones, qui, comme toute

caméra, doivent respecter certaines règles de vol et ne pas utiliser d'images d'autres personnes. Peu de gens connaissent en détail la RGPD en Belgique.

Martin Balgobin (BE) :
Oui.

Emilien Watelet :
Dans le détail, peu de citoyens comprennent qu'ils ne peuvent pas photographier leurs voisins. Certains ignorent la législation RGPD, et d'autres s'en moquent. Les PDR et STS standardisent les processus. Une entreprise suivant ces règles peut obtenir plus facilement une autorisation, avec une analyse de risque simplifiée. Toute non-conformité au cadre rend la PDR inutile.

Martin Balgobin (BE) :
OK.

Emilien Watelet :
Standardisation requiert des adaptations. Pour la livraison "last mile", les conditions seront différentes en ville dense qu'en zone rurale. De nombreux scénarios doivent être adaptés, mais aucune solution miracle n'existe.

Martin Balgobin (BE) :
OK, ça clôture la partie réglementaire. Pour l'aspect technique, vous avez dit que seules les conditions météorologiques seraient un principal obstacle. Autonomie de batterie, capteurs avancés, caméras, et systèmes de collision ne sont pas un problème majeur ?

Emilien Watelet :
Selon moi, ce n'est pas un problème, mais c'en est un pour les autorités aéronautiques. La communication entre drones, planeurs ou avions civils est essentielle. Le projet U-Space vise à une meilleure collaboration de l'espace aérien.

Martin Balgobin (BE) :
Oui, j'en ai entendu parler.

Emilien Watelet :
Le projet vise à investir millions d'euros dans des systèmes comme celui du port d'Anvers, mais c'est limité. Ce concept essaye de ne pas interférer entre drones et avions.

Martin Balgobin (BE) :
Oui, c'est clair.

Emilien Watelet :
Si on respecte les règles de base, il ne devrait pas y avoir de conflit. Une communication et inscription adéquates devraient suffire, mais en forte densité de drones, des soucis pourraient apparaître.

Martin Balgobin (BE) :
OK. Avec les technologies actuelles, la densité urbaine ne constitue pas un frein majeur.

Emilien Watelet :
Je ne pense pas. Sauf en cas d'atterrissage au centre d'un carrefour dense, il n'y a pas de barrière technique. Avec des QR codes et mesures précises, les drones peuvent atterrir au centimètre près.

Martin Balgobin (BE) :
OK.

Emilien Watelet :
Des interférences volontaires restent possibles. Pourtant, les drones sont souvent ignorés dans les zones fréquentées. La 5G, par exemple, n'est pas encore essentielle à la communication drone-opérateur.

Martin Balgobin (BE) :
Oui.

Emilien Watelet :
La 5G pourrait optimiser des vols massifs. Mais orienter la 5G vers le ciel servira davantage les drones. Pour l'instant, ce n’est pas stratégique.

Martin Balgobin (BE) :
Hum.

Emilien Watelet :
Elle reste un frein en cas de forte simultanéité, mais bien moindre aujourd'hui.

Martin Balgobin (BE) :
Oui, d'accord. Passons à l'obstacle économique. Quels sont les principaux défis économiques pour l'adoption de cette technologie ?

Emilien Watelet :
Quelles sont les dépenses et les gains ? Quel est le retour sur investissement ? Pour les sociétés, comme pour les clients, c'est crucial. Les gens paient cher pour de la rapidité, comme avec Amazon Prime.

Martin Balgobin (BE) :
Oui.

Emilien Watelet :
Si les drones permettent une livraison en 2 heures, les gens paieront plus. Pour des livraisons moins urgentes, les bénéfices seront moindres.

Martin Balgobin (BE) :
Hum, OK.

Emilien Watelet :
Chaque entreprise doit évaluer ses coûts et bénéfices.

Martin Balgobin (BE) :
Oui, mais quels sont vos avis sur les coûts initiaux, infrastructures, formations, et assurances ?

Emilien Watelet :
Pour moi, le coût d'une flotte est inférieur à celui d'un véhicule. Les investissements ne sont pas excessifs, même pour PME.

Martin Balgobin (BE) :
OK.

Emilien Watelet :
Les drones coûtent peu. Les petits drones pour 2 à 3 000 euros peuvent déjà porter des charges légères. Les infrastructures nécessaires sont minimes, avec quelques logiciels accessibles.

Martin Balgobin (BE) :
Hum.

Emilien Watelet :
La partie coûteuse est l'autorisation légale. Pourquoi des sociétés attendent ? Car aucune solution clé en main n'existe. Beaucoup choisissent des tests avec succès, cependant.

Martin Balgobin (BE) :
OK.

Emilien Watelet :
L'intérêt financier à moyen/long terme s'avérera évident.

Martin Balgobin (BE) :
OK, c'était intéressant. Une pharmacie à Porto utilise un drone pour desservir efficacement des zones rurales, chose impossible en voiture.

Emilien Watelet :
Le drone met 15 minutes pour une livraison, contre 1 h en voiture. Avec 5 000 €, ils ont investi dans un drone programmé qui opère automatiquement, confirmant la minimisation des coûts et l'efficacité comme valeurs clé.

Martin Balgobin (BE) :
Intéressante histoire.

Emilien Watelet :
Oui. Cela montre que le retour sur investissement n'est pas si lointain.

Martin Balgobin (BE) :
D'accord. Terminons avec les obstacles sociaux. La perception de confidentialité, pollution sonore, sécurité, et impact sur l'emploi sont souvent des préoccupations. Qu'en pensez-vous ?

Emilien Watelet :
Je pense que le drone ne vole pas de jobs actuellement. Les études montrent que cela augmente la productivité, mais n'enlève pas d'emplois. Les pertes d'emplois devraient se ressentir particulièrement en coalitions non régulières, comme pour les indépendants de livraisons.

Martin Balgobin (BE) :
Oui.

Emilien Watelet :
Les gens pourraient réorienter leur emploi en supervisant plusieurs drones et éviter les emplois précaires. L'impact est en fait une requalification, comme pour la robotique industrielle.

Martin Balgobin (BE) :
Oui.

Emilien Watelet :
Toujours besoin de maintenance et de logistique. Les anciens chauffeurs en ville pourraient superviser les flottes à distance plutôt que de perdre du temps dans les embouteillages.

Martin Balgobin (BE) :
Oui.

Emilien Watelet :
Ce sera une amélioration : avoir un emploi rémunérateur et utile.

Martin Balgobin (BE) :
D'accord. Et pour la confidentialité, c'est problématique ?

Emilien Watelet :
À mon sens, la crainte est théorique, basée sur l'inconnu. En réalité, de telles préoccupations diminueront avec l'expérimentation.

Martin Balgobin (BE) :
OK.

Emilien Watelet :
Nos enquêtes révèlent que ces craintes sont souvent exagérées. Beaucoup ignorent même les survols de drones durant nos tests.

Martin Balgobin (BE) :
OK.

Emilien Watelet :
S'ils restent inaperçus, les drones ne sont pas un problème. Beaucoup ignorent complètement l'existence déjà en cours de tests près de chez eux.

Martin Balgobin (BE) :
OK, donc au-dessus des zones habitées, c'est légal si autorisé ?

Emilien Watelet :
Oui, nos tests l'autorisent partiellement. En réalité, tant qu'on ne tient pas compte du drone, son intégration sera bien vue.

Martin Balgobin (BE) :
OK, oui.

Emilien Watelet :
Il ne faut donc pas s'en préoccuper tant qu'il reste un élément discret de notre environnement.

Martin Balgobin (BE): Pardon, ah oui.

Emilien Watelet: Je me rends compte que j'ai des positions assez tranchées, mais elles viennent d'un long historique.

Martin Balgobin (BE): Non, mais c'est parfait, c'est le but donc tant mieux. Ça clôture la section sur les obstacles. On va pouvoir passer aux facilitateurs. D'après vous, pas de souci ?

Emilien Watelet: Je prends une minute pour me rafraîchir, je parle tellement. La fontaine est à côté de la salle de réunion, c'est pratique.

Martin Balgobin (BE): Alors, même question que pour les obstacles, pouvez-vous lister pour vous les différents types de facilitateurs pour l'adoption des drones de livraison en Belgique ?

Emilien Watelet: Je dirais déjà la technologie en tant que telle, elle est assez éprouvée. Le besoin de réduire la densité de véhicules est là. Je dirais aussi le côté un peu luxe de se faire livrer plus rapidement qu'actuellement.

Martin Balgobin (BE): OK.

Emilien Watelet: Pour moi, ce sont les trois grands avantages à chaud.

Martin Balgobin (BE): Oui, OK. Ce que j'ai trouvé et listé, c'est un avantage environnemental lié à la réduction de la congestion du trafic. L'efficacité opérationnelle inclut les infrastructures logistiques, les institutions de recherche, les collaborations réglementaires, etc. J'ai aussi trouvé que des projets de Smart City étaient un facilitateur, et enfin, la demande du marché, semblable à ce que vous avez dit.

Emilien Watelet: Ouais.

Martin Balgobin (BE): Le marché du commerce est en croissance, le secteur logistique est très compétitif, et le consommateur souhaite des livraisons toujours plus rapides. Amazon Prime, par exemple, livre en moins de 24 heures. Passons alors aux avantages environnementaux : pour la Belgique, est-ce que cela matche avec les drones de livraison ?

Emilien Watelet: Oui et non. Il nous manque une analyse de l'impact d'un drone sur toute sa chaîne de valeur. Avec la voiture électrique, on remarque qu'elle peut consommer plus de CO2 sur tout son cycle de vie qu'une voiture à essence. Le drone suit un peu cette logique.

Martin Balgobin (BE): OK, ouais.

Emilien Watelet: Les drones ne consomment pas de carburant, mais les batteries doivent être rechargées, et leur durée de vie est limitée. Le remplacement d'hélices, par exemple, n'est pas recyclable. Ecologiquement, je ne vois pas si c'est vraiment mieux. Sur le papier, ça semble bénéfique, mais comme les voitures hybrides, c'est sujet à débat.

Martin Balgobin (BE): Exact.

Emilien Watelet: Sur le papier, oui, mais je ne m'en vanterais pas trop. La réduction de la congestion est réelle, mais dans les embouteillages à Bruxelles, par exemple, ce sont surtout des personnes qui se rendent au travail, et non des véhicules de livraison.

