A Work Project, presented as part of the requirements for the Award of a Master's degree in Management from the Nova School of Business and Economics.

ASSESSING THE VIABILITY OF DRONE TECHNOLOGY FOR E-COMMERCE LAST-MILE DELIVERIES:

A BUSINESS CASE ANALYSIS - Ramin Leon Schübel

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15/12/2023

Abstract

The integration of drone technology in logistic systems is a rapidly growing area of scientific research. This work project reports findings from expert interviews and a survey on the viability of drone technology as a method for last-mile deliveries in the e-commerce industry alongside a comprehensive review of existing academic literature in this domain. Several influencing factors were used to discuss results from a business and customer perspective on an economical, technological, and operational dimension. Overall, the results indicate that drones are not feasible for last-mile e-commerce deliveries, combining infeasibility from a business perspective and feasibility from a customer perspective.

Individual Abstract

The integration of drone technology in logistic systems is a rapidly growing area of scientific research. This work project reports findings from expert interviews and a survey on the viability of drone technology as a method for last-mile deliveries in the e-commerce industry alongside a comprehensive review of existing academic literature in this domain. Several influencing factors were used to discuss results from business perspective on an economical, technological, and operational dimension. Overall, the results indicate that drones are not a feasible solution for last-mile e-commerce deliveries from a business perspective.

Keywords: drone technology, e-commerce, last-mile delivery, logistics

This work used infrastructure and resources funded by Fundação para a Ciência e a Tecnologia (UID/ECO/00124/2013, UID/ECO/00124/2019 and Social Sciences DataLab, Project 22209), POR Lisboa (LISBOA-01-0145-FEDER-007722 and Social Sciences DataLab, Project 22209) and POR Norte (Social Sciences DataLab, Project 22209).

Table of Contents

1. Introduction

"It will work, and it will happen, and it's going to be a lot of fun". With these words, Jeff Bezos, founder and former CEO of e-commerce and delivery company *Amazon*, confidently announced in 2013 that the company's drone delivery service *Prime Air* would autonomously deliver packages to customers within the next four to five years (Kovach 2013). Today, a decade later, drone deliveries in e-commerce remain rare. Despite high expectations, *Prime Air* managed to deliver packages to fewer than 10 houses within a month of its launch in December 2022 (Wayt 2023). Other significant players in the e-commerce and parcel delivery space like *DHL*, *UPS*, and *JD.com* have also entered the drone delivery space, but their success remains uncertain due to several obstacles that must be overcome. Amid these challenges, the surge in online shopping has led to an increased need for efficient and prompt delivery methods, as the growth of e-commerce has complicated transportation systems, requiring streamlined logistics, optimized delivery routes, and innovative last-mile delivery solutions. The increasing adoption and innovation of Artificial Intelligence (AI) and the Internet of Things (IoT) have led to the emergence of smart technologies and intelligent transport systems. These include autonomous vehicles like drones, which have gained popularity in revolutionizing last-mile deliveries (Sorooshian et al. 2022). In sectors such as healthcare or food delivery, drones have already been successfully deployed for delivering goods (Ayamga, Akaba, and Nyaaba 2021). However, despite the promising idea and hype surrounding this innovation, the limited practical success of delivering parcels to customers raises questions about the feasibility of deploying drone technologies for e-commerce last-mile deliveries. Thus, this work project explores the complex dynamics of leveraging drones as vehicles for last-mile deliveries, assessing the feasibility and implications for businesses and consumers in the e-commerce sector. The scope of this research is specifically focused on business-to-consumer (B2C) logistics, concentrating on the final leg of deliveries (last-mile deliveries). Within technological innovations in this space, the study narrows its focus exclusively to parcel deliveries carried

out by drones in the e-commerce sector. This targeted approach ensures a concentrated investigation into the specific challenges and potentials within the e-commerce landscape, providing a nuanced understanding of the implications of integrating drones in this industry. The research methodology used in this study involves expert interviews to gain in-depth insights into the business side of utilizing drones for e-commerce deliveries. Additionally, a comprehensive survey has been conducted to evaluate customer demand and acceptance concerning drone delivery services for last-mile logistics.

Section two of this paper provides an overview of the e-commerce industry based on existing literature. It covers market trends, critical customer expectations, technological advancements in e-commerce logistics, particularly last-mile delivery, and the challenges associated with traditional last-mile delivery methods. Furthermore, the focus of the section will shift to the disruptive potential of autonomous drone technology, covering its classification, regulatory landscape, and diverse use cases. Following this exploration, the section will present the research gap. Section three will cover the research methodology, explaining the methods chosen for data collection and preparation. Section four covers the results and findings of leveraging drones for last-mile deliveries in e-commerce. It includes an analysis of the business case and customer demand on an economical, technological, and operational assessment dimension. Section five will discuss the practical implications and recommendations, drawing insightful conclusions from the results and findings. Section six will highlight limitations and avenues for future research, and section seven is dedicated to concluding this work project.

2. Literature Review

This literature review explores the dynamic evolution of e-commerce, with a specific focus on last-mile deliveries. The section further examines and classifies drone technologies and reviews a range of commercial applications for this technological innovation.

2.1. E-commerce Industry Overview

The explosive growth of the e-commerce industry has reshaped the landscape of retail, challenging businesses to adapt to the evolving demands of an increasingly digital consumer base and emerging disruptive technologies.

2.1.1. Growth Statistics and Market Trends

The e-commerce industry can be broadly defined as the method of buying and selling goods and services through online commerce channels. It can be categorized into four different types: business-to-business (B2B), business-to-consumer (B2C), consumer-to-business (C2B), and consumer-to-consumer (C2C), which are characterized by different business models. This work project focuses on the B2C market, as last-mile drone deliveries essentially impact the end customers of e-commerce companies. The B2C e-commerce industry (hereafter referred to as the e-commerce industry or the industry) has grown significantly over the past decade, reaching a total revenue of 3.32 trillion USD in 2022 (Statista 2022a). This is mainly driven by the immense rise of the internet user base and the ever-advancing global digitalization. In recent years, the industry has further experienced unprecedented growth driven by the Corona pandemic, which has forced companies and customers to adapt to online transactions. The industry's global growth surpassed initial projections, recording a 22% growth beyond the anticipated 12% from 2020 to 2021 (International-Trade-Administration 2022). The e-commerce industry is forecasted to reach 5.18 trillion USD in revenues by 2026, representing a growth rate of 56% (as of 2022 records). The top geographical markets based on sales revenue in 2022 within the e-commerce industry are China (1,236 billion USD), the US (811 billion USD), Japan (145.10 billion USD), the UK (132.70 billion USD), and Germany (100.90 billion USD) (Statista 2022b), however, emerging markets are also gaining significant relevance in the e-commerce industry (Yasmeen 2023).

2.1.2. **E-commerce Logistics**

Per definition, e-commerce is the electronic transaction between customers and sellers, however, one of the most important processes for selling/purchasing goods online are the underlying supply chain operations (Ramanathan, George, and Ramanathan 2014). The logistics behind e-commerce operations (also referred to as e-fulfillment) are complex and cost-intensive. Within existing research, e-commerce logistics is separated into five main areas: supply chain network design; outbound logistics (including last-mile deliveries), reverse logistics; warehousing; and IT and data management (Zennaro et al. 2022). E-fulfillment models exhibit distinctive characteristics such as their dynamic and fast-paced nature, differentiating themselves from traditional logistic models (Tarn et al. 2003). Disrupting trends such as evolving customer expectations and technological advancements force supply chain operators within e-commerce to constantly adapt. To retain a competitive edge over other participants (Wang et al. 2020) and achieve enhanced operational effectiveness (Alicke 2016), operations must consistently strive for increased speed, efficiency, and cost-effectiveness.

Customer Expectations

For e-commerce businesses, customers are the key players for success, as they drive revenue and profitability, are marketing drivers, and provide valuable insights and criticism leading to innovation and improvements (Brown 2022). Modern e-commerce companies' business models are designed to serve the customer's best interest and keep customers satisfied. A study by Homburg, Koschate, and Hoyer (2005) underlines a robust connection between customer satisfaction, particularly the perceived increase in satisfaction, and the willingness to pay for services and products, underlining the importance. One example of a customer-centric strategy is *Amazon*, which excels in prioritizing the customer and designing its business model around them (Slater 2023). The e-commerce growth has not only been increasing sales and revenues for operating businesses but has also elevated customer expectations regarding the underlying

supply chain operations, especially regarding delivery speed, flexibility, and convenience (Lim, Jin, and Srai 2017). Common customer preferences are free delivery, same-day delivery, predetermined delivery timeslots, and shipment tracking (Vakulenko et al. 2019). Sustainable operations to reduce CO2 emissions are also increasingly important to customers (Ignat and Chankov 2020). Meeting these expectations presents significant challenges for e-commerce and delivery companies as dissatisfying customers not only harms the topline but can also cause a competitive disadvantage in the industry.

Technological Advancements

E-commerce companies are forced to evolve and adapt not just due to shifting customer expectations but also because of technological advances. Rapid technological progress is a positive consequence of accelerating globalization, as it drives innovation across different industries and economies. The fourth and most recent industrial revolution, Industry 4.0, which describes the rapid technological advancements in the 21st century is revolutionizing many existing industries, including the supply chain industry (Alicke 2016). The industry has experienced substantial changes, revolutionizing not only the management of logistics but also significantly enhancing efficiency and effectiveness across the entire supply chain process. According to Khan (2023), technological advancements have helped "[…]businesses to streamline their operations, reduce costs and improve their bottom line" and will continue to do so. Many companies, such as *Amazon*, *UPS*, and *DHL* have started using innovative solutions within their supply chain operations to enhance efficiency and meet ever-growing customer expectations. Some examples highlighted by Khan (2023) are AI, machine learning (ML), and the use of big data to optimize supply and demand forecasting and inventory management. Furthermore, blockchain technologies and the IoT are leveraged for increased traceability, security, and better monitoring of goods, while autonomous vehicles like drones have the potential to improve logistics and transportation efficiency.

2.1.3. **Last-Mile Logistics**

One of the most critical aspects influencing the success of e-commerce companies is the efficiency of the last-mile logistics (Truxcargo 2023). Last-mile logistics refers to the final leg of the supply chain, where ordered products are delivered from a distribution center to the end consumer (Lim, Jin, and Srai 2017). It is a complex process influenced by various factors, including geography, transportation infrastructure, and consumer preferences. Efficient last-mile logistics can significantly impact overall supply chain performance and hold noteworthy importance in guaranteeing customer satisfaction (Truxcargo 2023). According to multiple studies, customers perceive a company's logistics performance, especially the last-mile distribution performance, as an important factor of their overall e-commerce satisfaction ((Agatz, Fleischmann, and van Nunen 2008), (Esper et al. 2003)). This showcases the importance of the close relationship between last-mile delivery performances and e-commerce customer satisfaction and loyalty (Yu et al. 2016). Existing solutions for distributing products to the end customer successfully include delivery trucks (electrical & combustion), crowdsourcing logistics, and delivery hubs that act as parcel lockers. Promising innovative solutions, already in existence but operating on a smaller scale, include delivery robotics and autonomous drones and vehicles, which are subjects of ongoing research and development (Ha et al. 2018).

2.1.4. **Challenges Faced in Traditional Last-Mile Delivery**

Currently, last-mile delivery operations represent the least efficient, most expensive, and most environmentally detrimental aspect of e-commerce deliveries (Mangiaracina et al. 2019; Gevaers, Voorde, and Vanelslander 2011). Estimations reveal that last-mile delivery costs can reach up to half of the total logistic costs associated with shipping a product to the end-customer (Vanelslander, Deketele, and Hove 2013). These high costs are mainly influenced by the inefficiencies within the process, such as (i) complexity of the route planning and batching of parcels for multiple stops which leaves little room for errors or delays due to described

heightened customer expectations; (ii) traffic congestions, especially in urban areas and during rush-hours, leading to delays in delivery and longer lead times, causing dissatisfaction for customers and drivers; and (iii) the management of delivery windows, which offer flexibility to customers, however presents challenges for delivery companies (Truxcargo 2023). The cost implications of last-mile logistics, including the cost of maintaining a fleet of delivery vehicles and drivers and ensuring timely and accurate deliveries, present hurdles that require innovative solutions that ultimately improve the top and bottom lines of companies operating in this space through more efficient and effective solutions for the supply chain and the customer.

2.2. Unmanned Aerial Vehicles

The global Unmanned Aerial Vehicle (UAV, hereafter also referred to as "drone") market is experiencing explosive growth, attracting substantial investments from both government and commercial sectors. The commercial drone market, which encompasses a range of applications including filming/photography, delivery and logistics, agriculture, inspection and maintenance, surveillance, and monitoring, was valued at 8.77 billion USD in 2022 according to *Fortune Business Insights* (FortuneBusinessInsights 2023). It is projected to undergo significant growth, reaching 10.98 billion USD in 2023 and demonstrating remarkable expansion, expanding to 54.81 billion USD by 2030. Notably, the delivery and logistics sector is expected to demonstrate a higher Compound Annual Growth Rate (CAGR) over the forecast period (FortuneBusinessInsights 2023). In the delivery and logistics sector, major companies like *Google* and *Amazon* are investing heavily in drone technology, with investments totaling about 2.5 billion USD between 2013 and 2019 according to the aerospace consultancy *Teal Group* (Streitfeld 2023). The drone industry is characterized by its untapped potential, with many unexplored niches. Therefore, researchers strive to identify evolving trends in this dynamic and rapidly growing sector.

2.2.1. **Classification**

UAV classification is essential for comprehending their varied applications. UAVs are aircraft that are operated without a human pilot on board and function autonomously. Within the context of UAVs, the term 'autonomous' refers to the capacity for drones to operate independently using sophisticated algorithms and sensor technology, thereby allowing for precise navigation in complex environments (T. Lee, Mckeever, and Courtney 2021). Initially designed for military purposes, drones are evolving from their strategic military roles to an assortment of non-military applications, profoundly transforming industries such as logistics, agriculture, healthcare, and entertainment (Kapustina et al. 2021).

Critical design factors such as weight, wingspan, range, speed, and level of autonomy differentiate drone models and serve as essential classification criteria. Fixed-wing drones are proficient in large-area mapping and agriculture, thanks to their capacity for long-range operations and efficient coverage. However, they do have their limitations, including the need for horizontal take-off and the inability to hover. Multirotor aircraft, such as quadcopters or hexacopters, are advantageous for aerial photography, search and rescue, and commercial delivery, as they can vertically take off and land (VTOL), hover, and maneuver in restricted spaces. Nonetheless, they are limited by their payload capacity and sensitivity to environmental factors like weather conditions. Single-rotor drones have various military, heavy transport, and surveillance applications due to their ability to carry heavier payloads and endure longer flights. However, they also have downsides, such as complex mechanics, higher maintenance, and increased costs. Hybrid drones, on the other hand, offer versatility for missions such as surveillance and inspections by combining the benefits of fixed-wing and multirotor types. Nonetheless, their design complexity and potential for higher costs pose certain challenges. Nano-drones, which are small in size and ideal for indoor surveillance or recreational flights are affordable but constrained by their limited payload capacity and short flight times. ((Heutger and Kückelhaus 2020), (Hassanalian and Abdelkefi 2017)). Regardless of the drone

classification, successful drone operations require a safe and secure environment for take-off and landing with sufficient space and minimal obstacles to avoid accidents (DSLR 2023). For last-mile deliveries, multirotor drones with the ability for VTOL are utilized in most use cases. Appendix 9.2. summarizes and visualizes the discussed drone types.

2.2.2. **Regulation**

The regulation of UAVs is crucial to guaranteeing their safe and responsible use. Across the world, governments and aviation authorities have implemented strict regulations to govern UAV operations. These regulations typically encompass aspects such as drone registration, pilot licensing, no-fly zones (including airports and sensitive areas), maximum altitude and speed limitations, and guidelines for safe flying practices (Bassi 2019). In addition, regulations commonly cover privacy concerns, data protection, and insurance prerequisites for drone operators. As technological innovation progresses, regulatory bodies frequently revise these regulations to achieve a middle ground between innovation and public safety, facilitating the ethical incorporation of UAVs into various industries while averting potential hazards (D. Lee, Hess, and Heldeweg 2022). Currently, there seems to be a lack of agreement in developing unified regulations that extend across global borders and continents. Rules vary considerably from country to country, leading to a complicated regulatory environment to successfully launch and scale drone activities (Heutger and Kückelhaus 2020).

2.2.3. **Use Cases**

UAVs are increasingly utilized in commercial and public sectors for a multitude of purposes. As this literature review highlights, innovation in logistics especially last-mile delivery is vital. Research on the applications of drones most relevant to last-mile logistics can be primarily grouped into three areas: global health, perishable goods, and e-commerce & package delivery, with most of the success being observed in the first two areas.

Global Health

In global health, drones have become an effective means of transporting essential medical supplies, especially in regions with insufficient road infrastructure or during emergencies (Konert, Smereka, and Szarpak 2019). Drones can be an efficient mode of delivery for medical supplies, such as blood samples or prescription medicine, due to their small size, low weigth and high value, making drones a suitable transportation method for urgent items (Moshref-Javadi and Winkenbach 2021). Drone manufacturers and operators *Matternet* and *Zipline* are among the companies that have pioneered drone delivery logistics, focused on using drones in the healthcare sector for the delivery of medical supplies. *Zipline's* operation in Rwanda has reduced delivery times from 4 hours to less than 30 minutes for blood samples and other medical products, demonstrating the potential of medical logistics through the use of drones (Ling and Draghic 2019). By September 2023, *Zipline* has safely completed more than 750 thousand commercial drone deliveries and is among the few companies that are authorized by the *Federal Aviation Administration* (*FAA*) to make deliveries beyond visual line of sight (BVLOS) and without human observers in the US (Zipline 2023). *Matternet*, in partnership with *UPS*, is one of the other major players that has obtained *FAA* clearance for the transportation of goods via drone BVLOS for commercial purposes, representing a significant stride towards the progression of medical logistics through the UAV technology (Fox 2023). To date, *Matternet* has completed over 20 thousand commercial flights (Matternet 2023). *Amazon Pharmacy*, a subsidiary of *Amazon*, has deployed its drone delivery service for residents in College Station, Texas, for the free delivery of prescription medications within just 60 minutes of ordering in October 2023 (Amazon 2023b). Hiebert et al. (2020) suggest in their review of the application of drones in healthcare and health-related services in North America that drones could already offer a financially viable solution in hard-to-reach areas, however, more research on the cost of such a service is suggested to be conducted. The discussed

applications indicate that commercial drone deliveries in the context of global health are successfully emerging as an innovative approach to last-mile deliveries.

