Last Mile Delivery by Drone

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***Abstract*:- Online retailers and delivery companies such as Amazon, are already filing up patents for the development of multi-level fulfillment centers for unmanned aerial vehicles or "drone-beehives" that would allow the deployment of this technology within built environment. A substantial amount of research has been carried out in the last years on the potential use of drones for parcel delivery, principally in the area of logistic optimization. However, little is known about the potential market and economic viability of such services in Worldwide. This paper presents a modeling framework using user-wide high-resolution population and land-use data to estimate the potential optimal location of drone-beehives based on economic viability criterion. It estimates the potential number of user model citizens that could potentially benefit from last mile-drone delivery services fewer than four scenarios. The performed analyses indicates that under the scenario considered as the most technologically realistic, up to 7% of user citizens could get access to such services. When considering technological improvements scenarios, the share reaches 30%. Furthermore, results suggest that due to the differences in population and land-use patterns in the different Member States, the potential drone coverage across Worldwide could be very heterogeneous, with the UK, Germany, Italy, France and India appearing as the most likely countries where drone-beehives may have the most efficient development.**

Keyword: Emergency service, Pharmacy needs, Safety equipment, Access to Service.

1. INTRODUCTION

Transportation is one of the main pillars of today's economies comprising a spectrum of individual systems and their interconnections that are intended to cover the mobility demand of people and goods. Transportation systems include an extensive series of physical and organizational elements and are being characterized by an overall intrinsic complexity. These elements can be influencing each other directly and/or indirectly, linearly or nonlinearly, having also potential feedback cycles. In particular, new technologies and Transportation trends add new levels of interaction with the society and users and may have considerable influence on people mobility and freight Transportation services [1]. In principle, the Transportation sector is intrinsically a very dynamic sector, even though conventional Transportation modes are nowadays consolidated, with mostly evolutionary improvements for what regards their capacity, efficiency, safety, and reliability in the last years. However, Transportation is also strongly linked to broad societal changes emerging from the ever-changing economies and the geopolitical situation: the global economic crisis, limited resources and new vulnerabilities and uncertainties have a direct impact on the way people and goods move.

Within this last point, the idea of using Unmanned Aerial Vehicles, or drones, for last mile delivery is gaining popularity. The use of drones to deliver parcels may have the potential to decrease delivery costs, having no driver or truck costs, eliminating congestion costs, having less missed-deliveries due to the very short delay, e.g. 30 min [10] between item dispatch and delivery, and is now the object of intense research activities [11]. Drone delivery may bring other significant advantages. From a consumer preference point of view, drone delivery combined with mobile phone applications to ensure traceability and scheduling, could provide conditions to satisfy highest demand probability [9] (combining home delivery with flexible delivery time, information traceability and reduced cost). Drone delivery could also reduce the need for local Transportation and decrease congestion and air emissions. Some potential issues have also been raised in term of the safety of drones to people and noise (that could potentially be addressed by active noise cancelling or bladeless systems).

Some limitations relative to the use of drone delivery services have been raised particularly for the need to relocate or build new distribution centers closer to customers [2]. A recent patent filled-up by Amazon Technology Inc., for a fulfillment centre is shown in Fig.1, designed to accommodate landing and take-off of unmanned aerial vehicles in densely populated areas (from here on referred to as drone-beehives) seems to confirm the industry is giving more serious consideration to this delivery alternative.

However, some authors have also suggested that the current hype for drones could lead to false expectations and that the drone delivery concept may not pass the economic viability test [3]. According to the Gartner hype cycle, drones spanned the "peak of inflated expectations" in just 1 year, and in 2017, they were about to enter the "trough of disillusionment".

Finally, any innovative logistics solutions should be integrated inside the concept of city logistics considering traffic environment, congestion, safety, and energy savings, and by engaging different stakeholders within the framework of the market economy. The same can be said for the location of urban distribution centers that define the last mile segment: their location should be set by optimizing both long distance freight provision and last mile delivery routings to retailers (including restocking) incorporating economic, environmental and social criteria and constrains. Drone beehives could be established as joined delivery systems where different freight carriers could cooperate to jointly deliver goods to customers and potentially also collect from retailers following a structure.