Martin Balgobin (BE): C'est vrai.

Emilien Watelet: Les camions sont bloqués par ces gens, et retirer les camions ne réduira probablement pas les embouteillages. Ecologiquement, est-il mieux d'avoir un camion bien pensé que 100 drones ? Je m'interroge.

Martin Balgobin (BE): OK.

Emilien Watelet: L'impact écologique n'est pas certain pour moi. La Belgique fait, de plus, de courtes distances entre 100 et 300 km. Aux États-Unis, par exemple, l’usage de drones pourrait être justifié par des livraisons qui prennent plusieurs heures par camion.

Martin Balgobin (BE): Ouais.

Emilien Watelet: Je ne mets donc pas l'écologie en avant pour promouvoir les drones.

Martin Balgobin (BE): D'accord.

Emilien Watelet: Prenons un autre exemple : en Espagne, où des camionnettes circulent constamment entre bâtiments, les drones ont remplacé ces trajets inutiles pour du petit matériel.

Martin Balgobin (BE): Ouais.

Emilien Watelet: Cet usage interne réduit du trafic, ce qui est bénéfique écologiquement.

Martin Balgobin (BE): En termes d'efficacité opérationnelle, un facilitateur est l'implication des institutions comme InoViris. Est-ce un facilitateur ?

Emilien Watelet: Je rêverais de dire oui, mais peu de projets sont réellement soutenus. La peur des drones est forte parmi les investisseurs, qu'ils soient institutionnels ou privés. Les PMEs font souvent faillite faute de fonds.

Martin Balgobin (BE): OK.

Emilien Watelet: Les fonds ne sont pas facilement accessibles, ce n'est donc pas un facilitateur à mon avis, sauf si l'accès aux investissements changeait.

Martin Balgobin (BE): Oui, si on est deux, c'est mieux que zéro, mais je comprends votre point.

Emilien Watelet: En effet, même si peu, c'est un début.

Martin Balgobin (BE): Est-ce que la géographie belge, un pays relativement plat, facilite l'adoption des drones ?

Emilien Watelet: Oui, si on parle de livraison depuis une plateforme centrale dans un rayon de 20 km. Cependant, pour le "last mile", je vois moins d'intérêt comparé aux États-Unis.

Martin Balgobin (BE): OK.

Emilien Watelet: Aux États-Unis, il y a plus de sens pour des livraisons de quartier à quartier dans les grandes villes rectilignes.

Martin Balgobin (BE): D'accord.

Emilien Watelet: La technologie est un facilitateur, testée ailleurs comme en Chine avec de la livraison par drone.

Martin Balgobin (BE): OK.

Emilien Watelet: Cela montre que les technologies fonctionnent sans incident majeur.

Martin Balgobin (BE): Hum.

Emilien Watelet: Notre technologie fonctionne bien, mais est freinée par la réglementation. Je pense qu'elle est assez robuste pour être utilisée, comme l'intelligence artificielle qui a ses avantages malgré les régulations européennes.

Martin Balgobin (BE): Oui.

Emilien Watelet: La technologie est suffisamment éprouvée pour un usage quotidien. Il y aura des améliorations, c'est le principe de la technologie, mais pour moi, il n'y a pas de problème à ce niveau.

Martin Balgobin (BE): OK, parfait.

Emilien Watelet: Concernant l'intelligence artificielle, c'est similaire. Elle est vue comme un danger, mais les avantages sont évidents pour ceux qui l'utilisent.

Martin Balgobin (BE): En effet.

Emilien Watelet: Avant que la réglementation freine ces technologies, de nombreux avantages peuvent être développés.

Emilien Watelet :
Ils ont comme client BF donc c'est pas rien non plus. Maintenant ils ont une ligne de livraison dans le port d'Anvers, donc à la limite, ça nous échappe un peu.

Martin Balgobin (BE) :
Oui, en effet. Hum.

Emilien Watelet :
Personne ne s'en émeut beaucoup. Mais concrètement, ces autorisations, ça a pris deux ans pour les obtenir, et maintenant ça fonctionne. Donc c'est sûr que ça va se développer. Avant que l'on reçoive nos pizzas à domicile un vendredi soir par drone, il y a encore un peu de chemin à faire, mais la livraison B to B, ça existe déjà et ça va se développer.

Martin Balgobin (BE) :
Ouais.

Emilien Watelet :
Elle existe et va croître, c'est certain.

Martin Balgobin (BE) :
OK, parfait. En fait, j'aurais peut-être une dernière question. Peut-être que vous pourriez m'aider. J'essaie d'interviewer des experts en logistique, en drones, comme vous, et en législation aéronautique. Avez-vous des contacts à me suggérer ? Actuellement, j'ai réalisé trois interviews, et c'est difficile de trouver des gens depuis cet été. J'ai contacté plusieurs entreprises et start-up sans trop de succès. Pensez-vous que l'incubateur aurait des contacts utiles ?

Emilien Watelet :
Les trois rendez-vous que vous avez eus, ça concerne qui ?

Martin Balgobin (BE) :
Je dois retrouver les noms, attendez. Il y a Franck Routier, mais je ne sais pas si vous connaissez ?

Emilien Watelet :
Non, désolé.

Martin Balgobin (BE) :
J'ai également contacté Unifly, mais je n'ai eu que des échanges par mail, rien de plus.

Emilien Watelet :
Oui.

Martin Balgobin (BE) :
Fly Unifly, ça semble être similaire.

Emilien Watelet :
Simple et Fly, c'est en fait l'outil de Unifly.

Martin Balgobin (BE) :
OK, j'ai également contacté Cadrone sans réponse.

Emilien Watelet :
Oui, pareil.

Martin Balgobin (BE) :
Jean-Pierre de Meute était initialement d'accord pour une interview, mais ça ne s'est pas confirmé.

Emilien Watelet :
OK.

Martin Balgobin (BE) :
Du coup, si jamais vous avez des contacts à partager...

Emilien Watelet :
Oui, bien sûr. SkyDrone est à considérer, ils ont testé beaucoup de choses à Bruxelles. ADLC pourrait être intéressant, c'est presque du last mile.

Martin Balgobin (BE) :
Oui.

Emilien Watelet :
Renseignez-vous aussi sur Grégoire Moreau d'ADLC, il est impliqué dans le transport à Anvers.

Martin Balgobin (BE) :
D'accord, noted.

Emilien Watelet :
J'ai une spécialiste en réglementation ici, mais ça risque de redire ce qui est déjà téléchargeable.

Martin Balgobin (BE) :
C'est vrai, ça peut être trop détaillé.

Emilien Watelet :
On a aussi un revendeur de drones qui a une bonne perspective sur la demande, ça pourrait être utile.

Martin Balgobin (BE) :
Ça peut être intéressant.

Emilien Watelet :
Je vais noter les contacts dans le chat pour ne pas oublier.

Martin Balgobin (BE) :
D'accord.

Emilien Watelet :
Donc Grégoire Moreau pour ADLC et Didier Vaness pour le revendeur de drones. Didier pourrait partager sa vision des technologies ainsi que des demandes.

Martin Balgobin (BE) :
Compris, merci beaucoup.

Emilien Watelet :
En Belgique, ce sont de bons contacts.

Martin Balgobin (BE) :
Connaissez-vous Michael Jem de Mim Médical ?

Emilien Watelet :
Oui, c'est lié à Elise.

Martin Balgobin (BE) :
Transport par drone, exactement. J'avais aussi essayé de contacter Steven Peters de Drone Futures, mais je n'ai pas eu de suite.

Emilien Watelet :
Ça ne me dit rien.

Martin Balgobin (BE) :
C'est un secteur de niche, faire du mass mailing n'est pas simple. Merci beaucoup pour votre aide.

Emilien Watelet :
Pas de souci, cela fait plaisir d'être utile.

Martin Balgobin (BE) :
Merci pour votre temps, c'est vraiment précieux toutes ces infos.

Martin Balgobin (BE): Bien sûr, comme on peut voir en Ukraine où des drones sont utilisés militairement.

Emilien Watelet: La guerre en Ukraine a accentué la prise de conscience des drones comme potentielles armes, une difficulté supplémentaire pour leur adoption.

Martin Balgobin (BE): OK.

Emilien Watelet: Cette guerre a rendu les règlements plus stricts, peu importe le contexte, notamment pour l'exportation de drones.

Martin Balgobin (BE): C'est devenu un frein réglementaire, je vois.

Emilien Watelet: Oui, c'est une conséquence que personne n'avait prévue. En termes de demandes du marché, ce qui importe est le facteur B to B, surtout pour les secteurs médical et de sécurité.

Martin Balgobin (BE): OK, pour le B to B en particulier.

Emilien Watelet: En effet, la demande forte se situe là, bien que le consommateur final apprécie également cette technologie.

Martin Balgobin (BE): Ouais.

Emilien Watelet: La Belgique étant compétitive en logistique pourrait adopteur rapidement les drones si elle surmonte ces barrières.

Martin Balgobin (BE): Je comprends.

Emilien Watelet: La logistique est effectivement très concurrentielle, mais pour l'instant peu y sont préparés. Les Espagnols par exemple construisent déjà des infrastructures prévues pour les drones.

Martin Balgobin (BE): Pour la Belgique ?

Emilien Watelet: Pour l'instant, le secteur belge n'est pas prêt, aucune grosse boîte logistique ne s'y prépare.

Martin Balgobin (BE): BIPOST n'a pas fait de tests ?

Emilien Watelet: À ma connaissance, non, mais je ne suis pas infaillible là-dessus.

Martin Balgobin (BE): D'accord.

Emilien Watelet: Cela prouve que beaucoup de sociétés ne prennent actuellement pas ce virage.

Martin Balgobin (BE): Dernière question : quelles sont les tendances futures pour l'adoption des drones en Belgique, à court, moyen et long terme ?

Emilien Watelet: À court terme, probablement rien à cause de la réglementation. À moyen terme, le développement se fera, essentiellement dans les secteurs stratégiques. À long terme, les sociétés IT géreront des flottes de drones, et le rôle de pilote disparaîtra au profit de la supervision automatique.

Martin Balgobin (BE): Donc, vous voyez un futur où les colis seront livrés par drone en Belgique à moyen ou long terme ?