Perishable Goods

Drone deliveries have also received increasing attention for the delivery of perishable goods. This is due to the demand for speedy food delivery, and long travel times in cities with heavy traffic (Moshref-Javadi and Winkenbach 2021). Ongoing innovation by companies worldwide showcases the potential of this technology: *Manna Aero*, a drone delivery company mostly focused on the delivery of food items from local vendors, completed over 100 thousand deliveries in Ireland and is in the process of expanding to Europe and the US in 2023. Their drones operate at 50 miles/hour (80 km/hour), conducting 7-8 deliveries per hour within a five-mile radius from local stores, at one-tenth the cost of a human driver (Koetsier 2023). Multinational technology company *Alphabet* conducted trials of drone deliveries through its subsidiary, *Wing*. The company used this service to transport, for example, *Chipotle's* burritos within Virginia and thereafter expanded operations to remote regions in Australia. Today, the company has completed over 350 thousand deliveries in 10 locations across 3 continents and has recently started to partner with *Walgreens*, an American pharmacy store chain, and *Walmart*, an American multinational retail corporation, to further expand its service into the retail business (Wing 2023). *Walmart's* drone delivery service is gaining momentum, with increasing demand for food and drink items. The retail giant has expanded its service to 37 store-based deployment hubs and 26 municipalities and delivered over 6000 orders via its drone service in 2022 (O'Brien 2023). The discussed use cases showcase the effective emergence of commercial drone deliveries within the context of perishable goods, especially in the food and beverage industry, showing promising potential as an innovative solution for last-mile deliveries.

Package Delivery & E-Commerce

In the field of package delivery, drones have become a technology with the potential to revolutionize expensive supply chain operations. Drones are expected to offer not only a cost-effective solution but also an environmentally friendly one for the expensive and time-intensive last-mile deliveries (Chiang et al. 2019). Postal service businesses, such as *UPS* and *DHL*, are investigating advanced multi-modal delivery techniques that combine trucks and drones to enhance productivity. *UPS* cooperates with *Workhorse*, a manufacturer of electric vehicles, by testing a configuration in which drones are loaded with packages from a truck, dispatched to deliver products, and then returned to the truck for package collection and battery replacement (Adler 2020). The project is currently in the research and development phase and, as of now, no packages have been delivered to customers by drones. Nonetheless, *Workhorse* announced it is making "significant advancements" and is working on legal and regulatory approvals with the *FAA* (White 2023). *DHL* presented its Parcelcopter 4.0, proficient in vertical take-off and horizontal flight, considerably diminishing delivery times to remote regions. However, the project was discontinued in 2021 (Daleo 2021), and according to *DHL's* website, the company estimates drones to only become a reality in 5-10 years given the limited applicability of use cases, despite drones being described as having a 'moderately high impact on logistics' (DHL 2023). Several other major retailers and e-commerce businesses, such as *Amazon*, *JD.com*, and *Rakuten*, are also investing in drone technology for quick and effective parcel deliveries. Chinese e-commerce company *JD.com* announced its drone delivery program targeted at rural areas in 2015 (JD.com 2017), with the ambition to operate one million drones in the sky in the future according to an interview with the company's CEO (WSJ 2017). In 2023, the company seems to have not realized its announced plans, as no information on its drone service can be found. *Amazon* introduced *Prime Air* in 2013 intending to deliver packages to customers' front doors within half an hour of placing an order. The company's drone prototype can travel up to

80km/h and carry a payload of up to 2.3kg, covering up to 86% of all products sold on the website (Singireddy and Daim 2018). An early study by Sudbury and Hutchinson (2016), which analyzed the costs of *Prime Air*, suggested that by implementing drone technology widespread, *Amazon* could gain a cost advantage of around one-third per package delivered against using ground delivery methods. However, *Prime Air's* delivery service seems to struggle to break through, as in its test trials, the company only managed to keep its drones flying by giving away free products according to the *New York Times*. Hurdles like weight, size, fragility, selection, weather conditions, cars in driveways, trees in backyards, and more have made last-mile drone delivery to homes a difficult project to realize (Streitfeld 2023). By the end of 2023, no actual widespread success of last-mile deliveries for their e-commerce business has been reported, however, the company is now set to start new trials with their new drone prototype which is planned to take off in late 2024 in the UK, US and Italy (Amazon 2023a). So far, the discussed applications of drone deliveries in the e-commerce sector have not demonstrated practical success, pointing to hurdles in innovating last-mile delivery services.

2.3. Research Gap & Research Scope

The existing literature showcases the potential of drone deliveries for various applications. However, when comparing the progress made by present drone delivery companies, it becomes evident that only the medical and perishable goods use cases can be considered successful, establishing themselves as an innovative solution for last-mile deliveries. These product use cases are distinctive due to their time-sensitive and urgent manner and are typically characterized by single-order deliveries. However, in the scope of e-commerce parcel deliveries, the integration of drone technology still seems to encounter difficulties when deploying drones for last-mile delivery services. Despite e-commerce and parcel delivery giants like *Amazon*, *JD.com*, and *UPS* investing millions of dollars in these operations for over a decade, no notable success can be observed, with the international parcel courier *DHL* even

completely abandoning the innovative operations. This raises questions about the feasibility of drone delivery technologies within last-mile parcel delivery operations in the e-commerce landscape. Thus, this work project seeks to answer the research question (RQ): ***"Are drone technologies a feasible solution for last-mile parcel delivery in e-commerce from a business and customer standpoint?"***. To comprehensively examine this feasibility, the work project is methodically structured around two paradigms as seen in Figure 1:

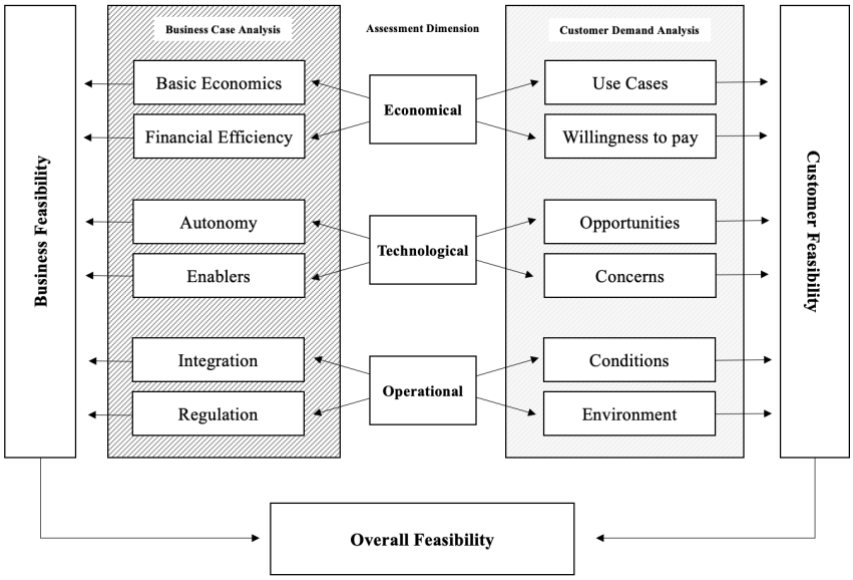

Figure 1: Research Framework

The paradigms, (1) Business Case and (2) Customer Demand, represent two main perspectives when analyzing last-mile drone deliveries in e-commerce. Businesses engaged in last-mile drone deliveries are the primary entities leading the process, directly influencing the efficiency and performance of last-mile delivery, and ultimately determining whether this technological innovation is realized on a larger scale or not. Further, given the importance customers play in driving revenues within the e-commerce sector, a part of the research is focused on the customer. Customers not only contribute to financial success but also are the final point of contact during the last-mile delivery process, experiencing this process firsthand. Within each paradigm, the research is further separated into multiple influencing factors which are categorized into three assessment dimensions: the economic, technological, and operational

dimension. All foundational influencing factors for the research are based on established business practices, consolidating micro- & macroeconomic components, as well as technological factors with significant relevance for drone technologies.

Within the economic dimension, the focus is on the basic economics and financial efficiency of businesses deploying drones as delivery vehicles. Simultaneously, general customer demand and willingness to pay for drone deliveries will be explored. Concerning technological factors, the study explores autonomy levels, as well as technological enablers, to assess the technological feasibility from the business perspective. Additionally, technological opportunities and concerns are explored from the customer´s perspective and their influence on customer demand. To establish feasibility in the operational domain, the operational integration of drones and regulations of last-mile drone delivery businesses will be analyzed. Furthermore, a focus is set on operational conditions from a customer perspective, while also considering the environmental impact on customer acceptance of last-mile drone technologies for parcel deliveries. Once all these underlying factors have been discussed from a business and customer perspective, an overall assessment of feasibility can be made.

3. Research Methodology

The feasibility of drone technology for last-mile delivery in e-commerce is a multi-disciplinary research field that combines social science and applied science in business and economics.

3.1. Selection of Methods for Data Collection

When conducting research, a structured and systematic approach is essential for ensuring the reliability and validity of the study. The research onion, developed by Saunders et al. (2007), provides comprehensive decision-making guidance that leads researchers through the layers of complexity inherent in the research process. This metaphorical onion consists of several layers, each representing a critical aspect of the research design, from broad philosophical considerations to specific data collection and analysis methods. Applying the research onion

to investigate the research framework, both qualitative and quantitative data collection methods were selected, allowing for a deductive approach to be explored. The strategies chosen are (i) expert interviews, a qualitative strategy, that allows for an in-depth exploration of the subject matter through conversations with knowledgeable individuals; and (ii) a survey, a common strategy in social research, involving the collection of categorical and qualitative data through a structured questionnaire. Both strategies follow a cross-sectional design, capturing snapshot data from businesses and customers.

3.1.1. **Expert Interviews**

The selected interviewees are considered experts due to their position, status, and the knowledge attributed to them (Bogner, Littig, and Menz 2009). The experts interviewed have explicit knowledge of the relevant topics and are interviewed with the help of a guideline that ensures a comparable survey situation for all respondents (Bogner, Littig, and Menz 2009). The direct advantage of guideline-based expert interviews is that different perspectives on a topic can be collected. In the context of this work, different stakeholders were interviewed who are involved in drone technology development and operation, as well as experts in the e-commerce and logistics industry. When selecting the interview partners, it was ensured that the experts were from different fields within the industries to guarantee the heterogeneity of the interviews. All experts interviewed are familiar with the topic of drone technologies due to their work and position and can contribute to answering the RQ with their expertise. The experts interviewed are listed in Table 1:

#	Date	Expert	Acronym	Industry	Company	Position
A	16.10.23	Frank Steinbrenner	FS	Logistics/ Last-Mile Delivery	*DHL*	Head of Subordinate Mannheim
B	19.10.23	Michael Cunningham	MC	Drone Delivery	*Manna Drones*	Head of Commercial
C	25.10.23	Nathalie Steinmaurer	NS	E-Commerce	*Amazon*	Head of AVS FMCG
D	27.10.23	Ana Manuel Almeida Martins	AM	Drone Delivery	*Connect Robotics*	Executive Management Assistant/ Business Developer

E	30.10.23	Lasha Sharikadze & Dr. Olaf Funke	LS & OF	E-Commerce & Technology	*Digital Settings*	CEO & COO
F	07.11.23	Ryan Walsh	RW	Drone Delivery Infrastructure	*Valqari*	CEO/ Founder

Table 1: Expert Interviewees

All interview partners were provided with the interview guide in advance of the interview so that they could prepare for the questions. The interviews were conducted via video conference and recorded with the consent of the interview partners. These recordings serve as the basis for the preparation and evaluation of the expert interviews. All interview partners agreed to be cited and named as part of this research.

3.1.2. **Survey Research**

A cross-sectional online survey was conducted to evaluate the impact of drone technologies on end consumers' demand and acceptance of last-mile delivery services in e-commerce. Technical abbreviations were explained upon their initial use. The information presented has a clear logical structure with causal connections between statements. The survey aimed to assess several factors influencing customer demand for last-mile delivery, including online shopping behavior, believed satisfaction uplift levels, and perceived benefits and concerns, which are assumed to affect the demand and acceptance of drone technologies for last-mile delivery in e-commerce. To accomplish a sufficient analysis of the demand, a subset of 27 questions (including 6 demographic questions) was created, structured by different factors and ratings (see Appendix 9.5. for the full set of questions). The survey mainly used Likert scale (1 through 5) measures, multiple choice, and a few open-ended questions to allow customers to share their ideas and thoughts. All questions were founded on the thorough literature review conducted before the investigation. The study's target population consisted of e-commerce customers with no restrictions on age, gender, nationality**,** or occupation. Given that the questionnaire was predominantly shared within the authors' network, it was provided in English and German. The research does not incorporate a control group, and the sample size of 138 participants

exceeds the predetermined minimum of 100 respondents, ensuring statistically relevant results. Ethical standards were adhered to throughout the research process, ensuring confidentiality for all participants, voluntary participation, and transparent data reporting.

3.2. Data Preparation

To assess and analyze data obtained from expert interviews and the survey, two distinct data preparation methods were employed. For qualitative interviews, it is imperative to standardize and present the interview data understandably. In qualitative interviews, the basis for the data is the verbatim transcription of the interview (Poland 1995). During the creation of the transcripts, a standard format was utilized which contained the name, position, and date of the interview, non-verbal aspects were not recorded. To systematically analyze the qualitative data obtained from the interviews, the Framework Analysis method developed by Ritchie (1994) was employed. By applying the various stages of familiarization, identifying themes, indexing, charting, summarizing, and mapping, the data is rendered comparable across various topics and within the interview.

The survey comprises mainly categorical data; therefore, a systematic approach was adopted. This approach arranged the dataset for analysis, addressing missing data through imputation or exclusion, pinpointing and handling outliers, coding, and recoding variables, creating derived variables, and transforming data to fit underlying statistical tests. Survey data was used to elaborate on descriptive statistics, showcasing customer trends as well as connections between variables. Data was analyzed to be comparable to previously explored literature as well as in line with the Technology Acceptance Model (TAM) (Davis 1989), which asserts the perceived usefulness and perceived ease of use concerning technology acceptance of customers.

4. Results and Findings

This section presents the results and findings of a comprehensive analysis of expert interviews and survey respondents to assess the feasibility of drone technology for last-mile e-commerce deliveries. The section comprises two distinct components: a business case analysis and a customer demand assessment.

4.1. Business Case Analysis

This business case analysis explores the feasibility of drone technologies in last-mile parcel delivery based on the influencing factors introduced in paragraph 2.3 of this work project. The primary objective is to build the foundation for making a definitive conclusion on the practicality and validity of using drones for last-mile deliveries in the e-commerce industry from a business perspective. The findings pave the way for a comprehensive discussion to answer: *"How do the influencing factors impact the feasibility of deploying drone delivery technologies for last-mile deliveries from a business perspective?"*, a sub-RQ that aims to support answering the main RQ.

4.1.1. Economical Dimension

In assessing the feasibility of deploying drones as delivery vehicles, understanding the economic principles that influence the e-commerce delivery ecosystem is crucial. The economic influencing factors on the business side thus include the basic economics and financial effectiveness of implementing drones for delivering orders on the last mile.

Basic Economics

In evaluating the basic economics, supply and demand dynamics and market forces are considered that collectively shape the economic viability and sustainability of last-mile drone delivery services.

The demand side is shaped by consumer preferences for faster and more convenient delivery options. Nathalie Steinmaurer (NS), Head of Amazon Vendor Services for FMCG at *Amazon*, highlighted the inherent challenges in reconciling the economics of these so-called 'quick deliveries', emphasizing the pivotal role of understanding customer needs and their willingness to pay for the expedited service. As the demand side is directly linked to customer acceptance, NS suggested fully framing the discussion around addressing customer needs rather than focusing solely on product selection or technical aspects to capture demand. Furthermore, education was mentioned as a significant factor in building trust and acceptance around drone delivery services. For the case of *Amazon*, finding the right value proposition to capture consumer needs and wants at the right willingness to pay is highlighted to remain the biggest challenge in successfully implementing the drone service, given that the company is said to be ready to scale from a technical standpoint alone. Section 4.2 will extensively analyze the role of customer demand for last-mile drone deliveries in e-commerce.

On the supply side, factors such as product selection, technological capabilities, and pricing come into play. NS highlighted a challenge rooted in the selection, noting the importance of identifying what proportion of goods has a speed benefit to customers, as the expert specifically classified time-sensitive products as the most advantageous use case for last-mile drone deliveries. Furthermore, the technological capabilities, like payload capacity and battery range of the drone, play a crucial role in successfully supplying the goods to customers according to Lasha Sharikadze (LS) & Dr. Olaf Funke (OF), CEO and COO from *Digital Settings*, a software and R&D solutions start up for innovation in the high-tech sector, focused on integrating software and hardware solutions. Furthermore, factors such as the cost and ability to adapt a company's operation to the existing supply chain were identified to influence the supply of goods via drones, according to NS.

Moving over to market forces, Frank Steinbrenner (FS), Head of Subordinate Mannheim at logistics company *DHL*, predicted the main market force to be competition, and that ultimately success will be determined by those who act fast and genuinely innovative, as opposed to those who adopt initiatives merely for image purposes or "greenwashing" without substantial impact. NS also noted that smaller firms may encounter competitiveness issues related to pricing and product selection, struggling to match the price and offering of established businesses in the e-commerce landscape. Furthermore, throughout all interviews, regulation emerged as the central market force in enabling or hindering the operation of commercial drone deliveries, which will be discussed in more detail in section 4.1.3. Similarly, technological innovation and integration with emerging technologies were pointed out as a key market force by several experts and will also be further elaborated on in section 4.1.2.

