Parcel Delivery with Eco-Friendly Drone Technologies

Gabriele Barrile[1], Clemente Maesano[2(✉)], Sonia Calluso[2], and Piero Francesco Spano'[3]

[1] LUISS Libera Università Internazionale Degli Studi Sociali Guido Carli - Viale Pola 12, 00198 Roma, Italy

[2] University of Rome "La Sapienza" – Via Eudossiana, 18, 00185 Rome, Italy
clemente.maesano@uniroma1.it

[3] Department of Civil Engineering, Energy, Environment and Materials (DICEAM), Mediterranea University of Reggio Calabria, Via Zehender, 89124 Reggio Calabria, Italy

Abstract. Several fields have benefited from the application of geomatics techniques. For example, concerning environmental conservation, the use of geomatics techniques facilitates: landscape monitor and analysis activities, the creation of map of interests, the assessment of human activities on vulnerable ecosystem. Always concerning the environmental point of view, geomatics techniques offer a reliable way to address the challenges derived from climatic changes. Geomatics has also a crucial role in the development of urban resilience: using satellite imagery, remote sensing, and geospatial analytics, cities can efficiently manage infrastructure, monitor environmental risks, and plan for disaster response. In the evolving landscape of transportation, geomatics intersects with the development of cargo drones. These unmanned aerial vehicles leverage geospatial data for route optimization, obstacle detection, and real-time navigation. Geomatics techniques contribute to the creation of efficient air corridors, ensuring safe and reliable drone deliveries. This research wants to illustrate the specific of an eco-sustainable cargo drone, taking in consideration also the different laws concerning UAVs flight; evaluating also the viability of an Italian Start-up based on this technology.

Keywords: UAV · Drone · Cargo Drone · start up · sustainable energy · geomatics technologies

1 Introduction

The spread of drones for shipments is a significant advance in the logistic and transportation sector. This type of drones are specifically projected to perform deliveries from different spot and they are reducing the need of human driers or conventional vehicles, [1, 2] this technology has attracted a lot of attention and has relevant improvements in several areas. Due to technological progression, drones have evolved in design and technology, becoming more advanced. Upgrades were mainly centered to improve reliability, efficiency and increase payload capacity specially on long distances. Drones

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designed for shipments are essentially equipped with high-level propulsion system, navigation system, High-quality cameras, obstacle avoidance systems in order to guarantee safety and precision during the flight. These type or drone have use in several areas [3], some of them, for example, are used to deliver packages or light weight goods straight to the customers, particularly in isolated or difficult to reach places [4]. They can also be used to deliver medical supplies during emergencies, especially in areas where traditional modes of transport have difficult in reaching. Lastly, some companies are also evaluating the idea of using cargo drones for supplying rural or isolated areas, and related to this, is taking hold the use of sustainable and eco-friendly drones for cargo transportation.

This drones are designed and developed focusing on minimize negative impacts on the environment specially during; they are also equipped with specific technologies able to maximize energy efficiency, [5], to reduce pollutant emissions and contribute to create a strategic logistic. One of the greatest obstacles to the spread of cargo drones are the regulations: many laws in most countries don't allow or limit drone use in thickly populated areas. Other limitations to the spread of this type of drones are: battery life, difficult to fly in adverse weather conditions and poor ability to handle critical conditions, [6]. Despite this, several companies and startups are financing the development of drones for the delivery of freight [7]. Some projects that have attracted the attention of investors are: Amazon Prime Air and Alphabet's Wing.

The goal of this study is to illustrate the characteristics of an eco-sustainable drone cargo transport prototype, highlighting the issues related to the Italian and foreign legislation about their fly and the possibility to create an Italian start-up using this technology,

2 Method

Companies are facing several problematics such as the increasing of the cost of feedstock and the lack of drivers, so the idea of an eco-sustainable drone arouses a lot of interest. These UAV bring to several benefits (less personnel cost) but also have implication for employment levels. Other strong points are the drones ability to running 24/7 (excluding recharging time) and the avoiding the problematics faces during ground or water transportation. Considering also the power supply for these UAV (typically electric) may also exist implication for lowering CO_2 emissions [8, 9].

2.1 Drone Characteristics and Legal Framework

Regarding the previously exposed problematics, this research is centered on a detailed feasibility study for the creation of an eco-sustainable drone, whose performance was simulated and provided interesting results. This environmentally friendly cargo drone has the following characteristics:

- Biodegradable material frame,
- Six motor with a power of 700 kV
- Lithium phosphate backup batteries
- GNSS navigation system
- Sensor enabling smooth flight

- Six two shape blade propellers (8/12 inch)
- Noise isolation system

About the legal part, for handcrafted drones and prototype designed in recent years, with the goal to have a more advanced and eco-friendly use in cargo transportations sector, the reference legislation is Commission Implementing Regulation (EU) 2019/947, besides several transitional laws [10]. The Italian legislator framework, currently, introduces some innovations: The equalization between Unmanned Aircraft System (UAS) and traditional aircraft; The registration to a recognition system by the operator at the European Union Aviation safety Agency (EASA). The UAS registration is required when it regards a certified UAS designed for a specific type of activities. The operational activities are divided in three categories, based on progressive degree of risk, shown in Fig. 1. The first category is called "OPEN", regards drones that weight less than 25 kg that are conducted under "visual line of sight" conditions, and in a maximum Flight height of 120 m. Aren't request any authorizations/declarations, except when the drone is used in a controlled airspace. This category includes other three subcategories. The second category, called "SPECIFIC", necessitate or an authorization from the national aviation authority or a previous declaration by the UAs pilot. The last category is called "CERTIFIED", this risk level requires: a previously authorization from the aviation authority, the operator needs to be certificate and needs to have the specific license, defined by the EU regulation 2019/945; also, the UAVS needs to be registered.