Emilien Watelet: Oui, cela semble évident. L'ampleur et la fréquence restent à définir.

Martin Balgobin (BE): OK.

Emilien Watelet: En fait, il y a déjà des tests réussis, comme à Anvers pour la livraison de produits chimiques, c'est déjà en place.

Martin Balgobin (BE): OK.

Transcript 4:

Patricia Van Acker – Head of unmanned aicraft systems at FOD Mobiliteit

Martin: OK, good. I'll start by introducing myself quickly. I'm Martin Balgobin, a consultant at PwC Belgium. However, I'm still working on my thesis, which is why I'm conducting this interview today. I'm conducting research as part of my Master's in Business Engineering, focusing on the adoption and integration of drone technology for last-mile delivery logistics in Belgium. My research question is: What are the critical barriers and facilitating factors influencing the adoption and integration of drone technology for last-mile delivery logistics?

Could you please introduce yourselves?

Patricia: Sure. My name is Patricia Anaka. I'm the head of the Anand Aircraft Systems Department at BCA. We deal with everything from certificates for remote pilots to licensing authorizations for training entities and more. What I can provide information on is the regulatory aspect rather than the technical side.

Martin: Perfect, great. For the structure of the interview, I wanted to start by identifying what you see as the main barriers. Of course, we'll focus on the regulatory issues, but if we have time, I would like to briefly explore the other barriers and facilitators as well. Is that okay with you?

Patricia: Yes, sounds good.

Martin: Wonderful. So, I'll start with my first question: In your view, what are the main barriers to the adoption of drones for last-mile logistics in Belgium? Could you provide a broad overview beyond just regulatory issues?

Patricia: Sure. When discussing last-mile delivery, do you view it as delivering directly to a person's house, or do you see it as deliveries from a company to a central point where people can pick up their packages?

Martin: I consider it more as deliveries to a central point.

Patricia: That's a valid perspective. We still have several questions that arise from this—such as where the drones will land and how to ensure that when people touch the drone or pick up a package, they don't encounter any issues. We then need to discuss ground risks and air risks.

If we look at last-mile delivery and the context of Belgium, we see that we have a dense population, unlike countries like Australia, where there are vast areas with minimal population. In Belgium, you'll encounter populated areas quickly, which is a scenario that drones need to navigate.

From an airspace perspective, the situation is similarly complex. In many instances, you'll be operating in controlled airspace, managed by air traffic control. We are still waiting for the authorities to establish how they will allow BVLOS flights to be conducted safely within urban areas.

I think we're one of the few countries that allow flights when there are BVLOS operations in urban settings. However, many rules still need to be finalized to enable these operations at scale.

As for operational altitudes, drones are likely to fly between 60 and 120 meters AGL (Above Ground Level). We also have a significant number of general aviation flights, including many helicopters with permanent authorizations to fly low, generally below 500 feet.

How do we ensure that there are no collisions in this context? One potential solution is to develop U-space, but that is still a work in progress. We currently have a preliminary U-space framework in place in Antwerp, but we need a complete strategy and roadmap to facilitate BVLOS flights across Belgium.

Martin: That's clarity on the regulatory and operational dimensions.

Patricia: Yes, indeed. Regarding the drones themselves, we face numerous challenges given the current air traffic situation. The European legislation places specific demands on safety features like parachutes or flight termination systems. Manufacturers are struggling to demonstrate that their systems comply with these stringent regulations.

We also need to consider how to achieve consistent altitude determination across operations. I'm not saying that we should only conduct initial test flights; if we want to move towards a scalable solution, consistency in height determination is paramount.

There are still some technical issues to work through. For instance, the way drones calculate height can differ significantly from how airplanes do. A drone's takeoff altitude could be inconsistent if it launches from varying heights, such as the roof of a building.

Martin: I understand. Moving on to other barrier types, can you provide brief insights into economic barriers, such as initial investments or operational costs? Additionally, how do you view public perception and privacy concerns?

Patricia: Economically, that's primarily the industry's call, but one significant uncertainty is around scalable BVLOS operations. If operators wish to use U-space, they'll need to engage with a UTM (Unmanned Traffic Management) service provider, which raises questions about the underlying business models. Right now, it's unclear how much a drone operator will need to pay these service providers for each flight.

From the client side, we need to examine potential business models and whether there will be sufficient demand for drone deliveries. This varies by country. For instance, in Rwanda, the business case is clear due to poor road infrastructure; drones can deliver essentials because they fill a clear logistical gap.

In contrast, Belgium has a well-established transportation network, be it road, rail, or river. Thus, we must evaluate whether it makes economic sense to implement drone deliveries here.

From an ecological perspective, there are potential benefits if drone deliveries can replace small delivery vans; this could reduce overall emissions. In terms of noise, while drones can create noise, they may produce less sound than traditional delivery vehicles. However, if drone deliveries are simply layered on top of existing delivery methods, we won't achieve ecological benefits.

From a social acceptance angle, noise is a concern, but the biggest barrier at the moment is privacy. Residents are often worried when they see drones flying above, contemplating

whether they are being recorded. We frequently receive complaints from civilians expressing concerns about drones flying over their properties.

This is a significant hurdle we aim to address through education, showing communities the advantages drones can offer, like emergency blood transport or assisting in search and rescue operations.

Martin: Regarding regulatory challenges, what do you identify as the main issues?

Patricia: Safety standards are critical. Currently, many standards regarding drones are still in development. While the technology is available, regulation has yet to evolve at the same pace. This lag means that although BVLOS flights are technically possible, they often aren't authorized at scale.

The regulatory framework currently in place is rather cumbersome, and we frequently hear from industry representatives that they perceive a mismatch between the regulatory requirements and the actual risk realities they face. For meaningful changes to occur, solid data from operators is essential to demonstrate that certain regulatory conditions can be relaxed.

Furthermore, when discussing certified drones or those flying over crowds, it usually requires authorization from national authorities, which adds to the regulatory burden. There are also capacity limitations within EASA, impacting the timely approval of requests from the industry.

From a privacy perspective, we find that existing legislation applies similarly to drones as it does to other forms of surveillance or data collection. This matters because it complicates the narrative we need to build with the public: that drones can operate without breaching privacy.

Martin: How are recent EU regulations, like those from 2021, impacting the regulatory landscape for drones in Belgium? Are there additional layers that we must navigate?

Patricia: We've implemented numerous EU regulations, including implementations for EU 947 and 945, as well as U-space regulations. Importantly, we aren't adding extra conditions on top of these; we're simply complying with European directives. Where we identify safety, security, or privacy concerns, we create geofenced zones accordingly.

For example, in areas like the CTR (Controlled Traffic Region) around airports, we've implemented restrictions due to safety considerations, aligned with European regulations. I don’t see any significant gaps between EU and Belgian regulations; we are effectively following the guidelines established at the EU level.

Martin: How does Belgium address liability and insurance regulations related to drone operations?

Patricia: Liability and insurance for drone operations fall under existing regulations. There is specific insurance coverage required for certain commercial instances. However, we’ve observed that not all insurance companies are familiar with the emerging drone industry, making it challenging for operators to find suitable coverage.

Martin: Regarding BVLOS authorizations, Belgium has initiated pilot projects, which indicate progress overcoming regulatory barriers, right?

Patricia: Yes, indeed. For BVLOS authorizations, we have granted approvals for specific locations, particularly in the Port of Antwerp, where we have developed a framework that facilitates BVLOS operations.

When we step outside established BVLOS frameworks, especially in densely populated areas, the regulatory environment becomes more complicated. Currently, we issue precise authorizations but are working on evolving toward more generalized operations.

While some areas may permit BVLOS flights, we need to assess these cases thoroughly and ensure an acceptable risk level for safety, considering that existing legislation might not account for specific scenarios where drones could operate safely.

Martin: Regarding current regulatory initiatives, how effective are they? For instance, are there collaborations with organizations like Belgocontrol?

Patricia: Yes, Belgocontrol actively participates in discussions surrounding regulatory frameworks, and there is a willingness to collaborate with us. Regular meetings help align our understanding of drone integration within controlled airspaces and potential impacts on air traffic management.

One key question is how the responsibilities of air traffic controllers will shift if BVLOS flights are permitted. Their current mandate focuses primarily on avoiding manned aircraft collisions; introducing drones could complicate their responsibilities significantly.

Martin: How does Belgium's regulatory approach compare to the neighboring countries?

Patricia: We are quite advanced, currently having the willingness to facilitate drone operations. When I look at the industry at the BCA level, it is tech-savvy and prepared to move forward. However, the European regulatory environment has lagged a bit.

Also, there's a concern about our capacity to conduct necessary risk analyses; this could restrict our ability to implement U-space fully. If we are mandated to provide authorizations, we need more human resources to manage evaluations.

Martin: Would you rank regulatory barriers as the main hindrance to drone delivery adoption?

Patricia: I would say that standards definitely need to be in place first and foremost. Without clear standards, it becomes challenging to assess whether a drone operation meets safety requirements. Standards need to be developed by the industry and harmonized at the European level.

I would hesitate to rank these barriers definitively as each situation is different, but regulatory evolution is critical to allow for the effective integration of drone technology, particularly in areas outside controlled airspace.

Martin: What facilitators do you identify for adopting drone delivery in Belgium?

Patricia: We have a growing ecosystem that includes companies working with UTM systems, manufacturers of drones, and other related stakeholders. This industry can help raise awareness among policymakers about the needs and possibilities of drone technology.

We also have a solid infrastructure in place with research institutions and innovation hubs like ID to Move and John Port.

What we also need is to adopt a more client-oriented approach from the BCA. We should bring together stakeholders, researchers, and the industry to ensure we effectively address the operational needs. Moving towards that collaborative mindset can facilitate progress.

Martin: You mentioned environmental factors as facilitators, but the ecological impact of drone batteries could be a sticking point. Would you still consider it a facilitator?

Patricia: It depends on the context. While drones may produce less noise compared to traditional delivery vehicles, we still lack comprehensive studies comparing the environmental impact of drones concerning battery production and use.

In Europe, many areas have been designated as natural reserves where drone flights are typically restricted. Therefore, understanding how drones could affect such conservation areas remains crucial.

Martin: Is there emerging market demand for this technology, especially in relation to online shopping companies?