Financial Efficiency

The financial efficiency of commercial drone deliveries in e-commerce is a complex and multifaceted issue, as expert insights have revealed. Financial efficiency in commercial drone deliveries concerns the cost-effectiveness of integrating drone technology into delivery services. This includes reducing costs related to drone manufacturing, maintenance, and operation while maximizing the economic advantages and returns on investment. Especially in the context of last-mile deliveries, which, as illustrated in the literature review, represent the most expensive part of the supply chain, the financial efficiency of commercial drones is a crucial factor in determining the feasibility of the technological innovation.

FS emphasized that the critical factors in the context of financial efficiency are always a question of cost and innovation: *"In the end, we were maybe a little more risk-averse in the next ten years. We say we want innovation, but after a certain time, I have to expect innovation. And if we don't make money with it and do it just because we say it's nice to have a few press articles, then we don't do it."* (Frank Steinbrenner, DHL). This demonstrates, that while

innovation is desirable, it is contingent on profitability because if a company is not generating revenue from it, they are unlikely to pursue it. FS mentioned the difficulty of achieving economies of scale with drone deliveries, especially when compared to the efficiency of traditional parcel delivery methods. The interviewee exemplified this by noting *DHL's* extensive operation: The company processes more than 5 million parcels every day, through which they optimize economies of scale by utilizing trucks that carry around 200 packages and make about 100 stops per truckload, effectively lowering the delivery cost per package. The same principle cannot be applied seamlessly to drone deliveries according to FS, posing a significant cost-related hurdle. However, for deliveries to rural or hard-to-reach areas like small islands or mountains, the potential positive financial impact of drones is acknowledged, given the expensive nature of traditional delivery methods in such terrains. Nonetheless, making drone deliveries financially worthwhile remains the biggest bottleneck in widely implementing the technology according to FS. NS suggested that to overcome the challenge of achieving cost-effectiveness with drone deliveries, the key lies in maximizing the number of packages delivered per drone to reduce overall costs. Additionally, the consideration of range and thus the geographical radius that can be served by the drone impacts the financial viability of the drone delivery system as it influences the number of flights that can be completed, and ultimately influences aircraft utilization (which measures the productivity of drones by looking at the hours flown by the vehicle a day). Overall, the interviewee emphasized however, that Amazon prioritizes a well-built investment over a quick payoff and highlighted the importance of understanding how a technological innovation can meet customer needs before focusing on making a return on investment.

As opposed to the inputs provided by the previously cited experts, LS and OF from *Digital Settings* presented a comparative cost analysis between traditional delivery methods and drone deliveries, suggesting cost advantages for the latter, particularly for urgent deliveries. This

stems from the fact that traditional delivery methods rely on humans to operate the vehicle, which involves costs such as salary, insurance, and pensions. They argue that for use cases outside of parcel delivery, like single-order instant deliveries such as pizzas, the utilization of drones present a significantly more cost-effective alternative compared to employing delivery personnel on scooters or in cars. They based this on two parallel trends: (1) the increasing costs associated with traditional transportation and (2) the potential for alternative delivery methods to cater to longer distances, integrating cheaper technologies, and accommodating heavier payloads. Thus, once current technological limitations are overcome, the interviewees expect to achieve economic parity and even surpass the cost efficiency of drone deliveries with traditional methods.

As a company that has implemented last-mile drone deliveries for perishable goods and items from local stores in practice, *Manna Drones* focuses on aircraft utilization and multiple revenue streams, including commissions, delivery fees, and product markups, to cover costs. Michael Cunningham (MC), Head of Commercial at *Manna Drones*, emphasized, however, that as of 2023, the company is still reliant on external funds to scale its business. Despite saving significantly on human capital expenses for deliveries, the company faces challenges associated with making drone deliveries more financially feasible. Thus, MC suggests implementing other revenue streams such as subscription models or advertising to lower the effective cost per flight. Similarly, even though revealing very little information on financial feasibility, Ryan Walsh (RW), CEO and Founder of drone delivery hub operator *Valqari* explained that revenue models may also involve selling/leasing systems, licensing technology, and, in some cases, offering end-to-end services for specific customers. NS from *Amazon* suggested adding the option of drones as a delivery mode to the existing *Amazon Prime* subscription model at a premium for paying customers, simplifying the onboarding process and providing them with a seamless and hassle-free experience.

4.1.2. **Technological Dimension**

The technological dimension explores the transformative impact technology may have on the feasibility of using drones for last-mile deliveries. This impact will be assessed by evaluating drone autonomy and technological enablers as influencing factors.

Autonomy

A drone's ability to navigate through its environment depends on either human pilots steering the drone or innovative autonomous technologies, such as AI-powered navigation systems and obstacle avoidance sensors. To compete against the economies of scale of traditional delivery methods, drones need to adapt to dynamic and changing conditions without continuous human intervention according to FS. Different levels of human intervention and challenges to autonomy were identified at different points of time during the flight journey.

Before the drone is set to take off, route planning is a critical component for commercial drones, ensuring efficient and safe navigation by considering factors such as airspace regulations, optimal delivery routes, and potential obstacles, thereby enhancing overall operational effectiveness. NS emphasized the technical challenges of route planning and mentions the need for adaptive navigation systems capable of handling diverse terrains and obstacles. The expert exemplified the challenge by pointing to regions with, for example, high-hanging electric lines which present a significant hurdle in many parts of Europe. In addition to route planning, loading the package onto the drone is a critical aspect where human intervention is still needed in most cases. MC from *Manna Drones* underlined this by saying that the company is still reliant on humans to manually load the goods onto the drone. Currently, one loader is said to handle approximately four drones at a time, which presents a hurdle in scaling the business's operation.

In flight, experts agree that the drone can operate with complete autonomy. MC explained that the navigational mission control function of their drones function fully autonomously. Ana

Manuel Almeida Martins (AM), Executive Management Assistant and Business Developer at *Connect Robotics*, who focus on drone delivery and automation for urban and hard-to-reach destinations for medical goods, similarly described their flight operation as 'truly autonomous'. However, MC noted that there may be human operators or technicians needed to oversee certain aspects of the operation, such as monitoring for unexpected events, performing maintenance, or handling specific situations that require human intervention. Ultimately, the level of autonomy is dependent on the technology used and available to the operator that enables the autonomous capabilities, and the regulatory framework in place, which determines the extent to which the drone is authorized to operate autonomously according to AM.

The landing of commercial drones at the customer site demands precision and efficiency, as autonomous systems or human operators carefully navigate the final phase of delivery to ensure a secure and timely arrival. FS from *DHL* discussed the details of drop-off procedures, contemplating the feasibility of allowing customers to specify alternative drop-off locations, such as driveways or balconies, as this requires a degree of automated decision-making by the drone, which is still mentioned to be operationally challenging in practice. Customers requested drop-off points, as explained by FS, may not be suitable for a safe package drop-off procedure, as often real-life scenarios differ from predicted environments based on data from communication systems, geographical mapping technologies, or satellite views. However, FS also pointed out the importance of offering dynamic delivery points to customers to ensure a satisfactory customer experience, making it more likely to require human intervention more often. *Valqari* on the other hand, who offer static delivery points at various predetermined locations, claim to benefit from zero percent human involvement in their operation. The company's expert emphasized the feasibility of full autonomy, assured through thorough and constant controlled testing, but at the cost of not offering dynamic delivery points to customers.

Technological Enablers

Collaborations with other technologies in the context of commercial drone deliveries refer to the integration and interaction of drones with systems and software products that allow for the autonomous delivery of packages to customers. The integration of mapping and geospatial technologies, communication systems, or artificial intelligence is essential in enabling the overall flight and delivery capabilities and effectiveness of a drone's operation.

To master the autonomous decision-making processes in commercial drone deliveries, the integration of artificial intelligence and quantum computing is found to play a pivotal role. The experts of Digital Settings explained this integration to be essential to automate product pricing and addressed factors such as weather fluctuations or individual customer preferences. Quantum computing, when employed in tandem with AI, is the technology in the background executing the needed complex calculations to encompass route optimization, predictive maintenance, and demand forecasting. In complementing and ensuring the autonomous decision-making of drones, the IoT is identified as a crucial element for effective drone delivery operations according to LS. Leveraging IoT allows for communication and interaction between the drone and other systems to enable real-time data transmission, allowing drones to swiftly adapt to changing conditions, ensuring secure and efficient deliveries. OF emphasized the efficiency and customer-centric benefits of IoT, where devices and sensors optimize delivery routes and provide real-time environmental data. This integration introduces a dynamic layer to drone delivery optimization, ensuring adaptability to real-world conditions. LS highlighted the potential of these technologies not only for flight operations but also in optimizing landing and finding safe delivery spots, showcasing a holistic and technologically advanced approach to drone delivery operations. To bring these technological innovations to work, LS highlighted the need and impact of leveraging 5G technology or services like *Starlink*, a satellite internet constellation, for drone flight operations. The high-speed, low-latency connectivity of 5G

enables seamless communication between drones and ground control systems, ensuring rapid, real-time data transmissions that are vital for adapting to changing conditions and ensuring secure, efficient deliveries. Additionally, collaborative mapping technologies, utilizing advanced satellite imagery and geographical information systems, enhance drone navigation in complex terrains and urban environments through the creation of precise maps according to multiple experts.

4.1.3. **Operational Dimension**

Mastering the operational challenges is key to navigating the commercial drone delivery landscape. This dimension, with a focus on operational integration and regulation, delves into the operational factors influencing the feasibility of deploying drones for last-mile deliveries.

Operational Integration

The seamless integration of drone deliveries into the supply chain ecosystem is deemed essential for operational success, especially in the context of last-mile deliveries, as these present a complex, expensive, and time-consuming aspect of the e-commerce supply chain as explored in the literature review. NS explained how the supporting infrastructure plays a crucial role in determining the success of governing the drone delivery ecosystem in e-commerce. If a delivery drone can be integrated into the existing operations of the complex network of the parcel supply chain, companies can scale and implement such an offering at a much higher capacity than new entrants with no existing infrastructure availabilities and capacities. However, adapting operations and integrating drones into the existing supply chain is associated with high costs and challenges, and is also limited in rural regions lacking adequate infrastructure according to NS. The expert also emphasized the opportunity of partnerships with established companies possessing existing volumes and products to overcome the challenge of scale in drone delivery services. The strategic approach to leverage existing external infrastructure, resources, or technologies for the implementation of drone deliveries

is, however, not deemed an option for *Amazon*, as the company generally focuses on keeping processes and operations in-house. FS also emphasized the need for operational integration, as he explained drone deliveries to be a technology to enhance existing last-mile delivery options, rather than functioning as a standalone service. Thus, the seamless integration with the current transportation infrastructure is crucial to the success of deploying delivery drones according to the expert. He discussed the concept of collaborating with, for example, delivery hubs, proposing a coordinated network of drone deliveries for small and urgent items between these stations. This collaborative approach aims to address logistical challenges by creating an interconnected system where drones move efficiently between delivery hubs, thereby enhancing the overall efficiency of the delivery process. *Valqari* follows a similar approach to the proposed concept by FS, but RW contrarily emphasized the complexity and aversion of making alliances too early in the industry. While recognizing the potential for strategic partnerships to expedite scaling, the cautious approach reflects the industry's dynamic nature, where premature alliances could be either beneficial or detrimental to a company's trajectory. Furthermore, the complexity of choices between central delivery hubs, direct home delivery, or designated drop-off areas for multistoried buildings adds further needed operational considerations. Especially for densely populated areas in cities, the operational integration is mentioned to be challenging. Experts' insights collectively suggested that the successful integration of drone deliveries into the supply chain requires innovative drop-off procedures and adaptability to diverse urban environments. AM from *Connect Robotics* underscored the critical need for high precision in autonomous landing scenarios, considering factors such as ground landing versus package drop-off via baskets or tethers. Landing strategies, as noted by NS from *Amazon*, have witnessed a revolution with the introduction of AI and camera-based landing verification, but landings remain inaccurate or unfeasible in many scenarios.

Regulation

As introduced in the literature review, regulations in commercial drone deliveries encompass the legal framework and guidelines set by aviation authorities and government bodies. These regulations dictate the permissible use of drones for delivery purposes, ensuring safety, security, and compliance with airspace rules.AM from *Connect Robotics* emphasized the extensive human involvement in navigating the regulatory landscape, particularly in constructing customized solutions that adhere to licensing, safety measures, and various operational processes. The inherent challenge lies not just in compliance but in delivering a value proposition that aligns with local regulatory specifications, which *Connect Robotics* mentioned to be the primary challenge in their operation. For example, the existing infrastructure of a country can influence drone regulations: urban environments may have different regulations compared to rural areas, considering factors such as population density, airspace congestion, and the proximity of critical infrastructure as stated by AM, leading to the demand for distinct value propositions. FS from *DHL* added a layer to the discussion by acknowledging the challenges that regulations pose to drone delivery services, but also emphasized the urgent need for regulation in air traffic management, especially with a growing emphasis on the environmental impact. While the potential ecological impact of drone operations presents a promising solution to reduce emissions in comparison to combustion vehicles, he questions the societal readiness and acceptance for the widespread deployment of drones, especially in terms of noise pollution, air traffic congestion, and privacy invasion. Furthermore, MC from *Manna Drones* shed light on ongoing regulatory challenges in specific countries such as the UK and the US. He highlighted how the industry needs to deal with country-specific regulations, which reflects exhaustive work needed to fulfill compliance requirements on a global scale, currently determining but also limiting expansion. Factors such as privacy laws, safety measures, environmental impact, and infrastructure considerations

emerge as critical elements businesses need to adapt for each specific country or local regulatory framework according to NS from *Amazon*. *Digital Settings* exemplified this regional perspective by highlighting the contrasting regulatory environments from countries within the EU, like Germany, to those outside the EU. While in the EU drone flights are heavily restricted due to air traffic regulations, regions with more favorable regulatory frameworks, like Georgia or Switzerland, have seen more innovation for drone deliveries. RW from *Valqari* characterized the regulatory landscape as a complex interplay between heavily regulated markets and institutions dominating last-mile delivery. As stated by the expert: "*The regulatory challenges are holding the market from scaling: BVLOS are keeping 99.5% of the market closed for approximately the next 15 months. Once those are lifted, I don't see too many challenges that aren't able to be overcome."* This shows how the expert anticipates regulatory changes, specifically lifting restrictions on BVLOS operations, as a catalyst for market growth.

4.1.4. **Implications of Business Case Analysis**

The business case analysis results offer valuable insights into the feasibility of adopting drone technology for last-mile e-commerce deliveries. The growing demand for fast and convenient delivery options provides an opportunity for early adopters and innovators to achieve market success in drone delivery deployment. This technology offers last-mile delivery providers the opportunity to showcase their focus on innovation and sustainability. However, integrating commercial drone deliveries demands businesses to manage diverse factors, including understanding and meeting customer needs, determining the right revenue model, addressing the critical dependency on the technical capabilities of drones, and recognizing the key role of operational and regulatory frameworks in either enabling or hindering success. The financial viability of last-mile drone delivery for e-commerce is a major obstacle to its widespread adoption, primarily due to significant cost challenges. Despite the promise of reducing costs through less human involvement and enhanced speed and efficiency, last-mile drone delivery

in e-commerce currently faces challenges that outweigh its potential as a cost-effective means of package delivery. Achieving comparable economies of scale to traditional methods remains impossible for drone deliveries due to technological limitations of batching and battery lifetime. This results in a heavy dependency on multiple revenue streams to cover costs per flight and high investments that delay the return on investment. These factors create barriers to entry for even the most established and innovative players in the industry posing a substantial impediment to the adoption and deployment of last-mile drone services in e-commerce, slowing down research and development. While these challenges are particularly relevant to last-mile delivery in the e-commerce sector, it is important to note that the same conclusions may not apply to drone delivery of perishable goods or medical supplies. The increased urgency and general characteristics of single-order deliveries in these scenarios provide a more favorable environment for drone deliveries. The technological readiness of autonomous drone deliveries in last-mile logistics is showing success in improving operational efficiency in flight and achieving accurate landings and drop-offs at static delivery points. Despite these advances, human intervention is found to remain critical, especially for loading packages onto the drone and making real-time interventions during flight or landing, decreasing efficiency and adding additional costs in the form of human capital. Furthermore, technical challenges in route planning and operational complexities in accommodating customer-specified drop-off locations present current limitations. While the trajectory is promising, achieving advanced autonomy with less human involvement is needed in line with regulatory frameworks. Technological enablers such as AI, cloud computing, IoT, 5G, and improved satellite imagery are contributing to smoother drone navigation. However, integrating such advanced technologies is complex and requires high investments and security requirements, which can pose additional financial and regulatory challenges for companies. Once these elements are harmonized, last-mile drone deliveries can be considered feasible from a technical standpoint.

The successful integration of drone deliveries into the supply chain ecosystem is found to be crucial for operational success. The extensive and complex supply chain networks of last-mile parcel delivery players offer a significant opportunity for implementing drone deliveries in the context of e-commerce from an operational perspective. This enables companies to scale and execute such offerings at a much higher capacity, particularly in developed countries that heavily rely on parcel deliveries. As opposed to the transportation of medical goods or perishable items, the parcel delivery sector provides various options for drone integration, such as operating in and out from delivery hubs or launching from and to delivery trucks. Nonetheless, despite having an established supply chain system and network, last-mile delivery businesses encounter operational difficulties in utilizing this current infrastructure to their advantage in deploying drones to complement traditional parcel delivery services. Obstacles to achieving inventive solutions within the supply chain are further exacerbated by regulatory barriers. The process of expanding operations poses significant challenges in the face of regulatory limitations, necessitating the provision of proposals that conform to regulatory prerequisites for approval. This entails maneuvering through regulations that are unique to individual countries and which both direct and restrict global, and even local, expansion. The focus on air traffic management regulations adds an additional layer of complexity. Thus, the complex regulatory environment creates a significant barrier to entry and growth, particularly in specific markets with strict regulations like the EU. These complications arising from the operational integration into the parcel supply chain and regulatory obstacles present substantial obstacles to the feasibility of utilizing drones for last-mile deliveries in the industry, currently hindering widespread deployment.