The EU regulation allowed a transitory period, from 2020 to 2023, where the drones that weren't marked CE could fly in a subsection of the OPEN category. From January 2023, the drone without the CE class identification can only be used in OPEN A1 (if they weigh less than 250 gr) or A3 (more than 25 gr but less than 25 kg). The transitory period ended on January 1st 2024.

Fig. 1. Division of the operational model

About the international legislation [11–14] the FAA (Federal Aviation Authority) has released new regulation for the commercial services made by drones, including delivery operation, even during nighttime. At the end of 2020 FAA has released new laws about drones and their utilization. This represents a significant progress for the usage of large-scale commercial UAV in the US, stimulating also the industries outsides American borders. The regulations require Unmanned Aircraft Systems (UAS) to send identity or location data and permit small drone operators to fly over people and cars at night and under specific circumstances.

Another important step toward will be the developing of regulation for operations that outline the visual line of sight. The interest in this kind of operation not concerns only the delivery sector: BNSF railway has asked, through a petition addressed to the FAA, for an exception to operate in remote with 5 UAV over long distances, for the purpose railroad inspection and control its private property.

3 Results

The idea was to implement an innovative startup using the concept of an environmentally sustainable drone prototype, which behavior in real world, at least from the simulations, seems to lead to positive results. The context of Italian startups is dotted with several successful stories but due to its small size, isn't possible to reach those kinds of markets that allows greater and faster growth. It is generally thought that Innovative Italian startups requires to make strategic agreements with larger companies, in such a way as to reduce the gap with the other countries. There is also the need to have more tax incentives and to find alternative finance strategies (e.g. crowdfunding). Many factories, especially that one from the one belonging to the transports sector, demand for eco-sustainable technology. Due to this, born the idea to found a start-up based on the creation of an eco-sustainable. The key innovation of our proposal are: the use of biodegradable materials and bioplastics, the use of less polluting batteries and 2-blade shape propellers able to reduce the noise; this features led to a reduction in environmental, atmospheric and acoustic pollution and consequently this will have a huge impact both on small scale, improving the quality life inside the city facing the main problems inside the city (noise and pollution) contributing so increasing the urban resilience, both in big scale, contributing to reduce the CO_2 emissions and focusing on environmental safeguard. In detail, the drone's frame and the main component are supposed to be constructed using biodegradable materials. The exoskeleton would be fungi mycelium based then coated with bacterial derived cellulose in order to make it waterproof. Is supposed also to add an extra layer of bioplastic to make it more robust and able to face the complication during the journey. The choose of bioplastic is due to its similar characteristic with normal plastic but without the environmental impact. Drone will mount 6 motor with a power of 700 kV that will ensure the necessary performance do complete the task. The main innovation will be the power supply system. The choice has fallen on the eco-friendliest alternative: solar panels (Fig. 2). Generally, the drone's consume for a flight with a small size cargo is about a 200 W; supposing a standard solar cell power of 3.5 W per cell and a solar panel efficiency of 20%, we estimate about 3 solar panels. This would give to the drone an autonomy ten times greater than the competitors. It would also be advantageous to install "backup" batteries in case the weather stops the panels from getting the necessary electricity. The batteries will be 6 s LiPo batteries with a capacity of 2200 mAh and ultra-lightweight.

Our goal is to create a completely self-sufficient drone that can travel to multiple pre-programmed locations without requiring remote pilot assistance. The drone needs sensors to detect impediments and guarantee a smooth flying in order to accomplish this.

The automation of the flight phase, however, is made possible by the integration GNSS system.

Fig. 2. Solar system power supply

It will be supplied with three carbon-based propellers (8/10 inches) that rotate at low rates to guarantee the necessary delivery speed, making them appropriate for large-sized motors. In order to reduce acoustic pollution, we have also thought of putting in place a noise isolation system. For example, we are investigating a novel technology that uses sound-dampening nanofiber materials to reduce drone noise. Therefore, the creative start-up would concentrate on the drone prototype that has these capabilities, which will require additional testing. Even so, the outcomes of the simulations that have been run thus far are positive.

4 Conclusion

The integration of drones into various industries holds immense potential to revolutionize processes, making them more efficient, safe, and environmentally friendly. Undoubtedly, the use of drones promises to expedite and simplify tedious and perilous tasks, fostering rapid advancements in applications for both home and business users. This not only streamlines approval processes but also enhances overall user experience, contributing to the swift development of drone-based solutions.

One noteworthy aspect is the significant improvement in flight safety, marking a crucial milestone towards the widespread commercial adoption of drones. The launch of an Italian startup dedicated to creating environmentally friendly cargo drones is a commendable and encouraging initiative. The innovative approach of employing drones for eco-conscious cargo transportation aligns seamlessly with the global shift towards sustainable solutions.

Examining the current regulatory landscape, this project stands poised not only to revolutionize the Italian cargo transportation industry but also to serve as a catalyst for global change, inspiring the adoption of environmentally responsible and efficient logistics solutions worldwide. As drones continue to evolve, they unveil opportunities across diverse fields, underlining the interconnected growth of society, the economy, and research.

It is imperative to recognize that societal investments ripple through the business sector and professions, creating a positive feedback loop that benefits everyone involved.

This convergence of technological innovation, environmental responsibility, and economic progress embodies a promising future. The trajectory of drone development serves as a testament to our collective ability to shape a more sustainable and interconnected world, where advancements in one realm positively impact others, fostering a holistic and mutually beneficial evolution.

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