Patricia: At this moment, we aren't seeing significant demand from major logistics companies for drone delivery. Many authorizations issued are often short-term trials that don’t lead to sustained services. We need to reach a tipping point where companies can effectively leverage long-term authorizations to scale their operations.

Martin: Human capital is another important aspect. If we move towards drone deliveries, who will handle command control systems, flight planning, and related responsibilities?

Patricia: It won’t be just remote pilots. As we transition toward more autonomous systems, we will need engineers specializing in AI and telecommunications among other roles.

Currently, we have enough personnel for these fields, but I see a gap in universities focusing on preparing graduates for the future demands of drone operations.

Martin: Do you believe universities are doing enough to prepare engineers addressing future air mobility challenges?

Patricia: Some universities focus on technical aspects like composites, which is helpful. However, I believe we need programs that explore designing airspace and developing urban drone integration, not just traditional engineering skills.

Martin: Finally, what future trends do you foresee for the adoption of delivery drones in Belgium? How can Belgium position itself as a leader in drone delivery technology?

Patricia: In the near future, we want to shift from isolated pilot projects to a full strategy for drone operations in Belgium. This will entail developing a comprehensive roadmap for the lower airspace.

We need to differentiate ourselves from other countries in terms of regulatory frameworks and operational capacity. While we still need to identify our unique selling proposition, I don't have a clear answer right now.

Martin: Thank you for your time and valuable insights. This was very helpful, and I look forward to sharing the results of my thesis when it's completed.

Patricia: Thank you! I look forward to your findings.

Martin: Have a good afternoon!

Transcript 5:

Jurgen Verstaen - Co-founder and Director Sales & Innovation of Unifly nv

Jürgen Verstaen
No problem at all. My name is I'm Co founder of company called Unifly, which is based in Antwerp with its offices. So we have some extra offices as well in the world, one in New York and one in Bucharest as well. My background is actually military air traffic control, so I did that for 16 years before setting up this company. And together with the current CEO, Andres von Swann, I set up Unifly. But we started actually off in 2012 already. With the company called Flight Plus and there we created what today is called Unmanned Traffic Management, so or UTM, we were the first to do that. Which is really nice. We were quicker than NASA body mall was the guy at the NASA who was also looking into certain stuff, probably space related. Less Earth related I would say. We created. That's in 2000 and. Yeah,

13, I think 12:13. We came with the idea. And then from then on, we participated in the Spin master class when we had our software and swim master classes system wide information management. That's what swim stands for. Just kind of protocol communication protocol that is used within aviation between several. Products I would say. We became second after. Airbus, but yeah, we were only two military guys, like OK and now what? So we set up the company. Then in 2015 Unifly and from then on it's. History and the make, I would say we are now exist 10 years August that comes we exist 10 years. Our product is being sold worldwide. One of our biggest customers is Canada. For instance, NAF Canada. So the Canadian air Traffic Control Agency. So our customers are mainly. Authorities.

Martin Balgobin (BE) 3:27
Mm hmm.

Jürgen Verstaen 3:28
A combination. So it's an ans P air navigation service provider. In combination with the CEA with the Civil Aviation Authority. They come up with public tenders and then we come in with our product and say, look, this is what you need and to enable drone operations, you actually need our system traffic management system. So they become visible. So that's in a nutshell what what we do. I'm responsible in the company for funded projects. So I am in the playground. I can actually do what I want is a big word, a word, but I can actually. Like, OK, we need to go that way or we need to think about multimodal transport. Or cybersecurity or counter UES. So those are the things I'm doing right now.

Martin Balgobin (BE) 4:24
Interesting. And so at the moment, how many, how many people are working at the unifly?

Jürgen Verstaen 4:29
Lost accounts between 35 and 50, I think somewhere.

Martin Balgobin (BE) 4:34
Mm hmm.

Jürgen Verstaen 4:37
It's we are midcap company because of our shareholders.

Martin Balgobin (BE) 4:41
Mm hmm.

Jürgen Verstaen 4:42
So we have. Japan, who is who has 51% of the of the shares, although we are not acquired. It's a split over two companies, the 51%, so one is steradrome. The other one is a join and join is a kind of vehicle that is being used in Japan to fund.

Martin Balgobin (BE) 4:58
Mm hmm.

Jürgen Verstaen 5:05
Companies outside of Japan that are not Japanese, for instance, next to that, we also have fpym which is Belgian government with their finance vehicle and we also have flounders in there, which is.

Martin Balgobin (BE) 5:09
OK. Mm hmm.

Jürgen Verstaen 5:21
Ali hawk. What's that name again? I forgot. Well, it's it's really hectic and my brain is somewhere else at the moment. So so like we have cubic fun in there. We have veto in there because we're actually Spanner from veito.

Martin Balgobin (BE) 5:38
OK. Mm hmm mm hmm.

Jürgen Verstaen 5:41
When we set up the company in 2015. Notes. Yeah, it doesn't matter.

Martin Balgobin (BE) 5:52
OK.

Jürgen Verstaen 5:53
It's not that important who are the shareholders, but it it means that like we have 3 governments and shareholder, which is really nice, it means that they believe in the in the

solution. And if you then look at what is happening on the on the European scale, they actually have use space created.

Martin Balgobin (BE) 5:59
Mm hmm.

Jürgen Verstaen 6:09
We were actually standing at the cradle of the birth of you space. We helped riding also the initial royal degree in Belgium was written by me and some other people as well. Until it was like torn up in ugly pieces, I would say and unworkable. And but where we are today is now we are at, yeah, this year is the. The year where BV Los Flights will be enabled. Although we already do that. In the port of Antwerp for a while now, for a few years. And if you look at the pick up there, the numbers also in Canada the same is like whoa. People are starting to understand that a drone can actually help them.

Martin Balgobin (BE) 6:57
Yeah, yeah, yeah. OK then it's it's, it's both go to my first question. So I'm studying the this opportunity of during delivery. So specifically for for the last mile. So does this align with an opportunity you foresee in, in the future or would it not be the first application area you would think of?

Jürgen Verstaen 7:17
On the last mile, that's a topic that is on the table since years. Many good ideas. Already many operations that are ongoing, there's like a big one in. I think it's an eyelid mana. Who actually delivers? I think it's like Biggie. No, no biggie burgers. That's Belgium. Let's say McDonald's or Pizza Hut's deliveries, but they're different in the backyard. I spoke to those guys.

Martin Balgobin (BE) 7:43
Mm hmm.

Jürgen Verstaen 7:46
They delivered it in the backyard because. The problem of last mile is obstacles, and in the initial years of the drone as a tool, this we are lacking technology to actually see obstacles in the vicinity of the drone. If it needs to come down and it needs to deliver a box, how would

you do that? And do we do that at the doorstep? People said you are nuts. That ain't going to happen. Another idea is using up stations. Like today in Belgium, they have like B poster and the Postal Service. Have like they don't work with drones yet, but they already work with the kind of package wall. So that's kind of a hub station. So if you start working with that idea, I pitch that by, by the way, to be post years ago, they didn't take it up. They have a kind of a department as well that's looks into innovation, but many people were scared in the early days that they say it won't work. We don't have regulation. It's too dangerous if we fly against something who's responsible if we lose a package? Who's responsible? I can already imagine if you know that there are several drones flying over your head with parcels and you know, like Amazon or things like that.

Martin Balgobin (BE) 9:04
Mm hmm.

Jürgen Verstaen 9:05
Bad people will try to get them out of the air to actually walk away with the package, you know, so. The idea is out there, but initially they say you know what? If we are going to use drones, we don't use it for the last mile delivery. We we can have the drone land somewhere at the hub station and from then we can use robotics for instance. Of the things that you're already conceiving in the in entropy, you can see it already. I think it's Amazon that have kind of robots that that. That moves from A to B. It's first steps because that's when I come to multimodal transport. The drones is only one. Part of the puzzle if you look at the entire ecosystem, if you want to have the last mile, if you want to have that working.

Martin Balgobin (BE) 9:53
Mm hmm.

Jürgen Verstaen 9:58
You need to see OK, who are the other stakeholders involved other than flying? What you hear now for this year is that's not a new hot topic. Is that multimodal transport part? That's something I pitched already for a few years. Is that my understanding is that you need to have an unmanned logistical chain, and that starts at a ship that comes in into the docks.

Martin Balgobin (BE) 10:24
Mm hmm.

Jürgen Verstaen 10:24
Which is unmanned, for instance, you have unmanned cranes taking up the containers or large packages from ships. They put it on the train or a truck, which is also unmanned. That drives to a warehouse somewhere in the suburbs and the warehouse. Everything is being placed. And then you have your drones that actually go from the suburbs into the city centres where they deliver at hub stations.

Martin Balgobin (BE) 10:37
Mm hmm.

Jürgen Verstaen 10:51
And from then on from then you can say OK, then we disperse the packages and how you do that robotics would be an idea. Drones could be an idea as well. But that would be a completely chain. Yeah, yeah.

Martin Balgobin (BE) 11:02
That's it. I've reduce. Yeah. OK. OK. So let's get to the very first question about the barrier. So what do you think are the the main barriers to the adoption of of delivery drones for last mile logistics?

Jürgen Verstaen 11:19
Well, like I mentioned, technology.

Martin Balgobin (BE) 11:22
Mm hmm.

Jürgen Verstaen 11:23
There are two things you need to it's one is technology, so you need to have like the eyes on the drone that you know. OK, it's clear. I can land the what ideas with work with the cable and and release it or things like that. We have to watch out with those things. So technology is important. About situational awareness. What is happening around my drone that you need to know that's 1/2 is public opinion. It doesn't help if the public is not believing in it. And they say, OK, it's nice to have my pizza delivered by a drone. OK, that could be nice, but is everybody asking this? So in the years that that have passed, public opinion has been more

positive towards drones and beginning was really bad. They saw drones as weapons. Now they see it differently.

Martin Balgobin (BE) 12:07
Mm hmm.

Jürgen Verstaen 12:13
But it's it's do those two things, technology and public opinion, that will enable lost mile delivery by drone.

Martin Balgobin (BE) 12:23
OK, so these are the two main important for you. So based on, sorry.

Jürgen Verstaen 12:27
Infrastructure. And infrastructure, I forget infrastructure as well because, yeah.

Martin Balgobin (BE) 12:32
K because. No. Go, go. Go for it.