Based on these implications, it can be concluded that from a business view, drone technologies for last-mile parcel deliveries are considered unfeasible, as especially financial and regulatory hurdles hinder businesses from widely deploying drones as a standard delivery method.

5. Discussion

The discussion section is the focal point of the academic exploration, revealing connections between business viewpoints and customer perspectives. Assessing the overall viability of drone technology for last-mile e-commerce and parcel deliveries requires the integration of findings from the business case and the customer demand analyses to answer the overall underlying RQ: *"Are drone technologies a feasible solution for last-mile parcel delivery in e-commerce from a business and customer standpoint?"*.

Figure 2 compares the retrieved implications on business readiness (Part 4.1.4.) (y-axis) and customer readiness (Part 4.2.4.) (x-axis). Based on the implications derived from the results and findings, it is concluded that implementing drones for last-mile e-commerce parcel delivery is not a feasible solution at this time.

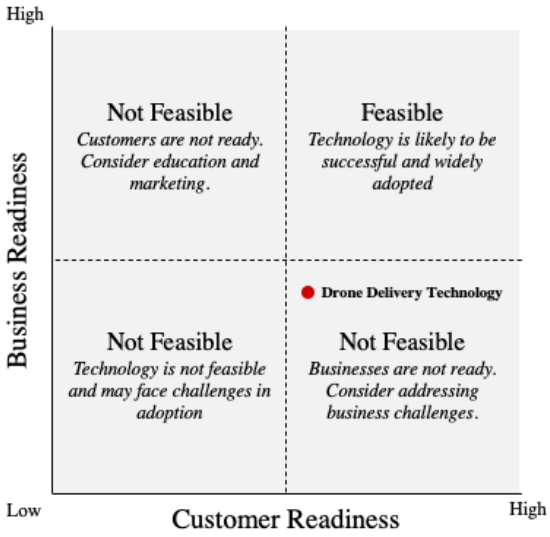

Figure 2: Technology Feasibility Graph

Discussing both perspectives simultaneously reveals dependencies and interactions between the influencing factors. Customers' willingness to pay for drone delivery services is directly influencing the revenue model and financial efficiency of businesses operating in last-mile parcel deliveries operating drones as delivery vehicles. As willingness to pay is generally low among surveyed customers, it poses significant challenges for businesses' financial efficiency,

and they cannot rely on customers' payment at the current state. The present reluctance to pay coupled with the substantial investments required to engage in last-mile drone deliveries and the inherent limitations concerning payload and battery life present significant obstacles to the revenue model of businesses, making it currently an inefficient space to operate in. Additionally, operational constraints do not permit heavy or long-route deliveries, leading to increased costs per delivery due to a lack of batching opportunities and economies of scale. Another challenge for drone operations is final meter deliveries and landing operations, as the customer demand analysis found that most surveyed customers' living situations are not ideal for drone deliveries, especially for the parcel drop-off phase. This misalignment of the ideal settings of the final meter requirements poses challenges, as urban landscapes entail obstacles, and apartment living introduces complexities in landing and delivery logistics. Additionally, the outlined use cases from the business and customer perspectives are largely in agreement that the most effective use cases encompass products with a time-sensitive nature and an urgent need. This coherence is in line with the established successful use cases, such as medical and perishable goods. Nonetheless, it does raise concerns about the viability of e-commerce products, as the majority of e-commerce orders lack the attribute of an urgent need and are generally not time sensitive. This again speaks against the feasibility and raises questions if it is worth the financial risk and high upfront cost if only a fraction of the selection is onboarded to the service. Although drone technology for last-mile parcel deliveries in e-commerce currently appears unfeasible due to the associated high financial risks, regulatory, and operational hurdles, this does not preclude the potential for this technology in the future. The interconnected supply chain networks, technological advancements, significant investments involved in the e-commerce parcel industry, and strong adoption willingness among customers indicate that businesses could eventually adopt this technology on a wider scale.

6. Limitations and Future Research

The assessment of the feasibility of last-mile drone delivery in e-commerce was based on predetermined factors identified through extensive research. It is important to recognize that additional factors may not have been included in this assessment, due to the scope and application of the work project.

The expert interview process faced a few limitations. Although the experts interviewed were drawn from a variety of sectors within the last-mile e-commerce drone delivery industry, ensuring heterogeneity of insights, the pool of experts remains limited due to constraints related to their availability, accessibility, and willingness to participate, potentially introducing bias. In addition, the subjective nature of expert opinions and their susceptibility to personal experience or bias may have influenced responses. The existence of non-disclosure agreements (NDAs) further limited the depth of insight into key factors determining the feasibility of deploying drones for last-mile deliveries. Additional limitations were identified in the survey methodology. It is worth noting that the respondents were not informed about the potential advantages of drone delivery services for last-mile delivery, nor were they informed about the current cost and pricing models of last-mile delivery methods. These factors may have impacted the context of their responses. Furthermore, the survey was predominantly disseminated within the authors' networks, thus restricting its representation of the entire population of potential customers.

To address these limitations and further contribute to the assessment of last-mile drone delivery in e-commerce, multiple future research avenues are suggested. These include a detailed analysis of the selection process for e-commerce products suitable for drone delivery, based on the establishment of eligibility criteria like urgency or weight. Additionally, the possibility of integrating drones into existing supply chains, including delivery vans and hubs, is another valuable area for investigation. Additionally, future research could focus on the exploration of

implementation factors from a local perspective, as the adoption of drone technologies is influenced by both global and local factors, and the successful implementation relies heavily on local considerations such as geography, regulations, and logistic networks in proximity which were not considered thoroughly in the underlying study. Further, future studies could look at the design considerations for drones, assessing the weight and range required to effectively overcome operational challenges. In addition, a quantitative break-even analysis could be included to thoroughly assess the profitability point at which the technology becomes financially feasible. This would provide valuable insights into the sustainability and viability of the examined financial model or strategy. These areas of future research will contribute to a more holistic understanding of the feasibility and implementation of last-mile drone delivery in e-commerce.

7. Conclusion

In conclusion, the assessment of drone technology for last-mile e-commerce and parcel delivery reveals a complex landscape at the intersection of business feasibility and customer readiness. While the innovative approach to last-mile delivery is technologically advanced, it faces significant financial inefficiencies and regulatory hurdles from a business perspective. Despite customers expressing positive curiosity and willingness to embrace drone deliveries, concerns about safety, technology, and operational unfamiliarity persist. The current landscape suggests that high upfront costs, coupled with operational and regulatory barriers, make drone technologies infeasible for a significant portion of the e-commerce market. However, the conclusion drawn from this assessment does not discount the potential of drone technology in the future. The robust interconnected supply chain networks, industry expertise, and significant investment within the e-commerce parcel sector suggest a possible trajectory for the adoption of drone technology once financial risks are mitigated and operational challenges are addressed.

8. References

Adler, Alan. 2020. "Workhorse perfecting HorseFly truck-based drone delivery." 2020. https://www.freightwaves.com/news/workhorse-perfecting-truck-based-autonomous-drone-delivery.

Agatz, Niels A. H., Moritz Fleischmann, and Jo A. E. E. van Nunen. 2008. "E-fulfillment and multi-channel distribution – A review." *European Journal of Operational Research* 187 (2): 339-356. https://doi.org/https://doi.org/10.1016/j.ejor.2007.04.024. https://www.sciencedirect.com/science/article/pii/S0377221707004195.

Alicke, Knut; Rachor, Jürgen; Seyfert, Andreas. 2016. *Supply Chain 4.0 – the next-generation digital supply chain.* (McKinsey). https://www.mckinsey.com/capabilities/operations/our-insights/supply-chain-40--the-next-generation-digital-supply-chain.

Amazon. 2022. "Multirotor Drone" https://assets.aboutamazon.com/dims4/default/464dc94/2147483647/strip/true/crop/2000x1126+0+104/resize/1320x743!/quality/90/?url=https%3A%2F%2Famazon-blogs-brightspot.s3.amazonaws.com%2F0e%2Fe4%2F11131320407f9a1e4407c7a94b35%2Fhero-shot-1-prime-air-drone-during-flight-test-1.jpg.

---, October 18, 2023, 2023a, "Amazon is launching ultra-fast drone deliveries in Italy, the UK, and a third location in the U.S.," https://www.aboutamazon.com/news/operations/amazon-prime-air-drone-delivery-updates.

---, October 18, 2023, 2023b, "Get medications faster with drone delivery from Amazon Pharmacy," https://www.aboutamazon.com/news/retail/amazon-pharmacy-amazon-air-prescription-drone-delivery.

Ayamga, Matthew, Selorm Akaba, and Albert Apotele Nyaaba. 2021. "Multifaceted applicability of drones: A review." *Technological Forecasting and Social Change* 167: 120677. https://doi.org/https://doi.org/10.1016/j.techfore.2021.120677. https://www.sciencedirect.com/science/article/pii/S0040162521001098.

Bassi, E. 2019. "European Drones Regulation: Today's Legal Challenges." 2019 International Conference on Unmanned Aircraft Systems (ICUAS), 11-14 June 2019.

Bogner, Alexander, Beate Littig, and Wolfgang Menz. 2009. "Introduction: Expert Interviews — An Introduction to a New Methodological Debate." In *Interviewing Experts*, edited by Alexander Bogner, Beate Littig and Wolfgang Menz, 1-13. London: Palgrave Macmillan UK.

Chiang, Wen-Chyuan, Yuyu Li, Jennifer Shang, and Timothy L. Urban. 2019. "Impact of drone delivery on sustainability and cost: Realizing the UAV potential through vehicle routing optimization." *Applied Energy* 242: 1164-1175. https://doi.org/https://doi.org/10.1016/j.apenergy.2019.03.117. https://www.sciencedirect.com/science/article/pii/S0306261919305252.

Daleo, Jack. 2021. "DHL pulling its Parcelcopter drone, ceasing drone development." *Freight Waves*, 2021. https://www.freightwaves.com/news/dhl-pulling-its-parcelcopter-drone-ceasing-drone-development.

Davis, Fred D. 1989. "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology." *MIS Quarterly* 13 (3): 319-340. https://doi.org/10.2307/249008. http://www.jstor.org/stable/249008.

Defensebridge. 2022. "Fixed Wing Drone" https://defensebridge.com/custom/domain_1/image_files/sitemgr_photo_5040.jpg.

DHL. 2023. https://www.dhl.com/global-en/home/insights-and-innovation/thought-leadership/trend-reports/drones-logistics.html.

DSLR. 2023. "From Liftoff to Landing: How To Find The Ideal Spot For Your Drone." https://www.dslrpros.com/dslrpros-blog/from-liftoff-to-landing-how-to-find-the-ideal-spot-for-your-drone/#:~:text=Safety%20is%20not%20just%20about,areas%2C%20people%2C%20and%20animals.

Esper, Terry L., Thomas D. Jensen, Fernanda L. Turnipseed, and Scot Burton. 2003. "THE LAST MILE: AN EXAMINATION OF EFFECTS OF ONLINE RETAIL DELIVERY STRATEGIES ON CONSUMERS." *Journal of Business Logistics* 24 (2): 177-203. https://doi.org/https://doi.org/10.1002/j.2158-1592.2003.tb00051.x. https://onlinelibrary.wiley.com/doi/abs/10.1002/j.2158-1592.2003.tb00051.x.

FortuneBusinessInsights. 2023. *Unmanned Systems: Commercial Drone Market.* (Fortune Business Insiights). https://www.fortunebusinessinsights.com/commercial-drone-market-102171.

Fox, Nick, 2023, "Matternet Partner UPS Flight Forward Receives FAA Authorization to Operate Matternet M2 Delivery Drones Beyond Visual Line of Sight," https://www.businesswire.com/news/home/20230906895698/en/Matternet-Partner-UPS-Flight-Forward-Receives-FAA-Authorization-to-Operate-Matternet-M2-Delivery-Drones-Beyond-Visual-Line-of-Sight.

Gevaers, Roel, Eddy Voorde, and Thierry Vanelslander. 2011. "Characteristics and Typology of Last-mile Logistics from an Innovation Perspective in an Urban Context." *City Distribution and Urban Freight Transport: Multiple Perspectives*: 56-71. https://doi.org/10.4337/9780857932754.00009.

Ha, Quang Minh, Yves Deville, Quang Dung Pham, and Minh Hoàng Hà. 2018. "On the min-cost Traveling Salesman Problem with Drone." *Transportation Research Part C: Emerging Technologies* 86: 597-621. https://doi.org/https://doi.org/10.1016/j.trc.2017.11.015. https://www.sciencedirect.com/science/article/pii/S0968090X17303327.

Hassanalian, M., and A. Abdelkefi. 2017. "Classifications, applications, and design challenges of drones: A review." *Progress in Aerospace Sciences* 91: 99-131. https://doi.org/https://doi.org/10.1016/j.paerosci.2017.04.003. https://www.sciencedirect.com/science/article/pii/S0376042116301348.

Heutger, Mathias, and Dr. Markus Kückelhaus. 2020. *Unmanned Aerial Vehicles In Logistics: A DHL Perspective On Implications And Use Cases For The Logistics Industry.* (DHL Customer Solutions & Innovation). https://www.dhl.com/discover/content/dam/dhl/downloads/interim/preview/updates/dhl-trend-report-uav-preview.pdf.

Hiebert, Bradley, Elysée Nouvet, Vyshnave Jeyabalan, and Lorie Donelle. 2020. "The Application of Drones in Healthcare and Health-Related Services in North America: A Scoping Review." *Drones* 4 (3): 30. https://www.mdpi.com/2504-446X/4/3/30.

Homburg, Christian, Nicole Koschate, and Wayne D. Hoyer. 2005. "Do Satisfied Customers Really Pay More? A Study of the Relationship between Customer Satisfaction and Willingness to Pay." *Journal of Marketing* 69 (2): 84-96. http://www.jstor.org/stable/30162046.

Ignat, Bianca, and Stanislav Chankov. 2020. "Do e-commerce customers change their preferred last-mile delivery based on its sustainability impact?" *The International Journal of Logistics Management* 31 (3): 521-548. https://doi.org/10.1108/IJLM-11-2019-0305. https://doi.org/10.1108/IJLM-11-2019-0305.

IlMioDrone. 2022. "Nano Drone" https://www.ilmiodrone.it/wp-content/uploads/2022/04/recensione-autel-evo-nano-800x445.jpg.webp.
International-Trade-Administration. 2022. "Impact of COVID Pandemic on eCommerce." https://www.trade.gov/impact-covid-pandemic-ecommerce.
JD.com, 2017, "Drone Delivery Program - Factsheet," https://corporate.jd.com/resources/downloadFile/JD.com%2520Drone%2520Factsheet.pdf/20396782-2095-40a8-8c20-9524afb75115.
Kapustina, Larisa, Natalia Izakova, Elizaveta Makovkina, and Michail Khmelkov. 2021. "The global drone market: main development trends." *SHS Web Conf.* 129: 11004. https://doi.org/10.1051/shsconf/202112911004.
Khan, Maaz. 2023. *Top 10 Supply Chain Innovations*. (LinkedIn).
Koetsier, John. 2023. "Irish Drone Delivery Startup Expanding To U.S. And Mainland Europe" https://www.forbes.com/sites/johnkoetsier/2023/03/20/irish-drone-delivery-startup-expanding-to-us-and-mainland-europe/.
Konert, Anna, Jacek Smereka, and Lukasz Szarpak. 2019. "The Use of Drones in Emergency Medicine: Practical and Legal Aspects." *Emergency Medicine International* 2019: 3589792. https://doi.org/10.1155/2019/3589792. https://doi.org/10.1155/2019/3589792.
Kovach, Steve. 2013. "Amazon Experimenting With Drones That Will Deliver Packages In 30 Minutes." *Business Insider*, 2013. https://www.businessinsider.com/jeff-bezos-60-minutes-surprise-2013-12.
Lee, Dasom, David J. Hess, and Michiel A. Heldeweg. 2022. "Safety and privacy regulations for unmanned aerial vehicles: A multiple comparative analysis." *Technology in Society* 71: 102079. https://doi.org/https://doi.org/10.1016/j.techsoc.2022.102079. https://www.sciencedirect.com/science/article/pii/S0160791X22002202.
Lee, Thomas, Susan Mckeever, and Jane Courtney. 2021. "Flying Free: A Research Overview of Deep Learning in Drone Navigation Autonomy." *Drones* 5 (2): 52. https://www.mdpi.com/2504-446X/5/2/52.
Lim, Stanley Frederick W. T., Xin Jin, and Jagjit Srai. 2017. "Consumer-driven e-commerce: A literature review, design framework, and research agenda on last-mile logistics models." *International Journal of Physical Distribution & Logistics Management* Forthcoming. https://doi.org/10.1108/IJPDLM-02-2017-0081.
Ling, Geoffrey, and Nicole Draghic. 2019. "Aerial drones for blood delivery." *Transfusion* 59 (S2): 1608-1611. https://doi.org/https://doi.org/10.1111/trf.15195. https://onlinelibrary.wiley.com/doi/abs/10.1111/trf.15195.
Mangiaracina, Riccardo, Alessandro Perego, Arianna Seghezzi, and Angela Tumino. 2019. "Innovative solutions to increase last-mile delivery efficiency in B2C e-commerce: a literature review." *International Journal of Physical Distribution & Logistics Management* 49 (9): 901-920. https://doi.org/10.1108/IJPDLM-02-2019-0048. https://doi.org/10.1108/IJPDLM-02-2019-0048.
Matternet. 2023. https://www.mttr.net/.
Moshref-Javadi, Mohammad, and Matthias Winkenbach. 2021. "Applications and Research avenues for drone-based models in logistics: A classification and review." *Expert Systems with Applications* 177: 114854. https://doi.org/https://doi.org/10.1016/j.eswa.2021.114854. https://www.sciencedirect.com/science/article/pii/S0957417421002955.
O'Brien, Mike. 2023. "Walmart Envisions Drone Delivery for Millions." *Multi Channel Merchant*, 2023. https://multichannelmerchant.com/operations/walmart-envisions-drone-delivery-for-millions/.