Furthermore, lifecycle analysis should be applied to drone manufacturing and use, as identified to assess the environmental impact of this technology compared to traditional van delivery.

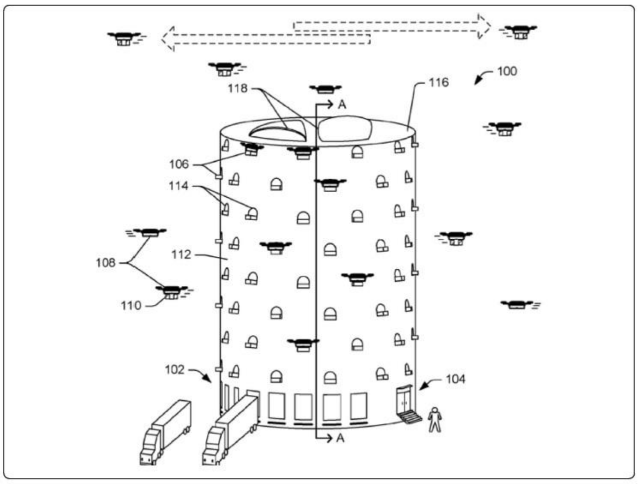

Fig.1 Drone Beehive Model

1.1 *EXISTING SYSTEM*

- ➢ In The Existing Technology Drones Could Deliver the Product Only Within A Particular Area

Drone last mile delivery is an interesting research topic with real world applications appearing very fast. McKinsey identifies autonomous unmanned aerial vehicles (UAVs) as a dominant option for last mile deliveries, especially of parcels, for (rural) areas with density smaller than 50.000 inhabitants, especially since it is expected that same-day or instant delivery will grow in the future . Home delivery by drones is being promoted and researched by a growing number of firms. Companies such as Amazon, Google and others have tested drone delivery for years, some since 2005, as a possible alternative or complement to traditional delivery [8]. More recently, Amazon is planning to use drones for 30 min deliveries directly to home, and has begun private trials in England, with the first customer delivery by drone becoming a reality.

1.2 *PROPOSED SYSTEM*

- ➢ With Some Enhancement To the above Existing System we have Installed Some Security Equipments.

This paper aims to provide a reality check to the viability of the drone delivery concept. It investigates the potential optimal location of "drone-beehives", such as the one patented by Amazon and their potential economic viability as a function of the density of reachable population [2]. The objective is to estimate how many USER customers could potentially benefit of this service under and range of different hypothesis. This paper is, to the best of the authors' knowledge the first to investigate this potential across the area [3].

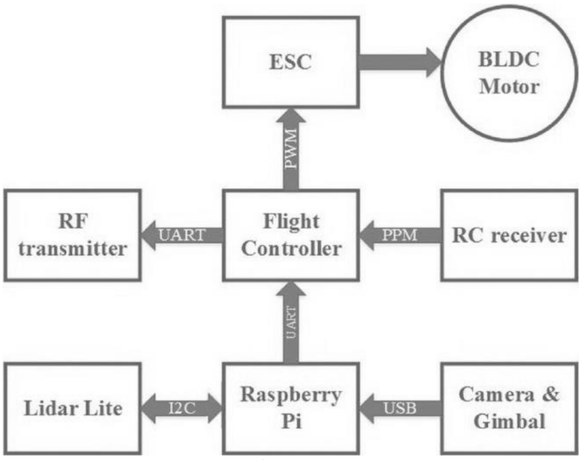

Fig.2 Block Diagram of Last Mile Delivery by Drone

The results of this analysis could be incorporated as a possible solution for specific cities as part of further integrated decision support system methodologies, as well as for ex-ante policy evaluation, to help experts and local authorities develop, evaluate and facilitate appropriate freight and last mile delivery plans for cities.

Based on the literature review focusing primarily on the drone last mile delivery and pertinent legislative and policy documents, provides an outline of the potential market for the delivery model [4].