Jürgen Verstaen 12:36
If you don't have the infrastructure, you can't do anything. Either one of those are like verticals which is used for drones, for larger drones, for drones with passengers. But if you talk with the industry, they say, you know what, this will only happen as from 20-30, they don't believe that this happens earlier.

Martin Balgobin (BE) 12:57
OK, OK. So just to make a comparison with what I found in the literature. So in the literature, in the literature, they're saying that regulatory barrier is the first one. So with the complex air traffic management and the strict safety regulations, then the technical one with the battery life, weather conditions, limited carrying capacity and also anti collision system as an example.

Jürgen Verstaen 13:21
Right.

Martin Balgobin (BE) 13:22
Then we have the economic one, because it's a high initial investment. The operational amendments cost as well, and the AOI, economic viability, and last but not least, so the the first one is the social. So public perception and and trust, also ethical and privacy concerns. So what do you think of this of these lists and also the fact that they're ranking regulatory as the most important one than technical than economic and then social? Is is would be a listing that you agree a ranking that you agree with or.

Jürgen Verstaen 13:55
I do. It's a good list, and indeed I I did mention regulatory first because I'm so busy with the regulatory part that I already I forget about it because it's on a daily basis. Malabos are now allowed in new space, so then you could say BF. That's the trigger then to fly beyond visual line of sight in the past that was not possible. The regulator reports. Excuse me, the regulatory bod stated. OK, you can only fly V loss, which is 400 metres. Then it has no. Benefit in using a drone to deliver last mile. If you OK then you can sit in the truck in front of the house and have a drone flying to the doorstep. I've seen that in the US. That's a joke. I did. All they park in in the middle of a neighbourhood and from then on you have drones that disperse in the neighbourhood. Oh, yeah. You know what? People need some some motivation as well. They need to run their. Their health is bad as well for most people. Or not as good.

Martin Balgobin (BE) 14:50
Yeah, that's.

Jürgen Verstaen 15:02
Regulatory is indeed important, but in Europe they have worked so hard on a regulatory framework that I think it's there.

Martin Balgobin (BE) 15:10
OK, mm hmm.

Jürgen Verstaen 15:10
The only part that people are afraid of is what do you do when you fly into a city environment? On the regulatory part, who's responsible? That's really straightforward and theory. The city is not responsible. Air is a responsibility of the Civil Aviation Authority.

Martin Balgobin (BE) 15:28
Mm hmm.

Jürgen Verstaen 15:29
So if they allow it, the city can't say anything about it. They need to allow it.

Martin Balgobin (BE) 15:37
Mm hmm.

Jürgen Verstaen 15:38
But. More and more cities are now opening up for the idea of using drones as well, and most of the time they do that in a proof of concept. We have done one in Paris, for instance, where we delivered fresh goods from the Fresh Market in RMV in Paris to the city centre and the drone landed on a rooftop from a hotel. So one of the customers wanted to have fresh roses when they had breakfast, so they were brought in by drone. So that was a proof of concept. Did anything happen afterwards? No, it stayed with the proof of concept. And then they said, yeah, yeah, we will see. Police was a bit against it. Things like that. Dangerous need to watch out people with bad intentions, things like you need to take that into consideration as well when you see a drone could be a good guy because it would be a bad guy. You don't know that with the UTM system. You do know that the UTM system will tell you he has. A authorised flight plan. He's OK. If he hasn't it, it would not show up on our system. But if you have counter US systems within the city, you would know that a drone is a rogue drone and actions need to be taken.

Martin Balgobin (BE) 16:58
OK.

Jürgen Verstaen 16:58
That that needs to. That's has also an influence on the entire idea of the last mile.

Martin Balgobin (BE) 17:05
Mm hmm.

Jürgen Verstaen 17:06
Trustability. So it's the regulatory part, yes. And then yeah, the the list is OK, the list is open.

Martin Balgobin (BE) 17:14
OK. And just good questioning on the the BV loss, so you said it's no authorised. But still from my understanding, in Belgium it's authorised but case by case. No, like risk analysis should be made first and you cannot just start your own Business Today and say OK, I'm doing BV loss flight and delivery parcel to people, right?

Jürgen Verstaen 17:36
Oh yeah, you can, but you need to have the necessary licences. You need to have a surr if you have everything in place. And then now you see now you see is that you can do operations in a certain environment.

Martin Balgobin (BE) 17:40
Yeah.

Jürgen Verstaen 17:50
A certain type of operations as well. If you all have that, you can just do your business. There are already many companies in Belgium that have have recurrent revenue.

Martin Balgobin (BE) 17:56
OK.

Jürgen Verstaen 18:00
One is adlc for instance.

Martin Balgobin (BE) 18:03
Yeah.

Jürgen Verstaen 18:03
They are. They are doing. They are doing their business infuriable they use drones. BV wants to check that lines to look for coppertuff, things like that. If if you look how many companies are already using drones today. It's it's, there's, there's no.

Martin Balgobin (BE) 18:20
OK.

Jürgen Verstaen 18:23
There was a kind of a dip that's true the last years because people said, hey, hello. I'm so restricted. I will move away from it, but if you don't see in a in an air space like from the port of Antwerp where they have 4800 authorised flights last year which is a mixed BV loss and and V loss it mean that's a lot. It means that.

Martin Balgobin (BE) 18:32
Mm hmm. Yeah.

Jürgen Verstaen 18:48
It's it's happening, it's working, there's no issue Canada as well. They have more than 10,000 flights.

Martin Balgobin (BE) 18:50
Yeah.

Jürgen Verstaen 18:55
It's a no brainer. It can be used, but people are still yeah, watch out with CTRS and with aircraft flying around. How will they see a drone who has a right of way that's still in there? That's still embedded in in the people's minds. So it's not common use yet to see, OK. It's do it safe and that's why within the regulation part they also speak about U space S space.

Martin Balgobin (BE) 19:07
Mm hmm mm hmm mm. Yeah, yeah, yeah. Hang on.

Jürgen Verstaen 19:22
Which is a new kind of air space that needs to be created. But we don't have that yet. So for Belgium that will be established hopefully this year and this is linked to a project called Birdie BURDI in which Adlc takes part as well as in.

Martin Balgobin (BE) 19:32
Mm hmm.

Jürgen Verstaen 19:41
And there they do. The certification process of both the CISP and the USSP. So the both

roles that you need as service providers on the national scale, that's done by skies and by skydrome, which is a daughter company.

Martin Balgobin (BE) 19:52
Mm hmm yeah.

Jürgen Verstaen 19:54
So if when that's in place, then you have a completely regulatory framework that is up and running and Belgium is one of the first countries in Europe because it's a European thing next to Spain that we'll probably have a national rollouts on on that.

Martin Balgobin (BE) 20:00
Claims. OK, so OK, it it it's a blocker but still we are getting there. OK, good.

Jürgen Verstaen 20:14
Yep, Yep.

Martin Balgobin (BE) 20:17
Just yeah, to get back on the technical challenges. So for you, the main issue in terms of of technology is read the anti collision system. This is this technology that for you is a blocker at the moment.

Jürgen Verstaen 20:31
Well, you you have already means the UTM system for instance. If you are filed within the UTM system, there you have tactical conflict resolution and strategic strategic is easy. That's when you plan your flight. You can change the hours if you see there's a conflict, that is OK. There are two drones in the same area. Operating can be they can meet each other. But that's on paperwork or digital. But then you have your tactical deconfliction. That's a problem.

Martin Balgobin (BE) 21:00
Mm hmm.

Jürgen Verstaen 21:04
For tactical in an aircraft, that's logic. Yeah, you have Tcas and both aircraft. They fly to each other with autopilot and they are separated automatically from each other. That type of technology we don't find back yet in the drones because you have to what you have today, an

aircraft in a cockpit is big. You need to minimise that to a chip size. And there we are. OK, you can say we can put cameras on that. Yes. OK. The UTS M system gives you an alert when two drones come too close to each other. You have an audible sound and also visual sound, but then you need to be on on the hey on the as a service provider you see that and then you can also inform the drone operator because they have the same view on their tablet. OK, I have to watch out. There's another drone today is that would that be possible to fly?

Martin Balgobin (BE) 21:45
Yeah. Mm hmm.

Jürgen Verstaen 21:57
Yes, it would be possible. If you see in China that they fly it, they delivered in China without a problem, but they don't have a UTM system. What's the risk of colliding today?

Martin Balgobin (BE) 22:01
Mm hmm. Yeah.

Jürgen Verstaen 22:08
Hmm, if you see the number of drones that are being used, it's so low that it's. Yeah. Can an accident happen? Yes. But then it's like 2 oil tankers on the sea that hit each other.

Martin Balgobin (BE) 22:13
Mm hmm. Yeah. OK.

Jürgen Verstaen 22:23
If there's an uptick of drones and you go into the hundreds and maybe thousands, that's a different story, yeah.

Martin Balgobin (BE) 22:33
Indeed, mm hmm.

Jürgen Verstaen 22:36
So you need to have that technology and they are working on it. They are working on several ideas on how to avoid.

Martin Balgobin (BE) 22:36
OK. Mm hmm.

Jürgen Verstaen 22:43
One of the ideas was using Park Park distance control systems from cars and then we said we started laughing with those people because we said the speed, the sheer speed, they go to each other. Parking distance sensor. It's too late if you don't need to take action, it's too late.

Martin Balgobin (BE) 23:01
Yeah, exactly.

Jürgen Verstaen 23:02
Also, a drone versus an aircraft. It's not only drone versus drone, but also drone versus an aircraft. How do you do that? Even an aircraft can't see a drone. It's too small for them. It's a burden, and if they hit it, yeah, it's like a bird strike.

Martin Balgobin (BE) 23:17
Yeah.

Jürgen Verstaen 23:19
So yes, you are lacking some technology and it's improving really quick. That's nice to see that and that's typically for the unmanned sector. The innovation cycles are so short. That every every month or something new coming out of a tracking system or another technology that you don't see in Mand Aviation. There, the innovation cycles are about 10 to 15 years. Which that takes too long, certainly for for a tool like a drone, it needs to be really quick. So yes, technical is A is an important one, but today.

Martin Balgobin (BE) 23:58
OK.

Jürgen Verstaen 24:00
With the things they already have, it is manageable through UTM system.