Poland, Blake D. 1995. "Transcription Quality as an Aspect of Rigor in Qualitative Research." *Qualitative Inquiry* 1 (3): 290-310. https://doi.org/10.1177/107780049500100302. https://journals.sagepub.com/doi/abs/10.1177/107780049500100302.

Ramanathan, Ramakrishnan, Joseph George, and Usha Ramanathan. 2014. "The Role of Logistics in E-commerce Transactions: An Exploratory Study of Customer Feedback and Risk." In *Supply Chain Strategies, Issues and Models*, edited by Usha Ramanathan and Ramakrishnan Ramanathan, 221-233. London: Springer London.

ResearchGate. 2019. "Hybrid Drone" https://www.researchgate.net/profile/Ilyas-Uyanik/publication/331719966/figure/fig4/AS:850895348719621@1579880668625/Fixed-wing-hybrid-VTOL-drone-image-credit-UnmannedSystemsTechnologycom.jpg.

Ritchie, J. and Spencer, L. 1994. "Qualitative Data Analysis for Applied Policy Research." *Bryman, A. and Burgess, R., Eds., Anal. Qual. Data, Routledge*: 173-194. https://doi.org/https://doi.org/10.4324/9780203413081_chapter_9.

Singireddy, Shiva Ram Reddy, and Tugrul U. Daim. 2018. "Technology Roadmap: Drone Delivery – Amazon Prime Air." In *Infrastructure and Technology Management: Contributions from the Energy, Healthcare and Transportation Sectors*, edited by Tugrul U. Daim, Leong Chan and Judith Estep, 387-412. Cham: Springer International Publishing.

Slater, Daniel. 2023. "The Imperatives of Customer-Centric Innovation." *AWS* https://aws.amazon.com/executive-insights/content/the-imperatives-of-customer-centric-innovation/.

Sorooshian, Shahryar, Shila Khademi Sharifabad, Mehrdad Parsaee, and Ali Reza Afshari. 2022. "Toward a Modern Last-Mile Delivery: Consequences and Obstacles of Intelligent Technology." *Applied System Innovation* 5 (4): 82. https://www.mdpi.com/2571-5577/5/4/82.

Statista. 2022a. B2C E-Commerce.

---. 2022b. E-commerce worldwide - statistics & facts.

Streitfeld, David. 2023. "Look, Up in the Sky! It's a Can of Soup!" *The New York Times*, 2023. https://www.nytimes.com/2023/11/04/technology/amazon-drone-delivery.html.

Sudbury, Adrienne Welch, and E Bruce Hutchinson. 2016. "A cost analysis of amazon prime air (drone delivery)." *Journal for Economic Educators* 16 (1): 1-12.

Tarn, J. Michael, Muhammad A. Razi, H. Joseph Wen, and Angel A. Perez. 2003. "E-fulfillment: the strategy and operational requirements." *Logistics Information Management* 16 (5): 350-362. https://doi.org/10.1108/09576050310499345. https://doi.org/10.1108/09576050310499345.

Truxcargo. 2023. *Challenges in Last-Mile Delivery and their Solutions*. (LinkedIn). https://www.linkedin.com/pulse/challenges-last-mile-delivery-solutions-truxcargo.

UnmannedSystemsTechnology. 2023. "Single-rotor drone" https://www.unmannedsystemstechnology.com/2023/04/new-investment-funds-expanded-production-of-velos-v3-drone/.

Vakulenko, Yulia, Poja Shams, Daniel Hellström, and Klas Hjort. 2019. "Online retail experience and customer satisfaction: the mediating role of last mile delivery." *The International Review of Retail, Distribution and Consumer Research* 29 (3): 306-320. https://doi.org/10.1080/09593969.2019.1598466. https://doi.org/10.1080/09593969.2019.1598466.

Vanelslander, Thierry, Lieven Deketele, and Dennis Hove. 2013. "Commonly used e-commerce supply chains for fast moving consumer goods: comparison and suggestions for improvement." *International Journal of Logistics* 16. https://doi.org/10.1080/13675567.2013.813444.

Wang, Ying, Fu Jia, Tobias Schoenherr, Yu Gong, and Lujie Chen. 2020. "Cross-border e-commerce firms as supply chain integrators: The management of three flows." *Industrial Marketing Management* 89: 72-88. https://doi.org/https://doi.org/10.1016/j.indmarman.2019.09.004. https://www.sciencedirect.com/science/article/pii/S0019850118308642.

Wayt, Theo. 2023. "Amazon's No-Fly Zone: Drone Delivery Largely Grounded Despite Splashy Launch." *The Information*, 2023. https://www.theinformation.com/articles/amazons-no-fly-zone-drone-delivery-largely-grounded-despite-splashy-launch.

White, William. 2023. "Workhorse (WKHS) Stock Jumps on Drone Business Success." *Investor Place*, 2023. https://investorplace.com/2023/10/workhorse-wkhs-stock-jumps-on-drone-business-success/.

Wing. 2023. Accessed 21 Oct 2023. https://wing.com/partner/.

WSJ. 2017. "JD CEO: We Want to Have One Million Drones" https://www.wsj.com/video/jd-ceo-we-want-to-have-one-million-drones/322A4978-DC1E-4269-9734-6E0C246A2193.

Yasmeen, Rabia. 2023. "Why Investing in E-Commerce Development in Emerging Markets Matters." Euromonitor International

Yu, Ying, Xin Wang, Ray Y. Zhong, and George Q. Huang. 2016. "E-commerce Logistics in Supply Chain Management: Practice Perspective." *Procedia CIRP* 52: 179-185. https://doi.org/https://doi.org/10.1016/j.procir.2016.08.002. https://www.sciencedirect.com/science/article/pii/S2212827116308447.

Zennaro, Ilenia, Serena Finco, Martina Calzavara, and Alessandro Persona. 2022. "Implementing E-Commerce from Logistic Perspective: Literature Review and Methodological Framework." *Sustainability* 14 (2): 911. https://www.mdpi.com/2071-1050/14/2/911.

Zipline, September 18, 2023, 2023, "FAA Clears Way for Autonomous Aviation in the U.S.; Unlocks Major Drone Delivery Expansion with Zipline Decision," https://www.flyzipline.com/newsroom/news/announcements/faa-authorizes-zipline-to-fly-bvlos.

9. Appendix

9.1. List of Abbreviations

AI – Artificial Intelligence

B2B – Business to Business

B2C – Business to Consumer

BVLOS – Beyond Visual Line of Sight

CAGR – Compound Annual Growth Rate

C2B – Consumer to Business

C2C – Consumer to Consumer

FAA – Federal Aviation Administration

IoT – Internet of Things

ML – Machine Learning

NDA – Non-disclosure Agreement

RQ – Research Question

TAM – Technology Acceptance Model

UAV – Unmanned Aerial Vehicle

VTOL – Vertical Take-off and Landing

9.2. Classifications of UAVs

	Use Case	Advantage	Disadvantage	Visual
Fixed-Wing drones	• Large area mapping and surveying • Agriculture for crop monitoring • Wildlife monitoring	• Long range • Efficient coverage of large areas.	• Horizontal take-off (more space required), • Limited ability to hover or fly slowly	 Source: Defensebridge (2022)
Multirotor drones (e.g., Quadcopters, Hexacopters, Octocopters)	• Aerial photography and videography • Search and rescue operations • Inspection of infrastructure • Commercial delivery	• Vertical takeoff and landing • Hovering capability • Maneuverability in confined spaces • Light weight	• Limited payload capacity • Short range • Susceptible to external environmental conditions	 Source: Amazon (2022)
Single-rotor drones	• Military applications • Heavy payload transport • Aerial surveillance	• Can carry heavier payloads • Greater endurance compared to multirotors	• Complex mechanics and maintenance • Higher cost	 Source: UnmannedSystemsTechnology (2023)
Hybrid drones	• Surveillance and reconnaissance • Mapping and surveying • Inspections of infrastructure	• Combine the benefits of fixed-wing (efficiency) and multirotor (vertical takeoff/landing, hovering) drones • Versatility for different types of missions	• Increased complexity in design and operation • Potentially higher cost compared to specialized drones	 Source: ResearchGate (2019)
Nano-drones	• Indoor surveillance • Monitoring in confined spaces • Recreational flying in small areas	• Compact size for maneuvering in tight spaces • Often more affordable	• Limited payload capacity • Shorter flight times.	 Source: IlMioDrone (2022)

Table Appendix 1: UAV Classification

9.3. Business Case Analysis Findings

Section	Factor		Opportunities		Challenges	
Economical Dimension	Basic Economics	Consumer Demand	Growing demand for faster and more convenient delivery options	Customer Acceptance	Understanding and meeting customer needs, willingness to pay, and building trust.
		Market Innovation	Early adopters and genuinely innovative players can seize market success	Product Selection	Identifying goods with a speed benefit to customers that can be delivered given technological capabilities of drone
		Environmental Impact	Opportunity for companies to emphasize sustainability and environmental benefits	Technological Capabilities and Adaption	Dependence on the technical capabilities of drones and supply chain integration
		Market Forces	Competitors, Regulatory Frameworks, Technological Innovation and Integration		
	Financial Efficiency	Last-Mile Delivery	Addressing the most expensive part of the supply chain	Cost effectiveness	Reliancy on multiple revenue streams (commissions, fees, markups, subscriptions, advertising) to cover costs per flight
		Specialized Markets	Drones can provide cost-effective solutions for hard-to-reach areas, specialized, or urgent deliveries	Economies of Scale	Difficulty achieving the same economies of scale as traditional delivery methods
		Autonomy	No need to employing delivery personnel	Dependency on high investments	Makes reaching ROI difficult and high reliance on external funds for scaling drone delivery operations
Technological Dimension	Autonomy	Mission control functions	Enhancement of operational effectiveness, especially during in-flight operations.	Human intervention	Human intervention is often required for loading packages onto drones or real-time adaptions/ interventions
		Static delivery points	Allows for precise and efficient delivery, meeting customer expectations.	Route planning	Technical challenges in route planning, particularly in regions with unique obstacles.
				Dynamic delivery points	Operationally challenging to accommodate customer-specified drop off locations
				Regulatory Frameworks	The level of autonomy varies based on compliance with local regulatory frameworks.
	Technological Enablers	Autonomous Decision-Making	Integration of AI and quantum computing automates pricing, addresses weather fluctuations, and enhances customer preferences.	Integration Complexity	Integrating AI, quantum computing, IoT, and 5G into drone systems requires complex technological integration.
		Seamless Communication	IoT technologies enable real-time data transmission, ensuring swift adaptation to changing conditions for secure deliveries. 5G connectivity facilitates seamless communication between drones and ground control systems.	Costs	Investment in advanced technologies may pose financial challenges for some businesses.
		Navigation	Advanced satellite imagery and geographical information systems enhance drone navigation in complex terrains and urban environments.	Security Concerns	Ensuring the security of communication systems and protecting sensitive data transmitted between drones and ground control.
				Regulatory Compliance	Adapting to and complying with regulations related to the use of advanced technologies in drone operations.
Operational Dimension	Operational Integration	Supporting infrastructure	Through integration into existing operations, companies can scale and implement such an offering at a much higher capacity	Complexity of Supply Chain Integration	Costs and challenges associated with adapting operations to the existing supply chain.
		Collaboration with technological partners	leverage established expertise and resources for scalable and efficient operations	Drop-off procedure	Complexity of choices between central delivery hubs, direct home delivery, or designated drop-off areas, especially in urban areas.
	Regulation	BVLOS operations	Approval of BVLOS operations serve as catalyst for market growth	Value Proposition Alignment	Delivering value propositions that align with regulatory requirements to gain approval.
				Country-Specific Regulations	Dealing with country-specific regulations that determine and limit global expansion.
				Air Traffic Management	Regulatory emphasis on air traffic management and societal readiness for drone deployment.

Table Appendix 2: Business Case Analysis – Results

9.4.Interview Transcripts

Free online services were used to transcribe the interviews, but it is important to note that the quality of the transcript may be affected by the use of these tools. Depending on the video conference tool, the meeting was transcribed in full or as a summarized condensed version.

9.4.1. **DHL: Frank Steinbrenner**

Transcript (full-length interview)

Interview with Frank Steinbrenner (Head of Subordinate DHL, Mannheim)

16.10.2023

Start of interview

Check of ethical considerations and greetings

Interviewer:

We have prepared a few questions, but you can start first and then we'll see what you're covering. But feel free to talk first.

FS:

I'm just going to go in. I'll put it this way, at Deutsche Post DHL, you want to be innovative when trying things, but until today, the result has certainly come, I'll say, the topic of cost-mass-business. So, if I think for you, in the German market, that's an interesting market, because we are a growing market. So, we have a market share of 45% Number 2 is now Amazon It's quite exciting, Amazon is our biggest customer with the Chinese together So Amazon and the Chinese, and Amazon is our biggest competitor, now even more than GLS, DPD, Hermes. You have to imagine that we alone from DHL supply 5 million parcels daily. And then comes the thought, I say it like this, in the urban area we supply daily, and in the urban area, that's great for us, a classic parcel supplier has a parcel carriage of 200 parcels, during a day, then maybe has 100 stops for the 200 packages. Because stop means he

sometimes gets several packages, be it with a private customer or with a business customer. And that is really the idea of this cost situation. These are the classic economies of scale that we have, because we simply export massively in mass business. And that's why, if you look at the costs, you think, yes, you could be, you see it in the beginnings, I'm sure the first consideration, as it was with the island of Juist, mountain regions. For example, we have a postman on the train station every day. Things like that, or islands, that's the first step, the far away, because that's more expensive for us. Because the mail carriers on the flat land don't earn as much money as in the city. That's why all the considerations that may come in the next 10, 20 years, I think, will go more in that direction. Not only, you have to think about whether you only take packages or whether you also have important documents. That would definitely be an approach. Important documents, that you actually transport them on islands. So in addition to the cost argument, where you have economies of scale, which I can hardly imagine how you can of course also check things like that in your master's thesis. Of course, you have to regulate the air traffic. That would also be a way to go in there and check. If we act as Amazon or DHL now, you have to imagine it in an exaggerated way, we have 5 million parcels a day, a market share of 45 percent, I'm not a part of 50% of the 12 million packages daily. It's exaggerated. Do you want to see 12 million drones every day in the sky? And that's why I'm sure for the entry, I think there will be something. I'll come back later with a thought that may also have a certain charm. With my entry, it won't be 12 million. And we will never, if we are at once in one recipient, it's more grotesque. Even if you imagine a drone, which maybe can take 20 packages, I don't know. So check out the air traffic, what's going on there. We're getting more and more of this ISG topic, sustainability. You may have noticed that with us, we have already in my report, so from us, I would say, 900 vehicles, we already have half with eco-fuel. So the topic of sustainability may also have a charm, which develops a dynamic because sustainability is, as a company you have to bring it. And I also notice that with us, I'm not sure I'm so much

to say bring a unique America by once the cool To fix me on the outside. I think I if a carbon saver is the other company the other side this is to reach out I'm going to be honest with you. Do you know the packing stations?

Interviewer:

Yes.

FS:

That's a patent of ours, it's just a little bit of politics. Amazon has the packing stations too, they are the only ones next to us. And we tolerated that. Actually, we could go against them without a doubt, because the patent is still in effect. But we tolerated that because Amazon is also an important customer of ours. So we now have about 13,000 packaging stations. And what is definitely... I say, you have to think about it, if that would be something. So I think that's quite charming. Then the drone would only be in the possession of the German Post DHL. So with the packing stations you can give packages or parcels. Some don't know that and let you do it. So, this thing is booming without end, because there are so many young people like you or people who go to work, they just think it's cool. We have some stations, huge packing stations, because people just say, cool, I can give out packages and I can pick up packages. And that would be a use, where you could think about it. It would be theoretically feasible to say that would be a package that is given up in the pack station. You could theoretically see if it doesn't work. For example, it's not just such a fan. If not, some system would be conceivable. Now I'm trying to be a visionary, but I'm not sure I'm doing it. If a drone reads the address, that somehow blocks up from the packing station, drone, and the drone flies to another packing station. So this packing station, that would be the beginning, that you say from customer to customer, from packing station to packing station. These are usually the customers who are a bit smarter, who

go along with these first changes. That was what I thought. So if you get more into the topic and say, man, the drones are getting cheaper, the air traffic will be regulated at some point. I think the first step will really be the classic mountains, remote areas, where you have to look at the other hand, now I'm sending a drone to a customer. How does the drone fly back? Do they fly back automatically. So you have to think about how that works. And as I said, the pack station, that might even have a real charm about it. Especially as we think of drones as an extension to our network, and not replacing it. So if we had thought about it in advance, what could possibly happen in the next time? That might be something, because then the drones would be completely with us. And I wouldn't have to deal with private customers. And let's say, at least 13,000 pack stations. And if there is a lot of traffic between the pack stations, that would really be from one pack station to the next. Could perhaps be conceivable for you as an idea?

Interviewer:

Yes, no, it's definitely an interesting approach. We tried to think about it a bit visionary, but we haven't thought about that yet. So thank you very much for that, it's definitely a good idea.

I'm just looking at what you've covered so far, especially the questions we had. because you also talked about this test phase in the e-mail that you wrote to Annelie. It would be very interesting if you could tell us if you know what factors were there that led to the closure of this test phase or that it was not carried on?

FS:

So it's going a little bit in the direction. You want to be innovative, but it was..., I would speculate on that. So that would be something. Now I'll say something, because, as I said, I

have now pulled out this info, for example, I called my press speaker. And then he gave me the things. So I'll note it down. We could talk a little bit, maybe I'll get something from us. But I, as I said, you have to imagine it that way. We are a huge store with us with 180,000 employees and 140 employees. I am now one of 40 employees. I'm not the one who buys e-cars. I use the e-cars where the central one has the strategy. Hey, I want to do something with e-cars now.