It focuses on modeling framework hypothesis and details, while, and provides the model outcomes. While research relative to overcoming technical limitation and developing logistics optimization algorithms is increasing, less work has been done in the area of optimal drone-beehive location and potential economic viability [5]. Little is currently known about the potential population that could viably be reached by such services.

2. LITERATURE SURVEY

Literature on drones has been thriving in the last years. Hassanalian and Abdelkefi provide taxonomy of drones and propose and discuss solutions for different design challenges, including the importance of swarm flight. Rao et. al., presents the recommendation on societal challenges from the implementation of drones, on safety, security, privacy, ownership, liability, and regulation. De Miguel Molina and Seggara Oña provide an overview of the drone industry in Worldwide, including data of manufacturers, revenues and forecast.

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On the issue of using drones for last mile delivery, Lohn provides a technical overview of the impacts of delivery drone operations at a city scale and explores the areas of energy consumption, infrastructure requirements, aerial congestion, privacy, and noise. The KiM Netherlands Institute for Transportation Policy Analysis identifies parcel delivery as one of the three principal applications and market opportunities for drones in passenger and freight Transportation.

More specifically, in the last years, a number of authors deal with the "last mile" delivery problem from a Transportation planning perspective. Murray and Chu provide mathematical programming models for the optimal routing and scheduling of drones and delivery trucks for parcel delivery, including a scenario in which a drone works in collaboration with a traditional delivery truck to distribute parcels. Building on this study, more recently, Ha et al., implement the objective of minimizing operational costs including total Transportation cost and costs created by waste time a vehicle has to wait for the other. Tavana et al., discuss the truck scheduling problem (i.e. the optimal sequence of inbound and outbound trucks at a dock doors), considering drones instead of outbound trucks. Poikonen et al. deal with the vehicle routing problem with drones dispatching from the top of trucks.

The same topic is investigated in a more recent paper by Yurek and Ozmutlu, focusing on minimizing the combined delivery completion time. Dorling et al., derive and experimentally validate an energy consumption model for multi-rotor drones within a vehicle routing optimization problem. More recently, Stolaroff et al., focus on possible reduction of greenhouse gas emissions and energy use by using drones for last mile delivery, and provide policy recommendations to achieve environmental benefits, focusing on warehouse needs.

Diverging from the existing literature, the present analysis does not focus on the potential economic, traffic-related or environmental benefits related to the introduction of last-mile delivery services based on drones, but it focuses on their practical feasibility considering the actual population and land-use pattern in World wide. The next section provides details on the modeling framework adopted to carry out the analysis.

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3. MODELLING ASSUMPTION

This study presents a modeling framework developed, to (a) identify the number of people present within the delivery range of potential drone-beehives across the user region and (b) calculate the costs and returns associated with delivering a parcel to each individual. This model uses a series of input data and assumptions that are provided below.

Drones used for delivery are similar to the Amazon Prime Air model [10] requiring a surface of "open space" to land is shown in Fig.3. As a proxy to estimate the availability of open landing space (gardens, etc.), a population density threshold of 115 person/ha is used [6]. This threshold was selected by visually relating the outputs of the LUISA population map with typical sub-urban areas identified from aerial imagery in India, France and the UK. A more complex approach using remote sensing model algorithms in combination with high-resolution datasets of green and built-up areas, from the Global Human Settlement Layer, was also explored but produced very similar results.

Drones are allowed to fly above residential area and cities, thus, no legislative block is imposed. This is in line with the uncertainty concerning future legislation, and possible amendments that could focus on the creation of drone networks [7]. Delivery would occur directly from the drone-beehive to the customer, thus, no multiple deliveries are foreseen. This assumption fully conforms to the Amazon prime delivery model. The drones can travel a maximum distance of 24 km (thus, 12 km one way). This distance is in line with the improved Amazon Prime Air model. Amazon Prime Air drone delivery prototype regarding the drone-beehives specification, the following assumptions is made:

- Only pixels of land-use classes corresponding to commercial/ industrial and abandoned commercial/ industrial sites are suitable to host potential drone-beehives so as not to compete with the residential market and to benefit from higher accessibility (commercial/industrial sites are often located near major roads).
- The necessary building permit is granted for the construction of drone-beehives (regardless of surrounding land-uses or building zones).
- A one-hectare pixel would be large enough to accommodate a drone-beehive (no need of multiple adjacent pixels
- Each drone-beehive can host a sufficient number of drones and has the capacity to dispatch them sufficiently quickly to satisfy the delivery demand. The authors estimate (see section 5 for details) that drone-beehives may need a maximum of about 100 drones and a maximum launching capacity of 2 drones per minute.