Martin Balgobin (BE) 24:03
OK. OK. Thank you for that. Yeah, for the economic borrower, do you, I mean, what do you think of the long term economic viability of drones if you compare it to traditional delivery

methods for example? What do you think about the high initial cost of purchasing drones and also the the related infrastructure costs? Is it a major barrier?

Jürgen Verstaen 24:27
No, I think if you see what the cost of a van is, when you want to deliver packages and you see what the cost of a drone is.

Martin Balgobin (BE) 24:34
Mm hmm.

Jürgen Verstaen 24:34
Then it can already say that the cost of a drone is rather low.

Martin Balgobin (BE) 24:38
Mm hmm mm hmm.

Jürgen Verstaen 24:39
Also, the sheer speed so you can do much more runs with the drone than you would be able to do with the car, because what what happens with the car or the van, you come into a traffic jam. That's it, end of story. Perfect example. Again adlc what they do with the with the the oil samples they pick up for a company called SGS. The the time they I think it's 20 minutes less 15 to 20 minutes less. Which is really good for them time wise. Personal costs money.

Martin Balgobin (BE) 25:14
Yeah.

Jürgen Verstaen 25:15
Putting a vehicle on the road costs money, certainly when it's in a traffic jam. So is it a drone as a tool, more logic and more profitable? I would say yes, yeah.

Martin Balgobin (BE) 25:27
OK, OK, clear. Yeah. And the last one was the the the social barriers. So in the literature they're mentioning like the the perception issues including like concerns about privacy, noise pollution as well. Safety and also even employment employment impacts the the the adoption of delivery drones can have. So what is your your opinion of this social barriers? Is it something that is not that important you think to to overcome? In the in the in the near future.

Jürgen Verstaen 26:02
If the tool is useful, social will have no impact. People will accept it as it is. That's the reason why they start to start today with medical flights, for instance.

Martin Balgobin (BE) 26:07
OK. Yeah.

Jürgen Verstaen 26:14
It's also to reduce that impact and the people will say, OK, that this can help my life, so they will prove it. It's step by step there. It's changing people's mindsets. No, I do think that the social blocks will will be will be removed on the long run anyway.

Martin Balgobin (BE) 26:26
Mm hmm mm hmm. Yeah, OK. OK, good.

Jürgen Verstaen 26:35
It's like mobile phone. Everybody uses a mobile phone now and then you think? Yeah, but I have no freedom anymore.

Martin Balgobin (BE) 26:42
Indeed, yeah.

Jürgen Verstaen 26:43
Oh yeah, but it it's everybody uses it now. If you don't look at IPR and and privacy. That's a discussion I have I have with cameras that are on the road as well. If I don't have any issues with Big Brother watching me because I'm I don't do anything wrong.

Martin Balgobin (BE) 26:55
Mm hmm. Mm hmm.

Jürgen Verstaen 27:02
For the drones, the same drones have cameras on board. They can. Can they hamper your privacy? Yes, they can. If they are malicious and they come and have a look into your garden or want to have pictures from you. Yes, it all depends on how it's how it's used as well. And you always have bad boys and good ones. It's done up to the service provider and the police

to get the bad ones, but that's in everything. It's not specific to a drone because a drone is just a tool.

Martin Balgobin (BE) 27:32
Mm hmm. Yeah. OK. OK, good. So this is closing the the part of the of the barriers. No, for the facilitator factors. So I found in the literature three of them. So I would like to know if you agree with them. If you have additional one or different one to to add. So the first one is the environmental facilitator, the fact that it's a greener solution. Second one is the operation operational efficiency. So the fact that that's Belgium is putting money in this kind of projects with institution like in ovaries Valley, you, this, this kind of incentive and the third one, the third facilitator is the is the market demand with the the the online shopping that is growing year after year and the fact also that consumer wants to be delivered. In less and less time, always, I mean in a short term amount of time. So this is the tree the tree facilitators that I found. What is? What is your your opinion regarding these these three?

Jürgen Verstaen 28:42
You have to say the points again later on that start with the first one, so the green, the green one it is seen within Europe as within the Green Deal kind of technology. So reducing the carbon footprint, yes, unmanned vehicles are in there then then there's a discussion on yes, but if you use a drone, the batteries, it's like with electrical cars. OK, yes, you are right.

Martin Balgobin (BE) 28:46
Yep.

Jürgen Verstaen 29:06
But still this greener.

Martin Balgobin (BE) 29:09
Mm hmm.

Jürgen Verstaen 29:13
I do see it as a greener solution and they are also looking into new technologies to be used on drones as well. Certainly the bigger ones. They also the same like in manned aircraft with a really big drones cargo drones they they say you know what we need to look at the different

propulsion system then it's not working with the battery of course. And the bigger they are you can't use batteries.

Martin Balgobin (BE) 29:36
Mm hmm.

Jürgen Verstaen 29:38
And they are greener. So that's for me. Check, yes. Drones are a thing, and it's also within the European plan. As being seen as that type of technology. The second one point was what was it again? Oh yeah. Yeah.

Martin Balgobin (BE) 30:12
Of of a facilitator.

Jürgen Verstaen 30:12
Belgium is not that proactive, to be honest. If you if you see what happens in in Europe.

Martin Balgobin (BE) 30:16
OK. Mm hmm.

Jürgen Verstaen 30:20
It's a big difference, so there are a lot of programmes that are out there in Europe under Cesar Joint undertaking for instance. Or CEF SEF is done for transportation but also from Europe. They do a lot on drones on new space. They use the ATM master plan and that's only two pages is on drones. To actually put programmes out there, to innovate. R&D process and it's really fun to see and it works. Belgium. However, yeah, you have some left and right a few. Projects, but there's no money in Belgium. When you go to, there's a difference already in the funding scheme. When you go to Flyo, which is in Flanders. I think you can get 50 to 60% funding rate for a for a project when you go to Brussels and to innovities or you go to Walloon region, that's 80%. Why?

Martin Balgobin (BE) 31:10
Mm hmm.

Jürgen Verstaen 31:16
You're Belgium, so that's not logic that a **** company gets 80% funded for the same idea.

And in Belgium, you're in Flanders. You only have like 450 to 60. Now I'm. I'm seen in Flyo not as a small or small a small, small company. I said there was a midcap, but I'm seeing immediately as a large company but a large company is not the midcap, that's 3000 plus personnel. I don't have that.

Martin Balgobin (BE) 31:28
16. Mm hmm. Yeah.

Jürgen Verstaen 31:45
And then flower says, oh, you know what, you can only get 25% funding anymore.

Martin Balgobin (BE) 31:50
Oh, OK.

Jürgen Verstaen 31:51
So what is happening is that Belgian companies, they don't want to have a project in Belgium because they don't pay it. They don't pay 35%. That's peanuts. When I go to Europe, Europe minimum 70%, OK, you have some projects at 50%, but people say you know what, I can ask 2 million, I still get 1,000,000 in the pocket.

Martin Balgobin (BE) 31:59
Yeah. Yeah. Yeah, that's the. Yeah, exactly. Yeah.

Jürgen Verstaen 32:14
And that helps you grow and and Europe understands that we need to grow our industry. But in Belgium we are like, yeah, Belgium is conservative.

Martin Balgobin (BE) 32:22
Mm hmm.

Jürgen Verstaen 32:22
And they want to change it. But now the military thing came into with Ukraine, then all of a sudden, they say. Yeah, funding rates will change. It will be maybe more military mindset, OK, it is what it is. I can sell my product to anybody, but.

Martin Balgobin (BE) 32:38
Mm hmm mm hmm.

Jürgen Verstaen 32:39
It slows down and if a Belgian company's is like they need the oxygen to grow. And that helps the our economy and then they can say, well, I don't put money in R&D, this is wrong because this is an innovative business. You need to work on R&D. It's crucial because there are there's so many things that don't exist yet in that ecosystem.

Martin Balgobin (BE) 32:55
Exists.

Jürgen Verstaen 33:04
And so that's for Part 2. It's a yes and no. They put money, but not enough. And in Europe they put enough.

Martin Balgobin (BE) 33:09
Yeah. OK. OK. I see. Yeah. That, that that's that's quite clear. Yeah, of course. In the of course, in the literature, it's not what I found out. So that that's why I need this interview. So it's a it's a good example that you're that you're giving the OK.

Jürgen Verstaen 33:19
And then the third one. Yeah. The third one was third pillar.

Martin Balgobin (BE) 33:32
Yeah, market demand. So the fact that you know that the growing online shopping and. It is pushing for innovative delivery solutions like drones.

Jürgen Verstaen 33:39
Yeah. I don't think online shopping forget it, that not today.

Martin Balgobin (BE) 33:49
OK.

Jürgen Verstaen 33:51
What you see the the initial pickup you see by use of drones is at the service site, not the

delivery site. And what do I mean by that? They sell like drone in a box for what do they use drones nowadays for inspection flights, for instance?

Martin Balgobin (BE) 33:59
Mm hmm.

Jürgen Verstaen 34:08
To most of the time, it's all inspection flights, but it doesn't matter in which industry branch you work. They use a drone in every industry branch because I don't believe in it. In the there's a drone sector, there is no there is no drone sector. There is an industry sector that uses drone as a tool. And the market demand is over there. When you go to petrochemical industry, for instance, why do do they want to use drone, they want to use a drone, they put a sniffer on it. If there's an emergency somewhere, they leak.

Martin Balgobin (BE) 34:31
Yep.

Jürgen Verstaen 34:42
Instead of sending a person in a hazmat suit with the risk of dying, they put a drone in there. Building roads, they use drones, they put them in the air to have bigger overview that the plans are being that that that's corrected. Infrastructure buildings, checking buildings, towers, you know, instead of putting people on there with robes, they put a drone in their camera 15 minutes up and down. So those are the sectors that the the the service sector in fact, then the defence, they are using drones more and more and not to deliver packages.

Martin Balgobin (BE) 35:22
OK.

Jürgen Verstaen 35:23
And that's good. That's good, because that's a really big sector then.

Martin Balgobin (BE) 35:24
Yeah. I don't know. Yeah. Yeah, yeah, this indeed. Yeah. Because what I also found in the literature they were saying. Yeah, but the the the fact that there is this competitive logistics

sector in Belgium, so maybe it can push this this companies to find way more innovative way to to deliver and then OK, it's where drone could be a good solution.