Interviewer:
I have another question. You said at the beginning that the idea was to make delivery to islands.

FS:
Yes, exactly.

Interviewer:
I don't know if you heard about it, but is it also a vision now actually day-to-day package now how you imagine to deliver it to the gardens of the customers ?

FS:
So I think that we will slowly begin with individual customers. So maybe for you too, we already have customer relations to the recipient customer, not to a deposit contract. That means, a customer tells me at Deutsche Post, that our supplier documents with signature, he has handed over the package safely. At Amazon, it is sometimes photographed. But we still do it like this, that we make so-called deposit contracts, that a customer says, listen, I'm often not home, but I want you to give it to me, put it in the garage. And there is a contract and it is documented in our hand scanner. I can deliver it there. So if we go further and I say we have innovative customers who may come to us and are active and customers say. Hey, I have a possibility here

on the balcony that's my landing site, I want to have my package there, and it is important to offer such a service. It is also difficult to let customers decide the drop-off point. Especially because the environment changes, one day the car is there, the other it isn't. So if it is a driveway or balcony, it is very difficult for the drones. That's conceivable. I always say I'm always hanging on the mass of 5 million in the growth market. So you have to imagine it like this, we have to think about it, we are in such a supply base where maybe 6,000 packages are being supplied to me this morning. That is exactly the question now, where do we decide then? The customer's agent would have to decide, now I'm sending it via drone. Yes, it is like that, who controls innovations? Is it the entrepreneur or is it the customer? If a dynamic would develop there, so the guys who are already taking pictures with their drones or whatever, and I say, hey, why can't you do that to me? In my catering business, you bring service and I have to cater for two years. So as I said, we already have an innovative attitude.

Interviewer:

Yes, definitely. If you're talking a little bit about customers did you notice anything during the test phase, how customers have received it from you? How it arrived in general? How did you guys approach this?

FS:

Well, in my opinion, the thing with Juist was a kind of apothecary. It's always complicated, the handling, the cost situation. They are a bit far behind. You can see the development. I don't want to make you worry. We didn't do anything with it last year. It was something from China, which is far away, where they tried something. It's always a question of cost and innovation. I think with Troisdorf we are on the right track.

In the end, we were maybe a little more risk-averse in the next ten years. We say we want innovation, but after a certain time I have to expect innovation. And if we don't make money with it, just because we say, nice to have a few press articles, then we don't do it. And that's how I appreciate our board of directors and our bosses up there, who also do it so well. We do what we earn money with and after a certain time we have to earn money with it. I think that's the biggest bottleneck. Although I can hardly assess the regulation of the planes. But I think that's the biggest bottleneck, that you want to make money in a tough competition.

Interviewer:

Yes, it makes total sense. That's the biggest problem we found out so far. That currently no one can do it, but the big players put massive money in it. And then probably the first to be. That's why it's interesting that DHL is currently in a standstill in Germany. But we also had the assumption that it is a marketing thing for many.

FS:

It just has to be proven to you. I have the idea, I have read it for over 30 years. It's like this, for example, we are, like we talk about others, for example. At Amazon we say, the clever ones, they were a long time ago, just before the day, what they do all green, so classic greenwashing or Hermes. and we say, now you have to admit a car. How many vehicles are really in your e-cars and how many not? There is of course also a fight and there is always the question of what you actually do and what you do only. And that's just every car is a G-strategy. And I say even the, now you have to be careful, I say even the company Hermes, who treat their people in some painful conditions. Even they leave and have to sell somehow. You have to swim with them in this thing. And maybe they are too solid in some areas that you say, we don't want to

do anything big there. But that's a bit of speculation again. But I think it's good that he gets as close as possible to Troisdorf. Because they are the heads that have the most in our direction.

Interviewer:

We've talked about a lot of things now. You were able to answer a lot of our questions like that. So really nice, thank you. That really helped to get some industry insight.

End of Interview

9.4.2. **Manna Drones: Michael Cunningham**

Transcript (condensed)

Michael Cunningham (Head of Commercial, Manna Drones)

19.10.2023

Start of interview

Check of ethical considerations and greetings

Interviewer:

Perfect, lets kick it of then. Could you explain the underlying rationale that made Manna Drones to strategically concentrate its drone delivery efforts specifically on perishable goods?

MC:

Sure thing. We noticed a big issue with hot food deliveries, it was arriving cold. And, you know, the whole rush-hour traffic situation from 5 to 8 pm was making it worse, especially in the suburbs. So, we decided to go for quick 3-minute deliveries, no matter the time.

Interviewer:

Makes sense. Is Manna Drones thinking about jumping into regular parcel delivery and getting into the broader e-commerce game? And how do the challenges for delivering regular stuff compare to perishable goods?

MC:

Absolutely, we're thinking about it. Non-perishable goods are on our radar because they're way easier to handle, especially when things calm down during off-peak hours. It's all about avoiding the congestion we face with perishable deliveries.

Interviewer:

Interesting, How's the public feeling about autonomous drone deliveries, especially with Manna Drones leading the change?

MC:

Oh, it's been great! Our surveys show over 90% of folks are totally down to use our services. We've hit up a 40% market share, and our Net Promoter Score is a solid 84. People are loving it.

Interviewer:

Impressive stats. We have another question for the domain of last-mile drone delivery, what are the pivotal operational considerations that Manna Drones prioritizes to ensure an optimal level of efficiency and seamlessness? And what is the current degree of human involvement?

MC:

It's a multi-faceted operational structure. Currently, we require human loaders to facilitate the loading process of the drones. One loader is adept at handling approximately four drones simultaneously. At the same time, other important roles like as mission control, dispatch, and customer service, operate in a centralized fashion, reflecting a strategic division of labor within our operational framework. But it is also worth noting that we always still need humans to oversee the entire operation, especially for the case of unexpected events that might require human intervention.

Interviewer:

Got it. Could you break down Manna Drones' business model all about? Spekaing of key revenue streams, strategies ensuring profitability on a per-use basis, and overarching operational methodologies?

MC:

A cornerstone of our business model lies in the optimization of aircraft utilization. Currently, our primary revenue streams comprise a commission derived from partner restaurants, a delivery fee imposed on the end customer, and a markup applied to our proprietary products stored at the base, including items such as coffee, drinks, and ice cream. We envision diversification in the future, introducing additional revenue streams such as a subscription model and advertising initiatives.

Interviewer:

What have been, or persist as, the primary challenges confronting Manna Drones in the application of drone delivery technology for its services?

MC:

Predominantly, regulatory challenges have proven to be a substantial impediment, particularly in countries such as the UK and the USA. Additionally, a notable challenge on the horizon pertains to securing the necessary funds to facilitate our envisioned scale-up endeavors.

Interviewer:

When contemplating expansion into new markets, what specific local factors does Manna Drones take into consideration, and how do these factors significantly influence the strategic decision-making process?

MC:

Excellent point. When expanding, our primary focal point is the regulatory landscape of the prospective market. Additionally, factors such as market size, housing density, climate considerations (with a current prioritization against extremely cold or hot regions), and the prevalence of food delivery trends all weigh into our strategic considerations. It's a meticulous evaluation, ensuring that each market's unique nuances are thoroughly considered in our expansion strategy.

9.4.3. **Amazon: Nathalie Steinmaurer**

Transcript (full-length interview)

Interview with Nathalie Steinmaurer (Head of AVS FMCG – Amazon)

25.10.2023

Start of interview

Check of ethical considerations and greetings

Interviewer:

Yes. Because quick background on kind of what we specialize in or what our kind of research question is or what we're looking at. So our overall topic is technology innovation with our professor and we look at innovation in B2C logistics per se. And within that we mostly focus on last-mile delivery or what at least is important for us now because you know most expensive time consuming part. And look at the biggest customer impact. Exactly, exactly. And then we kind of looked at what's happening there, how can you innovate, how can you increase efficiency, and within that part we focus on drone technologies.

NS:

Okay.

Interviewer:

Exactly. So then we kind of looked at what's happening, what has been done in the past years, months. A lot actually has happened, but we don't, we're not just focusing on Amazon, we're looking at the whole industry.

NS:

Yeah, yeah, everywhere, I understand. And I think a lot of companies, and I think different parts of the world might be more ready for it than others, right?

Interviewer:

And that's kind of where I was hitting, because, for example, healthcare, they're actually quite ready for it, and there is companies like Zipline, I don't know if you've heard of them, mostly operating in Africa, and they're distributing medical goods whatsoever all across basically where they're needed so they're not just operating in Africa because the use case there is given you know the pharmaceutical products are low-wage they're very expensive so they're really justify you know having a drone flying out there so that makes sense. So let's say...

NS:

And infrastructure are also very complicated. So the speed of delivery, which is a big topic.

Interviewer:

And very important there as well.

NS:

And the dedication is always timely. I think there is an economics question. I think the big challenge if you look and if you compare, not even drone delivery, but what they call the quick covers, right? So all of those old and gorilla and those guys, right? Who are kind of really focused on that last-mile, fast delivery, smaller choice, not. The economics don't always add up. Exactly. Right? I think it's the biggest challenge there. I think we are from a business standpoint, fully ready to scale, right? We scale as a living, right? This is what we do. But I still think there is an economics about, I don't know, do customers really need all that with that

kind of speed? And are they willing to pay for the cost, right? Because obviously it's a one-man drone, right? Like you do a parcel thing where parcel A goes to this place. I don't know if it's effectively possible, but that's the only way you would reduce the cost. So I it's very challenging.

Interviewer:

Yeah. That's also kind of our status quo, let's say, for what has been researched and so on already. That the use case is a bit questionable overall in e-commerce. I don't need my book within 30 minutes. One day delivery is great. And if I really need it urgently, most people live in cities anyway, you can also go out to your local... If it's that urgent, why pay extra?

NS:

Yeah, you're leaving the middle of Siberia where you're going to freeze yourself off going out to buy.

Interviewer:

Exactly. Exactly, and that use case is also out, at least for e-commerce, because it's again even less economically feasible, viable whatsoever to fly that far out, because then you need whole different type of drones than the drones that fly like 20 kilometers. So it's really short in distance, specific types of products, specific types of customers as well.

NS:

That is a big thing, the economic viability.

Interviewer:

Kind of question we try to figure out now is A, what factors, or are we looking at different factors that kind of just have to be given in order for that to make sense? Also, at one point economically, sure, back in the days people said with e-commerce you can't make money never I mean look at Amazon now

NS:

You know so at one point sure I think I don't believe it's a hoax the whole thing I just think right now. It's it doesn't make sense as people wanted to make sense yet Also, I think that's why kilos of rice over drones, not really. But as you said earlier in the case of medicine and the content of what to deliver, right, I think there is a potential.

Interviewer:

And that's also interesting that you said that you're in healthcare because I was going to ask kind of what selection you would think would make sense or what the customers want to see being able to deliver by drone. And do you think like, especially people that shop, you know, any pharmaceutical products, whatsoever, I don't know what the top sellers in healthcare are. Would, is the willingness to pay there from customers in your opinion, or what do you say?

NS:

So I believe it depends. So obviously, even though we do healthcare, we only do real healthcare in the UK, right? Because this legislation in, in mainland Europe is really complicated. So you cannot do half of the medication. In the UK we sell quite a lot of proper medicine, in the rest of Europe it's not happening. In the US it's a big topic as well, because we've opened kind of the, I don't know how it's called, Amazon Pharmacy, I imagine, I forgot the name.

So for those type of things that have a time sensitive element, I could imagine that that would work. So in the health and personal care, a lot of it is nutrition products. They are like shelf life products. I don't think that would make so much sense or CBD oil is a big topic, those type of things. I don't imagine there is such a need, like you run out, right? It's not like in the past where I ran out of cigarettes so quickly, I don't think people run out in the same way. And also I think what is the time saving element that customer would be willing to pay for that extra, right? I could imagine for some customer group that might make sense, I would imagine parents of a newborn that needs something quite urgently for the baby or something, you know, like you run out of paracetamol for the baby, the baby has a fever without having to get out of the house, you could do that. Or elderly people who are physically not able to get to the shop or customer that would be disabled, for example, or with chronic illness, like, you know, I think there are maybe some customer group as opposed to product per se. You know, I would maybe take more the angle of what customer needs is fixing as opposed to products. From a product standpoint, I think there's a big element of the weight, yeah, because I imagine anything that's bulky would be out, even though the first thing that came to my mind was nappy, right? To run out of nappy.

Interviewer:

If that's an emergency for sure I can imagine.

NS:

You know, like even though how much people really run out of nappy, I don't know. I personally never did. But for those type of things.

And I think also there might be different attitudes towards this, we are seeing more and more the kind of consciousness of customer rights. You've seen we've launched a lot of programs to

reduce packaging, for example, right? So we now have that project where products are delivering their original packaging without being wrapped with Amazon products, like Amazon Cardboard or anything, we stop all plastic. And so I think there is maybe an element there as well of the barrier will be that at the moment the world is a bit on fire. And so people are going to say, do we really need drones to come and pollute in a way, right? So that I see as a very, very big topic on top of customer mind at the moment.

Interviewer:

But do you think it would make a difference then to kind of market the whole drone technology delivery also as a more sustainable choice, because it is more sustainable than delivering via truck in general.

NS:

Yeah. I think anything today that helps customers realize that there is a benefit from an ecological or sustainability standpoint always works. You will always have the customer that are like, oh, of course, we don't need that. We need to go back and grow our own fruits and veg in the garden, right? Like, there are all customers on the spectrum, and yes, I believe to be able to demonstrate, even though there is also a lot of work being done on moving to electrical vehicle, this type of things. Yeah, so I think that that will do. I think the other thing is, what proposition do you have for customer? Is it something, an additional, so you can have it delivered with Prime, super quickly, not so Prime, and then sort of slower, and then like, you were fast, you have the drone delivery. Is it something like you would imagine, like a subscribe and save program, where a certain number of select customer, pay a premium to have access to have that service on a selection of products that are available for them. It's all that economic model of saying, do you make that part of the prime offer for us, for example? Is it something

that customers would want as part of the, I have one need and as a one-off, I'm going to do the drone delivery. How do you educate customer about what it means? So I live in a high rise, I have no balcony. Where on earth is this going to be delivered, right? Because it's always the challenge of, oh, my driver didn't leave the parcel where I said it should be delivered. You've left it in the wrong balcony. So I think there is a big element of customer education as well, and customer feasibility. Are all customer able to receive these? How do you assess who are the customer? Because for us, like if I would think, and obviously I'm thinking from an Amazon standpoint, right? But if I would be Amazon, can I deliver every customer with drone? Maybe not, but how do you, you know, do you need a questionnaire for, and determine a certain number of factors that the customer needs to have. So me, I have a garden, you know, so it's not a problem. The drone can access and leave it in front of my door. But if I live in a high rise, I don't know, in a region of high highs or something like this, it's a little complicated, right? So is there a questionnaire you need your customer to fill in to be able to evaluate who could be a candidate? And then how do you manage the expectation, right? If people want it and you can't do it, it creates a lot of frustration for customer.

Interviewer:

That is actually also, in general, super interesting because there's a massive, that's the thing, you know, it's a global solution, but scaling it locally is super difficult, especially because I mean, in general, you can say that the countries within Europe are similar in that sense, the topography and stuff, but you know, in comparison to the States, for example, the suburbs, they have space. So totally different. But even though I would say also the attitude in Europe might be different. I can't imagine that really working out in Germany, for example.

NS:

The data privacy, the need to have a camera to figure out where they land. This is going to be a revolution. Where I think in other countries might be a bit less. It depends also how safe the place is, but it's as safe as dropping a parcel when you have a, you know, and how the customer proves that they've received, right? Because sometimes the driver is clicking and saying, yeah, it's been delivered, but how do you do that with a drone?

Interviewer:

And generally, I don't know if you have an opinion on that or know anything about that, but what is kind of your impression on the future trends. Again, it doesn't need to be specifically Prime Air now, but would be also interesting to kind of see it from an Amazon perspective to see what the future trend with that technology is. How would Amazon leverage that? Would it make sense? How big will this be scaled whatsoever? Because currently, massive investments going on for 11 years, I think.10 years, 11 years, yeah. And no results really. I mean, they tested it and stuff like that. I think last month there were 100, or in May, 100 deliveries in total, so nothing. No scale. In that type of time. But I would imagine that if Amazon does the scaling, I think they might identify a set of market where it makes sense, right?

NS:

So there's a test being conducted, but we've just announced we're opening South Africa. Yeah, so Amazon is opening in South Africa in 2024. My main door is there, opening Amazon there. And, you know, I think what is interesting is understanding, right? Is there a specific marketplaces where that would make sense because it makes sense from a customer standpoint. You know, like it's the same if you look at digital payment, China, Africa, a lot of parts, they do everything through mobile phone where some parts in Europe are not, yeah? And so I imagine there is a question of where to test, what to test it with, and I think having different

hypotheses of things you test. I would say we as Amazon never care about how long an investment is going to pay off if we build it well. Yeah, we've always done that, you know, Amazon Germany just celebrated 25 years. You know, if people would have said 25 years ago that we would be where we are, I don't think it would have worked. So I think there is really a question of what kind of a customer proposition is there and what needs does it answer and how does the technology then enable. Technology is always an enabler to do something that is good for customer. If the customer either don't want it, don't see it, then I think it's different. But if you start and you work backward for customer, I think there will be a need. But maybe not in all the country the same way, not across all the products the same way. There are parameters that would need to be evaluated, right? The thing, how heavy can a drone be in the future, if I make an order with five or six products, is it a multi-product possibility? Because that means you need to have the warehouse set up in the way, because today your parcel might be delivered from four or five, you know, you make one order, it might be delivered from different warehouses. If you do the drone, it would mean one pick-up point. This also ties into the integration of the existing supply chain network we have here at Amazon, its huge, really huge. This is a huge advantage for our operation with drones, we can scale at much much bigger capacity than other companies, making this a factor to be on the lookout for.