The maximum return associated with drone hives identified by the modeling approach assumes that for each year one parcel is delivered to every person within the drone delivery range. In order to derive a more realistic financial return associated with the operation of drone-beehives, a scaling factor is calculated based on the following hypotheses:

Online buyers are distributed uniformly across all countries (excluding islands). 10% of online buyers would use drone air delivery once per year. Using a conservative 300 million estimate of online buyers and a population of 500 million, this scaling factor is estimated equal to 0.06.

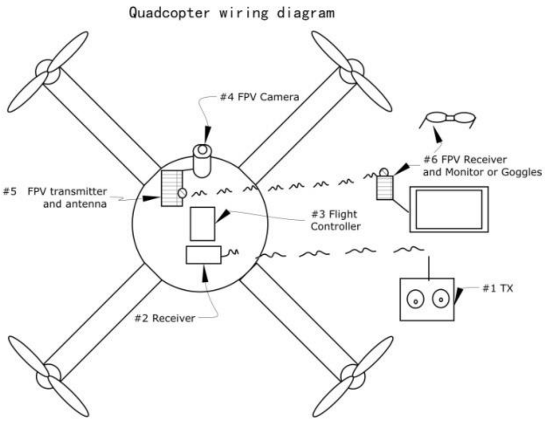

Fig.3 Model of Air Drone Delivery

This scaling factor was applied to calculate the estimated return from the value calculated by the modeling approach. Illustrate the results from the modeling and estimation of financial return for potential drone-beehives for the functional urban area of London in the UK. The hive location and financial return is calculated using a 12 km drone flight distance and a 115/ha population threshold. Circles with yellow outer lines represent the range covered by drones around each hive. Hives, which range areas are trimmed by the range of others indicate that a proportion of potential customers within their servicing area have already been allocated to a hive of higher economic return.

4. EXPERIMENTAL MODEL

The modeling approach is composed of two steps, which are run in sequence multiple times.

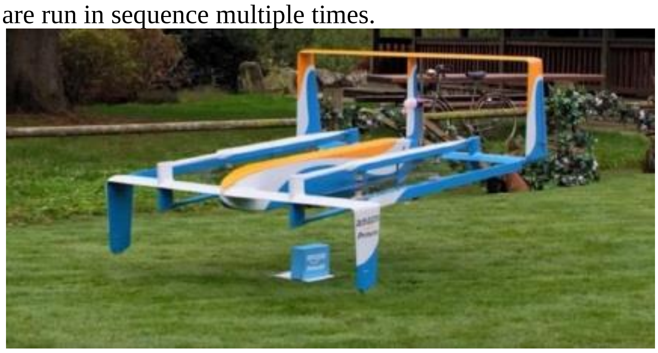

Fig.4 Prototype of Air Drone Delivery

- The first step creates a USER MODEL wide map, which associates to each pixel of industrial land-use the potential economic return resulting from the delivery of a fixed-price item to all people located within the drone delivery distance.
- The second step identifies the pixels with the highest economic return and allocates drone-beehives to these locations. It also removes the population "served" by these warehouses from the map used as input.

5. CONCLUSION

Finally, it should be emphasized that, while the development of drone-beehives for last mile delivery may already be viable, the setup of such distribution centers would require important industry and public involvement. Such consultations would be particularly important, considering the novelty of drone delivery, to address concerns and policy implications in terms of safety, environmental nuisance, urban planning, air traffic, city logistic, and employment in the delivery industry.

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