Jürgen Verstaen 35:53
I I follow your reasoning and I want to see that happen as well, but today nothing is happening. The big transport companies that are out of there like SS for instance is a big one that I think they talk about drones, but then they talk about drones to do parameter security of their compound.

Martin Balgobin (BE) 35:57
Mm hmm. Mm hmm.

Jürgen Verstaen 36:13
Yeah. So they don't use the drone yet as a delivery vehicle. It's still on the service side. Katunasi also in the port of Antwerp, really big, a lot of warehouses.

Martin Balgobin (BE) 36:19
Yeah.

Jürgen Verstaen 36:25
They I haven't heard that they would be using that to deliver stuff. It's again are no security.

Martin Balgobin (BE) 36:33
Mm hmm.

Jürgen Verstaen 36:33
So are we there yet on the on for the transport? No, we aren't. And I need to talk in Belgium with Phil and Flanders. That's VIL they are looking into the logistical innovation of Flanders. And I spoke with those people in January during a New Year's drink from Flanders, from the Minister President, and they said, yeah, we know unifly and. We should meet up, I said. Yeah. Why? OK, because the transport, they look into innovation as well. But yeah, today it's like putting unmanned trucks behind each other that they follow.

Martin Balgobin (BE) 37:17
Yeah, yeah, yeah.

Jürgen Verstaen 37:18
That's one of the things that they are doing at the moment. And then the question came up, what about last mile delivery? And then I said, aha, here we go. Yes, the idea is there correct, but implementation isn't.

Martin Balgobin (BE) 37:34
Yeah. OK.

Jürgen Verstaen 37:35
And we need to work on that. That's true.

Martin Balgobin (BE) 37:37
OK. So just to sum up out of the three that facilitator factor I've found, is there any any additional one you're thinking of or?

Jürgen Verstaen 37:52
They're all mentioned there. No, the three groups you can put a lot in those groups other than the Green Deal, but the other two.

Martin Balgobin (BE) 38:03
Yeah.

Jürgen Verstaen 38:07
Certainly the third one on market because it's not only industry, it's also like I say, security police, Fire Brigades start using it. Military use it already for years. But you see more and more implementations like the fire Department and West Flanders. I think Vivian called, it's called Frivia, the department, they used drones. If there's an incident, they up it's it's airborne and they can immediately give feedback to the Operation Centre. What kind of vehicles they need before they arrive? Port of entry. The same sorry port of entry. The same. They have used drones as well to go to a fire hazard and to arrange people around the facet hazard and how to attack. That's also.

Martin Balgobin (BE) 38:44
Mm hmm mm hmm.

Jürgen Verstaen 39:01
Really important branch in the markets market can be industry, but can also be.

Martin Balgobin (BE) 39:03
OK.

Jürgen Verstaen 39:08
The blue light services, they call it the.

Martin Balgobin (BE) 39:11
Yeah. So, in, in, in your point of view, this market demand facilitators, this is the most important one that will enable drone delivery in the future.

Jürgen Verstaen 39:23
Yes. Yeah. The other two are no brainers innovation. Yeah, innovation happens everywhere. There's 50% of most of the companies is innovation and the Green Deal. Yeah. Well, it's nice to be in the Green Deal. Let me do something about nature. Yes. Is that a changer? No.

Martin Balgobin (BE) 39:24
OK. OK, OK.

Jürgen Verstaen 39:41
That's some that's like certificate. There I can make a lot of certificates. I just need to come up with a framework.

Martin Balgobin (BE) 39:44
Yeah. Yeah, see. Like this. Yes. OK, but maybe maybe just to to close a bit subjective question, but. In five years, in 10 years, what do you what do you see? What do you foresee for delivery drones in in Belgium for the last mile? Logistic. Do you think something will change in the next two years or no? It's it's really too early. What what is your your global opinion on that?

Jürgen Verstaen 40:16
For the sake of the ussp in Belgium, this is SkyDrive. I would hope for them in two years. There's a there, it is ongoing. Because they need to survive as well, you can set up a

company, but if there's no revenue, it stops there. So. I wish between now and two years that this will happen.

Martin Balgobin (BE) 40:39
OK.

Jürgen Verstaen 40:40
Certainly before 20-30.

Martin Balgobin (BE) 40:43
OK, so for you it's sure it will happen one day.

Jürgen Verstaen 40:47
For sure, because if you see what the push is towards big drones like the the unmanned taxis.

Martin Balgobin (BE) 40:48
OK. Yeah.

Jürgen Verstaen 40:56
And they all talk about it. However, now we have, like Airbus for instance with, with his city bus that they made, they stopped the development completely. So Airbus moved away completely from the unmanned. But the reason why has to do with the Ukraine Russian war.

Martin Balgobin (BE) 41:08
Mm hmm.

Jürgen Verstaen 41:17
Because they are now looking into military assets more than in something which is logic, every company should do the same. You need to follow where the money is and the money is at the moment. Now in the military side and not the civil side. It has an effect on the on the time plan that we foresee for implementation of unmanned a taxis. But will that happen? They they fly already Ian flies in China already.

Martin Balgobin (BE) 41:40
Mm hmm.

Jürgen Verstaen 41:40
You have big companies in America as well, like Joby Aviation. The other one. Just forget the name. There's third one as well. The German ones. They went bankrupt, but they are bought up. So you had volocopter, which is now bought by Diamond Aircraft, which is Chinese. Well, we test Chinese shareholders. So they went from bankruptcy to live again.

Martin Balgobin (BE) 41:59
Mm hmm.

Jürgen Verstaen 42:06
Libya was the other one in Germany and they are saved by, I think, Saudi Arabia or one of the Middle East.

Martin Balgobin (BE) 42:13
Yeah.

Jürgen Verstaen 42:15
So they there you see that they do believe in that technology. And will, will it happen? Yes, it will happen.

Martin Balgobin (BE) 42:23
OK.

Jürgen Verstaen 42:24
But time wise it yeah, it depends on what is happening in the world.

Martin Balgobin (BE) 42:30
Yeah, it's unsure and yeah, OK. Mm hmm. OK, OK.

Jürgen Verstaen 42:32
Yeah, but before 20-30 I do certainly see a pick up on using more and more drones, because then you will have everything in place. You will have your UTM system on your USS, you will have your airspaces. Those are things that are happening this year. So I would say then As for next year, you see things evolving, industry picking up, shops using it. I when I talk to mana, I saw that that company from Ireland in at Iyasa in Germany. So that's European regulator and they said, yeah, yeah, we want to come to the mainland as well. So you see in

those companies there is ambition to actually come to. Certain like for instance, Belgium, they did mention Belgium. They are looking for where they can earn money, of course.

Martin Balgobin (BE) 43:21
Mm hmm.

Jürgen Verstaen 43:22
But I think I would welcome them if they come to Antwerp, but say, comment here and test it we and that's we try to get them bidders into the further projects, the European ones and then for instance, then we say you know what we will do this in Belgium. So in European projects, you can always choose where you do demo flights.

Martin Balgobin (BE) 43:40
Yeah.

Jürgen Verstaen 43:43
It helps. In the past, we did it with Amazon as well. So the software project was with Amazon Prime, but at a certain moment, Amazon decided to stop. The now they revived it again, so Amazon Prime Air is looking into using use of drones yet again.

Martin Balgobin (BE) 44:00
Mm hmm mm hmm.

Jürgen Verstaen 44:00
In the UK, and I think in Italy. And the third country as well. So there you see that if those big companies are starting, look into it like Amazon, you know it will happen.

Transcript 6:

Mikael Simam – CEO at Helicus

Mikael: That sounds very exciting and relevant, especially given the current trends in technology. What specific areas have you explored in your research on drone delivery?

Martin: As part of my thesis, I'm investigating the barriers and facilitating factors that impact the adoption of drone delivery, particularly for last-mile logistics in Belgium. So far, I have interviewed professionals from various organizations, which include industry leaders such as

ID to Move, Ford Mobilitate, ADLC, and Unifly—all of whom operate at the forefront of drone technology and logistics. For instance, I engaged with individuals like [N from ID to Move, Jurgen from Unifly, and Patricia from Ford Mobilitate. Additionally, I connected with experts from Kim Consult regarding drone construction and manufacturing.

Mikael: Those are some significant names in the industry! How did you go about establishing these connections?

Martin: Initially, I leveraged online research to identify individuals who are influential in the drone delivery sector. I found many interesting professionals, but reaching out for responses proved to be quite challenging. Fortunately, Grégoire Moreau was instrumental in facilitating introductions by providing contacts to key individuals within these organizations. Jurgen and Emil from ID to Move also contributed significantly by suggesting companies and personnel who would be valuable for my interviews. Furthermore, I interviewed a logistics professor from UCLouvain to gain an academic perspective on the issues I'm studying.

Mikael: It's great to see how networking can enrich your research. Can you provide some insight into the specific focus or research question you are aiming to address in your thesis?

Martin: Certainly! My thesis is centered around assessing the current state of drone delivery technology and identifying the barriers that hinder its widespread adoption in Belgium and especially for parcel delivery in B2C context. Additionally, I intend to explore the facilitating factors that could promote its integration into the logistics framework we currently have. Essentially, I am analyzing how these barriers—such as regulatory obstacles, technological limitations, economic factors, and social acceptance—affect the capacity for drone delivery solutions to be realized.

Mikael: That sounds incredibly pertinent given the technological shifts occurring in logistics.

Martin: Now, can you describe Helicus's mission and objectives? I'd like a global overview of what you're doing there.

Mikael: Of course! Helicus was established in 2016, and as of next year, it will be approaching its ninth anniversary. Our mission centers around innovating solutions to the complex challenges involving logistics and aviation. The founders of Helicus possess substantial experience from a medical background, as they previously operated a hospital

group. They used this expertise to embark on a project aimed at revolutionizing delivery methods in this industry. Since then, we have been actively working on creating an open modular architecture that facilitates collaboration among various partners and organizations. This structure allows for integrating multiple systems and providing comprehensive solutions tailored to client needs.

Martin: That's quite ambitious! How do you coordinate efforts among such diverse stakeholders to ensure efficient collaboration?

Mikael: Collaboration is truly vital at Helicus, especially given the multifaceted nature of this industry. We are involved in several projects, coordinating the efforts of various operators and stakeholders while also assisting in securing funding for these initiatives. Our approach ensures that everyone is working towards common goals, which helps harmonize our efforts across different domains. With our extensive experience in aviation and logistics, we strive to create an environment that fosters continuous collaboration and innovation among the key players in this industry.