Interviewer:

That the whole logistical integration into the existing systems is also a massive, massive part. And personally, we don't focus on it but you showcase like how is that going to be possible with a new technology like that.

NS:

But I think the question is really location right? I know Portugal for example is super early adopter of new technology and they've always been for whatever reason right like some of those things. So I would also focus on what are the parameters that would facilitate this scaling, right? So there is obviously the regulatory framework about are you allowed to have cracks lying around in the city, you know? How do you do with countries where kind of electric line are still out, yeah? Because some parts of Italy, some parts of France, the electricity cable are not working. So it's an absolute maze. So I would look at that, right? What are the regulatory framework when it's even possible? Is there anything today that define the condition in which products have to be delivered? Yeah, obviously if it's medication, it means there might be a temperature component. There might be some of that. I would also look at customer willingness to try new things and funny enough, they're not all the same. I'm not surprised that the Irish are trying that, right? Because Ireland, in my experience, I worked in Northern Ireland for a while for projects and they were very open, very, very open to try new things. So I think there's an element of, can you do it? Do the customer want it? And is it effectively doable, right? Because again, as you say, if you deliver within Munich city center, I mean, Amazon Fresh doesn't even deliver to me in Switzerland, right? And I'm like 20 minutes from the city center. So, you know, what's the radius that you can serve, because then that also impacts your ability, I think, to make it economically viable.

Interviewer:

And do you think, because for example, the company that I told you about in Dublin, for example, that delivers these perishable goods, they have a very strong position on that e-commerce, especially they always focus on Amazon, that that is not happening, that it does not make sense. Sure, maybe it's their marketing, they want to showcase themselves in a better light, but do you think that, especially in e-commerce, only a company like Amazon, you know,

with the funds in the background, is it possible to tackle such a big challenge rather than, you know, having the given use case? Or do you think also like smaller startups?

NS:

The challenge always goes back to selection. Right? If you are advertising yourself, how big of a selection can you even offer? And it's true that obviously, you know us, right? Selection for us is about everything. So if you say, okay, I'm gonna take 10% of the selection of healthcare products, let's say, if the customer are not, and again, you can refine and say, okay, we're gonna evaluate what products, I think smaller firm will have, because they will not be competitive on price. We see that even with Amazon Fresh, yeah? When you go talking to a Coca-Cola, even when you're Amazon, they laugh, right? Because Coca-Cola, they prefer to work with the Rewe or Lidl, you know? Because the volumes are there. I think that's the biggest challenge, I think, a partnership with a company that could do the technology, but Amazon generally don't. Amazon generally do in-house, but I could imagine, right, if I would be a technology company that would be providing such a service, having a partnership with a Reve, a Neleca, whoever, right, and some of the big guys who have the volume and the price and the products, right? So you don't have to build warehouse from scratch. You don't have, because this is the problem, right? It's all the scale at which you can do it. Yes, of course, you can do one warehouse and you have like, I don't know, 50 drones and you do a bit here or there. But if you want to do something very like scalable, all the scalable part needs to be there. And you need to be able to sustain, I think a long time before, because it's not gonna be adopted.

Oh yeah, now I do all my shopping with a drone. Yeah, I don't imagine it's gonna be. And the customer education will require a large amount of time. And I think you need to have a position of trust. You know, I'm a random company A, and I'm coming in and I'm going to tell you how

to do drone holder. Yeah, some customer will be willing to try, but I imagine quite a few will be like, oh my god, is that a scam?

Interviewer:

That is very true. That is also, I guess, why Amazon can do it the way they are doing it, in a way of being the drone technology provider and the goods provider. Because, for example, Wing is a drone company from Alphabet. They're for example just partnering with companies like Walmart or DoorDash or whatsoever.

NS:

And they're just doing the technical drone delivery aspect. And then you know, it's like a Gorillaz or whatsoever, but it's a drone and Gorillaz in that sense is a wing. So I mean, my opinion, my biased subjective opinion, only really Amazon could pull that off now because, you know, at this stage. Yeah, I think it depends on the country, Ramin. I think it depends on the country.

I mean, I'm an Amazonian. I'm an Amazonian, I can do anything. This is what I've been fed for the last three and a half years, right? But I think it requires a lot of different components, right? So it's not just about developing that technology. Because if you think about it, there is a lot of application you can have elsewhere, right? I'm a hospital, I need to have blood transported, I have a shortening, like there's a lot of other things. But in the context of e-commerce, obviously, the later entrant, and you can see, right, if you look at something like Knusper, for example, who is doing really well in Germany, right, is that, you know, those type of a big niche, they do the product from the farm and they do the standard kind of everyday shopping essential, then you can add that value, that value add, right? The reality is for Amazon at the same time, we're all about speed and everything we do is focusing on the speed of

delivery. Will it be any faster than ordering from yesterday and getting it today. Yeah, what comes, what proportion of the selection effectively has a speed benefit?

You know, and it all comes back to that, even though you could say in the past, people were very happy, I mean, I placed an order, at Decathlon the other day, it took almost two weeks to arrive. I was appalled, I was like, I love the product, so that's why I put a shop there. But they closed the shop near us, so we have to order online. But you know, those type of things, yes, in the past, that was normal. Right? Today, it's not acceptable anymore. Today, it's like, I was really pissed. So I think there is that element what proportion of that will become a bit more mainstream. Realistically, it will not be mainstream with everybody. Especially if you consider at the moment the cost of living crisis, right? The increasing cost like in the UK even more than in the rest of Europe. Is that a must or is that a, I don't know, you know, like you buy a new fancy car and you're like, yeah, I'm showing off, right? I'm having a drone delivery. And for me, this remains the biggest barrier to this. And that's why when I look at those guys, those gorillas, I've been approached a lot in the last year or so to go work with those guys. And I'm like, I don't believe in the model. I absolutely don't believe that it's, you know, and the other thing that I would say though, is if you think about specific, so I'm thinking about Zoopla, you know, the pet company, right? So some pet owner are crazy, yeah? They would go to, you know?

And so if you have a customer group that had, and they love their animals, and I don't know, they have cats, and they have, then you could imagine that people would be willing to pay a premium, right? They buy clothes for their dogs, right? So at some point, it's already crazy. So if you have some customer group that has specific needs like this, you could say hey actually yes you know I could imagine for product like my daughter comes home and she has life I don't know how you say in English you know like the little things that you know I mean I don't know

I think it's like obviously I need to buy a thing so me I have the thing at home because I'm prepared but you receive a message from school, your kids come home, they're scratching, of course you want the thing in an hour. But those things I think are more exception versus the norm. And the reality is how do people shop? Even me, I don't shop my groceries on Amazon. I shouldn't be saying that, but I don't shop on Amazon because I don't find the value proposition very easy. Me, I prefer to do my one weekly shop. I do everything that I need and everything comes together at one time. If you have to have a drone delivery, you want 10 products, does it mean what, 10 drone delivery? does it mean what, 10 drone delivery? To five pounds or something per delivery. And you know, groceries can get heavy, so I don't think groceries is the good use of case. I think the healthcare part, I think, makes a lot of sense, right? Someone is, let's say we're back in COVID time, right? If you would have another pandemic, how do you deliver medication to people without having to have someone taking the risk, you know, in the case of something quite contagious. Those type of use cases, yes, definitely. But otherwise, I think there is still more to be done on the economics model. I think the technology is there. What is refined enough to be able to make it work, I still think there is a customer proposition question. Yeah, it's gonna be super interesting to see how that is going to evolve or how is it evolving and how is it developing. I'm very curious to see. And you never know, right? My husband wrote a thesis in his university time about pods in airports to be able to sleep and to work, right? I remember what maybe 10 years ago we went into whatever airport and he's like, oh wow, they have pods now. Right? And I think some of those things, I think that's the thing when the technology is there, I think it works. You know? But... Interesting. Maybe in 10 years, I'll be walking around and be like, oh wow, they do have these drones. They do have drones.

Interviewer:

Thank you for your insights.

NS:

For me it always, look at the flywheel, right? If you want to look at the parameter, look at the flywheel and look at every single component of the flywheel and you will see where is it blocking, yeah? Because you need enough selection for customer to be able to find, you need to have enough volume to bring the cost of doing this down. And if the fly, and we know that even when the flywheel fly it doesn't always fly, yeah? Because the cost doesn't always reduce proportionally, right? I still think the cost of delivery compared to a tradition, because that's the competition. Traditional delivery versus what's the benefit for what cost. If it costs three times more, will the customer be willing to pay? I think in, yeah, to try out for fun.

End of Interview

9.4.4. **Connect Robotics: Ana Manuel Almeida Martins**

Transcript (condensed)

Interview with Ana Manuel Almeida Martins (Executive Management Assistant / Business Developer)

27.10.2023

Start of interview

Check of ethical considerations and greetings

Interviewer:

Alright, let get started. Could you elaborate on the factors that led Connect Robotics to foccuus specifically on the delivery of medical goods within the expansive realm of drone technology?

AM:

Certainly. The motivation behind our strategic focus on medical goods delivery emerged from the notable traction observed in the market and the distinctive niche it represents. This niche is characterized by an imperative need for expeditious, contactless responses, particularly in areas with challenging access, be it the rural expanses or urban and suburban locales grappling with high density, population, and the perennial issue of traffic, all of which inevitably culminate in deleterious delays, thereby impacting not only time but also financial resources and, most significantly, human lives.

Interviewer:

Interesting. When looking into the future, does Connect Robotics harbor strategic visions of integrating drone deliveries for general parcels, thereby potentially venturing into the expansive domain of e-commerce delivery services?

AM:

Yes, our overarching goal is to democratize the utilization of drone delivery, rendering it accessible to a number of businesses. While our current focal point remains on the health market, it's pivotal to underscore that our modus operandi is not exclusively tethered to this sector. Rather, our fundamental purpose lies in meeting the exigent demands for safe, swift, and autonomous deliveries, not confined solely to the health sector but encompassing a broader spectrum of destinations, both urban and those arduously hard to reach.

Interviewer:

What distinctions or unique challenges does Connect Robotics grapple with when contemplating the deployment of drone deliveries for general parcels as opposed to the more specialized field of medical goods?

AM:

The core technology, at its essence, remains consistent across these diverse applications. It is, therefore, more apt to conceptualize the challenges in terms of the inherent value proposition. We possess the nimbleness to seamlessly adapt our software to harmonize with a number of hardware options available in the market, meticulously aligning with the idiosyncratic needs of our esteemed clients. The challenges, therefore, are contingent upon the nuanced specifications of each business, the difficulties of the landing scenarios (precision paramount, albeit distinct when grounding or employing the innovative drop-in-a-basket technique), and, significantly, the extant regulations governing each sector. For example, urban environments have different regulatory requirements we hav to follow in comparison to rural areas. In the context of Portugal, for instance, the transport of medicines necessitates explicit authorization from Infarmed, an authorization that we, in fact, have successfully secured. Furthermore,

dealing with goods requiring special licenses is a challenge we stand adequately prepared to navigate.

Interviewer:

Lets talk about the public perception, how has the reception been towards the concept of autonomous drone deliveries, particularly in the context of Connect Robotics' pioneering initiatives in the medical supply sector?

AM:

The reception from the public sphere has been very positive. We have not merely encountered, but diligently addressed, a number of challenges, thereby substantiating a demonstrable enhancement in efficiency, both in terms of cost-effectiveness and temporal expediency.

Interviewer:

Okay thats good. If we are now zooming in on the specifics of last-mile drone delivery, could you explain the key operational factors that Connect Robotics meticulously prioritizes to ensure not only efficiency but also the seamless orchestration of operations in the delivery of goods?

AM:

At the forefront of our operational ethos lies an unwavering commitment to safety. This manifests in a rigorous testing and approval process, where we leave no stone unturned to ensure the integrity of our operations. Coupled with this commitment is our dedication to harnessing the crème de la crème of technology and deploying a cadre of specialized professionals who function as the linchpin in guaranteeing operational efficiency. Moreover, a

pivotal facet of our operational strategy revolves around the active involvement of end-users in comprehending and proficiently utilizing the technology at their disposal.

Interviewer:

In the grand scheme of Connect Robotics' operations, could you provide nuanced insights into the current level of human involvement and concerted effort necessitated for the seamless operation of drones within your organizational framework?

AM:

While our operations are inherently characterized by a pronounced degree of autonomy, it's imperative to acknowledge the substantial human involvement that transpires during the nascent stages of our operations. This involvement is particularly salient in the meticulous construction of our solutions, the bespoke customization of projects for each client spanning diverse operational spheres, and the intricate navigations pertaining to licensing intricacies, safety measures, the formulation of a cogent business strategy, and a panoply of other pivotal considerations. Rest assured, we maintain an unwavering commitment to having a dedicated team, one hundred percent vested in addressing the unique needs of each operation, with the client assuming a direct and consequential role in shaping the trajectory of our operational paradigm. Ultimately, the goal is to achieve complete autonomy, but that is certainly dependent on the regulation in place and technological compliance with these regulations.

Interviewer:

In a nutshell, could you succinctly outline the fundamental elements encapsulated within Connect Robotics' overarching business model? This could encompass key revenue streams,

delineation of plans aimed at ensuring profitability on a per-use basis, and the strategic operational approaches specifically within the purview of the medical goods delivery sector.

AM:

In essence, our business model is intricately woven around a turnkey subscription model, a model that lends itself to flexibility, accommodating the nuanced needs of our esteemed clientele. The lucidity of our plans stands as a testament to our commitment to reach both clients and funds, thereby fortifying our organizational bedrock for growth. Our operational strategies remain steadfastly aligned with the exponential growth witnessed within the health sector, charting a trajectory that ensures synchronous evolution.

Interviewer:

Looking into challenges, what have been, or continue to be, the primary impediments that Connect Robotics grapples with in the application of drone delivery technology specifically for medical goods services?

AM:

Undoubtedly, the regulations within the EU.

Interviewer:

Navigating towards expansion, when contemplating entry into novel markets, what specific local factors does Connect Robotics judiciously take into consideration, and how do these factors intricately influence the meticulous strategic decision-making process of the organization?

AM:

When embarking on the exciting trajectory of market expansion, we exercise judicious consideration of a myriad of factors indigenous to the locale in question. Foremost amongst these considerations is the presence of an open regulatory environment, a receptiveness to embrace and implement our avant-garde services, the omnipresent ethos of safety, and, unequivocally, the fiscal considerations that underpin the deployment of a service that seeks not only to meet industry standards but to exceed them. It is this confluence of factors that forms the fulcrum of our strategic decision-making process, encapsulating an open-minded regulatory ambiance, an amenable attitude towards our service implementation, the bedrock of safety, and, naturally, a judicious assessment of the associated costs that pave the way for us to unfurl the banner of quality that distinctly sets us apart.

9.4.5. **Digital Settings: Lasha Sharikadze & Dr. Olaf Funke**

Transcript (full-length interview)

Interview with Lasha Sharikadze (CEO) and Dr. Olaf Funke (COO) from Digital Setting

30.10.2023

Start of interview

Check of ethical considerations and greetings

Interviewer:

I will shortly introduce to you what we are doing or what we are working on is that, so we try to explore in our master thesis the use of drone technology within the e-commerce last-mile deliveries. And if there is a potential for that technology to kind of enhance e-commerce last-mile deliveries, or if not, what are the factors that are not contributing to it, or if what are the factors that could contribute for this to revolutionize this industry. So this is just a short background and basically how we want to study this is we're going to talk to different experts, including you, and also going to do a customer survey to see if there's some customer acceptance, if customers are willing to pay for the service, if they're willing to accept the service as an alternative. So yeah, that's basically just a short summary of what we are working on within our thesis. And that's also just as a background for the questions that we are asking. As I already said in the email, if you don't know the answers to some of them, it's totally fine. We're just very interested to hear from your perspective and also your thoughts on this whole topic. So maybe it's, to start off, maybe first explain what you guys are working on and what your roles are so we are on the same page.

LS:

Perfect so maybe I will start. Okay I'm representing the digital settings this is a technology and innovative company mostly working on different solutions like IoT direction, Internet of

Things, also e-commerce and also too many different types of applications for clients. We are let's say founded at first in Georgia too. So we created as a digital settings, we created different solutions for Meama like vending machines, coffee capsule vending machines. This was a really innovation for the whole market because already win worldwide award twice and it was one of the best solutions for offices with different size like small and big offices to distribute coffee capsules amongst the employees. payment methods and it works totally with cloud system. It has also an administrative panel. And so we created the whole vending management solution, the classical VMS system from zero with inside resources. one main IoT direction which we are doing for now. The second thing is the e-commerce direction. We already created e-commerce from scratch. We are working for now the application and also we have the core system which unites, I will explain for now, which unites all the sales channels for this Meama company. So Meama is not only coffee capsule provider for the market, it's also a technology company. It unites every sales channel, every customer in one place, every sales transaction from vending machines, from e-commerce, from application. Also it's connected with a physical shop and the business owner can control everything from one dashboard, let's say, every transaction, every user and business owner has holistic control of his business. We also for now are working to implement BI solutions like business intelligence to predict the next steps for the business, marketing, optimization, and everything. Another direction which our team has a big experience is like hospitality business. Kailas system for hotels and applications for users and plus CMS. So we have one-stop solution for hotel owner to digitize their business more wide perspectives than he can do himself. And yeah, this is shortly what we are involving in too many small and medium-sized projects also. And yeah, I will be happy to share my knowledge and experience, 10 plus years almost, in e-commerce and startup industry.

Interviewer:

That's very interesting.

OF:

Lascha, you told all about digital settings. I joined digital settings to make operations and to help out in different business areas. And we want to partner up with the hospitality business as well and in the coffee business at the moment. And after, during Lascha explained, I had a few ideas and questions. I think drones, I think Lascha showed yesterday what we explored. Lascha and me was at the weekend, I showed him the countryside of Germany. I think Theresa, you will know the Eifel area. She's from Cologne, so she knows this area here. And she knows the little villages which have no shop anymore, nothing. Maybe this could be a really innovative thing where we can go straight forward to deliver in these little villages directly at home. This can be something. Because you know it, the old people in these areas. It can be a market. And not only in Germany, I think I see Belgium, I see the same in Luxembourg, I see the same in France and Austria is similar.

Interviewer:

So what you're saying basically also goes into our first question about drones. What do you think is the use case for drones in customer e-commerce deliveries? And you're saying Olaf, is those villages, which definitely is a use case, which we also found already.

OF:

I think big cities are crowded and it's not undangerous, it's forbidden, you have to control the air. And I think in big, clouded cities it's not really needed. For example, if you see Cologne, the city of Munich, you go in the night out, you find a gas station, you find a kiosk, you get

anything you want around the clock in principle. But on the countryside it's completely different and it's easier to send a drone out because of the air, because of the Luftraum, I think, the air control.

LS:

Yeah, I will add some comments also here. Not only countryside, I think, I mean the villages outside of the city, also the not city centers, the city suburbs are interesting, the homes with their own yard, I mean enough space for drones. It's also considering and interesting because in a drone delivery, with a drone delivery you can offer to the potential users with totally touchless service. Let's say that it needs only put some mark where can drone put down the parcel and that's it. It doesn't need any let's say sign up or mark that you got something the drone can itself do everything automatically, sees a specific area where it should put the parcel, takes a picture or screenshot to prove that it really provides a product to the customer and that's it. innovative and seamless experience for the clients. Only one thing is only the privacy and regulation and the legal issues that different drones should fly over the neighborhood with different yards. And maybe if I'm a neighbor and I'm not using the drone delivery system, I have some issues or doubts what these drones are crossing my yard and what is happening there. Maybe it should be an issue, but everything is changeable I think because I'm looking this in a positive manner. For now, from my view of perspective, I am a non-EU member, not yet, but from my view of perspective, the European Union has big issues that the laws too many GDPR compliances and these things. So it's, let's say, it gives a break to the innovation. I mean, if regulations won't be so strict and so high, then every innovation easily tested on the markets and easily adjustable. Yeah, this is my opinion regarding drone delivery.

Interviewer:

Very interesting. When we talk about the use case, do you think that drone deliveries are feasible for any kind of e-commerce product or would you say it's rather limited to some products that you need it I think.

LS:

If you have time to get it, I think no one will take it wrong. Fine, the post brings it, that's fine. I think it's for maybe, I think for food can be a really good thing to send out a pizza or whatever. For medicine I see it as immediate. I think this is totally important. What I thought from the countryside as well because if all people want to have medicine and if someone needs something really urgent and you have the possibility to send it via drone for example. He has no catheter capsules anymore and he needs it and it's cost him so much time to get it, then it's, you can, you can, I think that it makes sense, but not in any case. And the regulator will kill us because they want to control our... Yeah, also we can use drone delivery in a medical use. I mean when there is an emergency situation situation, someone can provide even blood with drone. Why not? Yeah, when we're talking about emergency situation. But regarding products, I think even subscription-based products are beneficial for drones and drone users for example food for pets which you can get regularly even weekly newspapers for example or coffee capsules and tea capsules why not and yeah things even wine or cigars or anything which users are consumed regularly. It should be provided via drones. It depends where. I think it depends a little bit where the location is. In the city center I wouldn't do it because the regulator would never allow it. At the moment we have the law that you cannot use a drone because if it comes down, if it breaks, you have an issue, you kill the people, Therefore, the regulator is really strong with this.

Interviewer:

Yeah, exactly. So these use cases are generally good for drones. Kind of question on that also because you have that background in e-commerce. And let's stick to the example with, for example, coffee cups. A very big question for this whole drone topic still is the economic viability. How that's also probably still one of the biggest issues for the companies, why it maybe hasn't taken off to that level that was maybe predicted a couple of years back yet. So how would you think, is for example, let's say coffee cups, is the profitability per use case given? How is that financially feasible? Because if you imagine the drone has to fly, let's say, 20 kilometers just to drop off a few coffee cups to a user, right now at least that's difficult and it's not financially feasible. So how do you think companies can tackle that?

LS:

Okay, I will start and try to answer. If we take only one example, one exact example, and compare it with what is a traditional method of delivery, we can also doubt which one is cheaper or expensive. And I will try to explain. If we want to see the big picture, we need to put every aspect of participants, let's say. For example, what alternatives we have for now? The fast delivery, which includes the scooter, electric scooter or traditional engine scooter or car This person we need to hire, we need to give them an application, we need to give them insurance, salary, every aspect. And also there is plus safety things, also too many aspects are participating. that if you take one big machine and then imagine like 10 points where should this machine go step by step and deliver, maybe it should be price wise. But if we imagine like only one pizza should deliver from point A to point B and it delivered by a guy who sits in a motorcycle versus drone delivery, it would be way cheaper than the person who needs to be delivered. Also, there should be in the later, near future, there should be no reason why someone should work as a courier, as a delivery guy. And it means what? It calculates in salary wage, yeah? It needs more salary for this delivery guy. And if we reach the automatization of

drone delivery, then it should be way cheaper than hire someone, train someone, give them salary, give them insurance, transportation, personal health. Yeah, this is a tool. complex manner. Drone delivery should be cheaper than the traditional delivery, I think.

OF:

I agree fully to Lasha, but one thing has to happen. The drones have to have the possibility to transport more than they can do at the moment with the weight and the distance because the battery technology. This is a little issue. If you can harm 10 points, I think I fully agree, it's cheaper. You cannot compete with a delivery person. But at the moment we have only the possibility for, I don't know, one or two points a can. So, I think this is a little issue. Which makes it more expensive.

We need to consider these two things that in parallel, the traditional transportation getting expensive and expensive and alternative way of delivery is promising to extend inequality like the long distance, the cheaper technology, more weight. Yeah, this is two parallels.

One big thing, there's a big thing because if I see in the city center the guys with the electric vehicles, they are driving around. This is at the moment not a problem, but I think for the environment, if you have in the countryside or wherever, in the suburbs, you have for sure people with cars which are driving around and then you have the CO2 issues, environmental issues, I think drones can save a lot of this. Because they are electrical, you can choose the energy with which you charge them, and so on. I think this is a real dream, a dream that will be pegged as well, for the world.

Interviewer:

Yeah, for sure. And you already covered a lot of points there. Maybe one other interesting point would be, especially when you say you work in the field of IoT, how do you see potential collaboration of emerging technologies like IoT or AI collaborating with drone deliveries to make the whole process more cost-efficient and generally efficient?

LS:

Yeah, exactly. So, even in today's world, we see that AI is taking over in many directions. So, these quantum computers, maybe you already know it and see it, can do the calculations like thousands more faster, like wiser than the man, than the GPT-4, for example. Yeah, so, it will think what? That this quantum computing plus AI should give us the direct prompts how to automatize price-wise, not only price-wise, in other economical issues and factors, and give us better solutions for drone delivery automatization. For example, in a bit later the data, I believe that they can analyze not only how to deliver smartly the parcels, also the spots. Where should we have the centers of drone delivery? I mean, with the suburb areas, with the user-customer spending possibilities, with the potential customers and it will give us a prompt map where we should put the centers of drone delivery centers, the charging centers, service centers and everything. And yeah, quantum computers can handle things in a more complex way than humans are seeing in act for now because we have the limits to think in many diverse directions. AI and quantum computing can handle it and plus we cannot analyze in many like mathematical algorithms or something. So, yeah, this is what I'm thinking.

I think in the case of IoT, I think the... I was in a project by Cisco. And they had the reverse switches and routers for telcos worldwide. And there was a project which has taken all data from the switches from the routers and has seen if there is an upcoming problem because of the log files you see, you can see if you measure the temperature or whatever, that the router

will die in a few minutes or a few days or whatever. And what they did was to inform the service people. They told him, hey, check it, go there and replace it before it breaks, so that we have no issue with the SLAs. In future, it can be so that a drone will deliver the device because it's thousands of types of devices. And this is still a problem to get it from the dock, where it's this device which breaks in two days. They know this, they can predict this. And I think this can be a piece for a drone to deliver it or to see, okay, we have a problem there. Bring it up front there that the service person is there. It's still existing because I have seen this as a problem. They have known it was really an issue. In India, I was there and then they had the issue that they have seen that by the problem that five switches were dying. But they couldn't deliver it because of the traffic. It was impossible to deliver it in time, so it broke. And they have no one that could watch the break, they could watch the fail, but it was still in the taxi on the road. For hours. And one comment regarding IoT. This 5G technology is overtaking in a short period of time, I believe. Plus, the Starlink-like technology and itself Starlink and cloud computing, it means if we plus everything together and to put everything together, It means that users can have a more faster internet, more fast connection and coverage. Plus, we should have more precise maps, more precise pins. near future regarding some starting technology regarding 5G and plus this cloud engineering. But for me it's all a business case of a business case. I think so far it is useful or price wise from the margin good to use it or cheaper. People will, the industry will use it, will spot it. At the moment it's not effective enough, I would say. Only for a few islands in North Germany. And to give them medicine.

Interviewer:

Yeah, for sure.

I actually have another question because to all the points you mentioned before that and also would kind of briefly touch upon it in the beginning, the whole regulation topic, especially in

the EU, so far, you know, with AI, IoT, quantum computing, all of that, data privacy point or legal issues whatsoever. These are obviously the main challenges for the application of drones right now. When and how do you think companies will, or not even companies, will ever tackle that in order for drone operations to scale? Because currently it seems like this is not happening in the next one or two or even few years. Do you have any prediction if that's going to evolve somehow?

LS:

I can tell you more. In Georgia, in my country, there is one company, they are coming from Israel, Israel-based company, they already starting the drone delivery because in Georgia it's more easy to start particularly anything because the law regulation. There is also the regulations for drones, but yeah, it is starting. Even three years ago when Myanmar coffee getting popular in Georgia, we wanted to do it with ourselves because there was no one who can give us offer that we have a drone delivered because it It should be beneficial in two ways. At first, we are positioning ourselves as an innovative company that we have the service that no one has. It would be first. And second, Georgia, to be listed as the capital of the city, And second, Georgia, to be listed as the capital of the city, has quite big traffic jams in the early morning and the late evening. It would be a great advantage for delivering something. And yeah, we thought to do it, but we did not solve because we are working in too many directions in parallel. So, the human-sized taxi drones are already operating in the US and in Dubai as I talked. We are also interested in this topic. We are looking for the solutions just for to buy the one drone for the commercial reasons to show that we forward thinkers, let's say. And in Estonia, Latvia, also some Eastern European countries, maybe also in Georgia, there are some robot delivery companies. So, I think it's not already tomorrow we are talking about two days think I think the same and I think if I see the military sector drones are really popular they are really useful

and helpful to save people and it doesn't mean that they kill someone like the US doing very often. I think I mean to protect, to clear, to clarify therefore drones are really useful and they are state-of-the-art at the moment. It's not a future technology that uses even this hobby drones. I think the technology will go straight forward but I mentioned at the beginning we need to have drones which are a little bit more more performant. I totally agree in a manner of like war industry let's say because drones are totally changed everything as I see in how countries or how escalated sides to have war on each other. I can remember Armenia-Azerbaijani war. It was five years ago and Azerbaijan has total advantage and total control of the war because they have drones from Turkey and they are dominating and they get total win to the Armenia because they do not have drone technology. I can say the same within Russia-Ukrainian war because it doesn't for now, it seems it doesn't have a matter US made or Russian made because one smart drone can destroy it and that's it. Even I can say it's the same in Israeli Gaza conflict. Also, the two sides can be, let's say, have the same power if both sides have drones. because this is smarter, this is cheaper, and this has really big power to destroy enemies, any war machine. So, lots of game changers in any sector.

End of Interview

9.4.6. **Valqari: Ryan Walsh**

Transcript (condensed)

Interview with Ryan Walsh (CEO and Founder of Valqari)

07.11.2023

Start of interview

Check of ethical considerations and greetings

Interviewer:

Let's start by diving into Valqari´s strategy. What motivated the company to develop its patented Drone Delivery Station instead of pursuing solutions that directly address the "last inch" of the last-mile logistics problem, similar to the direct-to-consumer approach of initiatives like Prime Air?

RW:

Absolutely, happy to provide more context. When we initiated our patent filings, the existence of solutions like Prime Air from Amazon wasn't on our radar. Our initial goal was to explore innovative solutions for the last-mile utilizing drones. However, recognizing the historical prevalence of patents related to remote vehicles dating back to 1898, and acknowledging the scale and resources of industry giants such as Amazon and Google, we pivoted our strategy. We realized that direct competition in the realm of remote vehicles might not be sustainable at scale. Consequently, our focus shifted to finding a patentable solution that served as a pivotal support function for drone delivery, rather than concentrating on the drone itself. This quest led us to the development of landing stations. Anticipating the inevitable evolution of drone delivery to parallel traditional delivery services, driven by customers' demands for convenience, we honed in on solutions that mirrored existing customer habits. Our patented

innovations cover mailboxes, lockers, and window stations, aligning with contemporary customer preferences.

Interviewer:

An insightful journey indeed. Transitioning to challenges, what unique considerations or hurdles arise when contemplating drone deliveries for general parcels via air?

RW:

This is a complex landscape, and I appreciate the opportunity to elaborate further. Combining the intricacies of the heavily regulated aviation market, which demands zero tolerance for errors, with the colossal institutions dominating last-mile delivery—such as USPS, FedEx, UPS, and Amazon—alongside considerations like HOAs, municipal zoning, and other regulatory factors, results in a landscape that is inherently multifaceted. The convergence of these elements creates a web of challenges that need careful navigation and consideration.

Interviewer:

Certainly a multifaceted and challenging landscape. How has the general public responded to the concept of drone deliveries and the pick-up/drop-off stations that Valqari provides?

RW:

It's been a pleasantly surprising response, and I'm happy to share more details. Contrary to cautious expectations, the public response has exceeded our initial anticipations. During our installations, we haven't encountered a single upset resident. On the contrary, people have not only been receptive but genuinely excited about the prospect of drone deliveries and the

associated pick-up/drop-off stations. The overall sentiment has been one of enthusiasm and eagerness.

Interviewer:

Exciting to see such positive reactions. In the last-mile drone delivery sphere, what operational factors does Valqari prioritize to ensure efficiency and seamless operations in delivering goods?

RW:

Delving into operational nuances is always interesting. While I can't reveal specific trade secrets, what I can emphasize is the inherent uniqueness of every deployment. Each location, customer, and use case presents a distinct set of variables, making flexibility and modularity paramount for ensuring seamless operations. Our approach revolves around adaptability to cater to the specificities of each deployment scenario.

Interviewer:

On the human involvement front, what's the current level of human involvement and effort required for operating drones within Valqari's operations?

RW:

The operational aspect is a critical dimension. At present, our software operates with virtually zero human involvement. Theoretically, it can be configured to run entirely autonomously. The high level of autonomous operation is ensured by offering static delivery points, making the learning and adaptability for the drone much easier. While our system includes safety measures that necessitate a human pilot's approval for the mission and takeoff, aligning with FAA and

regulatory requirements, we routinely run our system entirely autonomously in controlled testing environments.

Interviewer:

Can you elaborate on the fundamental elements of Valqari's business model? This includes key revenue streams, plans for profitability on a per-use basis, and overarching operational strategies in the drone delivery sector.

RW:

While I would love to provide comprehensive details, I must respect confidentiality considerations. However, on a publicly disclosed level, our revenue model involves selling and leasing full systems or landing stations, licensing our technology and intellectual property, and in some instances, providing end-to-end services for specific customers. The broader operational strategies align with ensuring the sustainability and scalability of our drone delivery solutions.

Interviewer:

I understand. Reflecting on challenges, what have been the primary hurdles that Valqari has faced or continues to face in the application of drone delivery technology, given the diverse range of services it provides?

RW:

A critical consideration, and I'm glad you brought it up. Regulatory challenges, particularly those hindering Beyond Visual Line of Sight operations, are a significant hurdle, essentially

restricting 99.5% of the market for the next 15 months. Once these regulatory barriers are lifted, the landscape appears more navigable, with challenges that seem surmountable in the long run.

Interviewer:

Regulatory landscapes can indeed shape the trajectory of drone delivery initiatives. Looking towards expansion, when considering new markets and sectors, what specific local factors does Valqari weigh, and how do these factors influence the strategic decision-making process of the company?

RW:

An excellent question, and one that involves nuanced considerations. Unfortunately, I can't delve into the specifics due to confidentiality and proprietary considerations. However, it suffices to say that local regulatory landscapes, market size, housing density, climate conditions, and prevalent trends in the delivery domain are integral factors that guide our strategic decisions. Each market presents its unique challenges and opportunities, influencing our approach to expansion.

Interviewer:

Ok, considering the future, does Valqari have strategic plans to diversify its drone delivery services, possibly through partnerships with the broader e-commerce delivery industry?

RW:

Indeed, and I appreciate the opportunity to share insights into our strategic vision. In short, yes, we do have strategic plans for diversification. However, the landscape is intricate, and forging alliances too early with end-user partners requires careful consideration. It's a situationally

dependent process. Nevertheless, a savvy strategy of strategic partnerships across multiple verticals seems to be an integral part of Valqari's future.

Interviewer:

On the regulatory front, can you elaborate on the role of FAA regulations and other regulatory challenges that Valqari encounters in its drone delivery operations? How does Valqari's approach to regulatory compliance differ from that of its competitors?

RW:

A critical aspect of our operations, and I'm happy to provide more insights. While Valqari isn't a drone company per se, we find ourselves intertwined with our customers, partners, and end-users who do fall under these regulations. As a result, we pay close attention to FAA regulations and other regulatory landscapes, considering them as core drivers for our user base. Our approach differs in that we aim to be a neutral operator within the market, akin to a mailbox today. We strive to enable and support our user base without seeking the spotlight, adopting a role devoid of bias, agenda, or ego. Many competitors tend to place themselves in the limelight, but Valqari's role is to be a neutral and supportive player in the market.

End of Interview