Martin: I can appreciate the complexity involved! Now, shifting towards the topic of drone delivery specifically, do you foresee it becoming a common reality for last-mile logistics in Belgium in the near future?

Mikael: I strongly believe that drone delivery will eventually become a common practice; however, it won't happen overnight. There are several substantial barriers that we face at the moment—primarily regulatory constraints, technological challenges, and issues surrounding social acceptance. Until we successfully navigate these obstacles, the large-scale implementation of drone delivery solutions across Belgium will remain a significant challenge. Can you tell my which barriers you have identified in your study?

Martin: In the literature review, I pinpointed four primary barriers to the adoption of drone delivery technology:

1. Regulatory Challenges: The existing legislative framework is inadequate to govern drone operations comprehensively. This prevents companies from conducting thorough testing and widespread implementation.

2. Technological Limitations: While technology has advanced, there are still gaps in safety assurances and automation systems necessary for safe drone operations.

3. Economic Constraints: The initial investment costs for deploying drone technology are often substantial, and organizations may hesitate to allocate funds without guaranteed returns.

4. Social Acceptance: Public trust and perceptions of drone technology shape its viability. People may have concerns about safety, privacy, and environmental impact, which could impede acceptance.

These barriers collectively create significant hurdles for companies looking to implement drone delivery systems in logistics.

Mikael: Your analysis provides valuable insights into the existing impediments. Can you elaborate further on the regulatory challenges you mentioned?

Martin: Certainly! In Belgium, regulatory guidelines for drone testing and pilot projects exist but are rather restrictive. Organizations like ADLC have obtained permissions for limited test flights that adhere to safety standards, but comprehensive regulatory approvals for broader drone delivery are still lacking. The primary regulatory obstacles encompass the requisite authorizations and operational protocols that must be established nationally before effective deployment can occur.

Martin: This highlights the vital interplay between regulation and technology. Regarding technological hurdles, what specific challenges do you face?

Mikael: The primary technological challenges lie in ensuring the safety and reliability of drone systems. Currently, we need more advanced anti-collision technology and system automation. While some countries have made leaps in drone safety technology, Belgium still needs to keep pace. There’s a pressing need for a unified approach to integrating these technologies to ensure seamless operations and safety in various environments.

Martin: That makes sense! Now, transitioning to the facilitating factors, what drivers do you identify that could bolster the adoption of drone delivery technology?

Mikael: I’ve identified several key drivers influencing this trajectory:

1. Market Demand: The exponential growth of e-commerce has created a significant demand for faster delivery methods. Many consumers now expect almost immediate fulfillment of their orders, increasing pressure on logistics providers to innovate.

2. Ecological Benefits: Drones present an opportunity to reduce carbon footprints compared to traditional delivery vehicles, especially in urban areas congested with traffic.

3. Belgian support: Belgium is investing in innovative solutions through various subsidies and initiatives that encourage the adaptation of drone technology, making it a viable option in logistics.

I believe these factors play crucial roles in promoting the integration of drones into existing logistics frameworks.

Martin: Do you think the ecological argument can stand scrutiny?

Mikael: It’s a complex conversation. While drones potentially offer some ecological benefits, such as reduced energy consumption and lighter transportation, we must conduct a thorough life-cycle analysis of the technology, including aspects like battery manufacturing and disposal. Various studies present contrasting opinions, so it’s essential to dig deeper into data-driven assessments to reveal the true ecological impacts of drone technology.

Martin: Several perspectives indeed exist on this topic. Regarding future trends, how do you foresee the evolution of drone deliveries in the coming years?

Mikael: I foresee a gradual but steady adoption of drone delivery technology over the next five to ten years. Nonetheless, it's critical to maintain realistic expectations about the timeline for widespread implementation. If industry stakeholders over-promise capabilities without tangible progress, we risk facing backlash that can erode financial support and investor trust. Thus, creating a robust infrastructural foundation to facilitate gradual drone adoption will be essential for future success.

Martin: Thank you for sharing such insightful and detailed information, Mikael. I believe this wraps up our discussion nicely.

Mikael: Thank you, Martin! It’s been a privilege to explore these topics in-depth with you.

Martin: One last unrelated question—are you considering pursuing a pilot's license to further your aviation interests?

Mikael: I have! I've long dreamed of obtaining an ATPL (Airline Transport Pilot License), but the cost of training has always posed a barrier for me. Now, I'm seriously considering pursuing it again because every time I see an aircraft, I feel an urge to be in the cockpit. It's a passion I want to explore further.

Martin: That's fantastic! I wish you the best of luck on your journey!

Mikael: Thank you! I appreciate that, and if you require further information about our projects, please don't hesitate to reach out.

Martin: For sure, and thank you once again for your valuable insights today!

Transcript 7:

Didier Van Nes – CEO at PimConsult

Martin: Here we go. As I mentioned, I am studying the topic of delivery drones for the last mile. Do you see this as an opportunity, an application area where you see potential for adoption in the near future, or is it not the first application you have in mind?

Didier: I would say not for at least another ten years.

Martin: Could you expand on why you think that? What do you think would be the main barriers to the adoption of this technology?

Didier: For me, the first barrier would be legislation. The second barrier concerns demand and airspace, which is not at all ready for this. Those are really the three main blocking points I see.

Martin: In the literature review I conducted, I identified four main types of barriers. First, legislation, as you mentioned. Then, the technical aspect, with technologies that may not yet be on the required level to ensure this type of service. Thirdly, there is the economic barrier, with a very high initial investment and operational costs, as well as the long-term profitability

of the project. Finally, the last barrier concerns social concerns, particularly public perception, ethical issues, and privacy. That's the ranking I found in the literature. Do you agree with that?

Didier: For the technical point, I don't agree with you. There are many applications for drones, and applying them to delivery is not an issue. However, the question of delivering to a building, for example, poses challenges. If a drone has to deliver to a house with four facades, that will be a completely different dynamic than in an apartment building. So there are many technical questions to consider. We could consider solutions through distributors by neighborhood, where the drone doesn't deliver directly to each person but drops off several packages in one place, which would make the process more efficient.

Regarding the economic aspect, I think the demand is there. So I don't see it as a barrier. For the social aspect, I don't see any potential issues, especially if we replace a van and a delivery person with a remotely piloted drone.

Martin: What often comes up regarding the social aspect is the GDPR regulation and drones equipped with cameras flying over homes.

Didier: Yes, but if you look at the current legislation, it's not a problem. For instance, with GPS, a drone can fly over a home. You just need to prove that the cameras were pointed in the right direction at the time of the breach. Furthermore, delivery drones don't necessarily need cameras; they mainly need obstacle detectors. So there are not really major issues at that level.

Martin: Another aspect that is often mentioned is noise pollution and the level of safety, which can be a hindrance to consumer adoption.

Didier: I return to the idea that if you opt for deliveries at reception points where all packages can be delivered, this reduces the risk of flying over homes. Thus, noise pollution would not really be an issue, as these distribution points are often located in areas where there aren't constantly people present.

Martin: To summarize, you believe that these social barriers are not blocking and do not pose major issues.

Didier: No, I don’t see any real blockers at this level. I think that if this technology is well adapted with reduced risk-taking, there won’t be any major concerns regarding the social barrier. Additionally, if the system is to be adopted, it will need to comply with very strict safety standards, making it a reliable solution.

Martin: Regarding the economic barrier, do you think the significant initial investment cost for implementing this system represents a major obstacle?

Didier: Currently, for service drones, delivery, and surveillance, some drones can carry up to 90 kg of goods for about €20,000. For a company, that may seem high, but it remains comparable to traditional delivery with a van.

Martin: In terms of comparison, when you mention drones costing €20,000, do you consider that this gives them an economic advantage over traditional delivery methods?

Didier: Yes, a drone can go directly where it needs to without worrying about traffic congestion. Since it is not tied to terrestrial roads, that can be really advantageous.

Summary of Barriers:

Martin: To summarize what you said, the technologies are there, but to minimize risks, a more hybrid model will need to be considered. For example, delivering to a distribution point where several packages can be dropped off, rather than to every house. Regarding the technical barriers, you say they are not major, just like the economic barrier. The main obstacle remains legislation.

Didier: Yes, absolutely.

Martin: Regarding legislative barriers, do you think this is the most important issue currently, especially in 2025?

Didier: Yes, it’s crucial to have dedicated airspace for drones and an authority that recognizes that these drones pose no risk and can coexist with helicopters and other aircraft.

Martin: It is crucial to define standards to facilitate adoption. In your opinion, what could take so long at the legislative level?

Didier: We are still at the beginning of remotely piloted drones. The time needed to validate all these authorizations and implement several application cases could take some time. It will take years before we can authorize this kind of operations.

Martin: In relation to that, we can consider drones as intermediaries to deliver to a distribution center before reaching the end consumers.

Didier: Exactly, it's a way to reduce the risk associated with flying over homes.

Martin: Let's move on to discussing the facilitators. What could promote the adoption of this technology in Belgium?

Didier: We will need to conduct several concrete case studies and trials before reaching an acceptable level of adoption. The technology also needs to improve, and we need to show convincing results.

Martin: According to the literature, I identified three main facilitating factors: the environmental factor, operational efficiency, and market demand, particularly through online shopping. What do you think?

Didier: For the end user, the important thing is to receive their delivery quickly and without issues. The environmental aspect is relevant but less so for the consumer than for managing operational costs. For example, considering a €10,000 drone, that represents one hour of helicopter flight. That doesn't necessarily make it an ecological solution.

The batteries need to be manufactured, and there are still no ideal solutions for recycling them. Moreover, the Asian industry, which currently holds 85% of the drone market share, is progressing faster than Europe.

Martin: In conclusion, delivery drones for the last mile, or even for logistics hubs, won't be happening anytime soon. Legislation poses significant barriers, hindering the development of such projects?

Didier: Yes, that's correct. It will take some time before we see significant adoption, mainly due to the regulations that hinder initiatives.

Martin: It is now 1:01 PM. I don’t want to take up more of your time. Thank you very much for your availability. I will get back to you once my thesis is finished to share my findings.

Didier: Very well, I will read it with great interest.

Martin: Thank you again for your time and insights.

Didier: Goodbye.