Evaluation of models for implementing Physical Internet standards via simulations of Complex System: “Using drones for the last mile”

5th IPIC Rijksuniversiteit Groningen 2018

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Introduction

In this work, we put forward a model to analyse the impact of a hypothetical scenario in which a group of businesses in the Cadiz area is cooperating in the implementation of common standards that enable them to incorporate a PI system for their last mile deliveries.
Background: Interaction between LEAN & PI

ECONOMICAL | SOCIETAL | ENVIROMENTAL
---|---|---
EFFICIENCY | SUSTAINABILITY | PHYSICAL OBJECTS

MOVE | STORE | REALIZE | SUPPLY | USE

MOBILITY WEB | DISTRIBUTION WEB | REALIZATION WEB | SUPPLY WEB | SERVICE WEB

LOGISTIC WEB

UNIVERSAL INTERCONNECTIVITY

PHYSICAL | OPERATIONAL | DIGITAL

ENCAPSULATION | INTERFACES | PROTOCOLS

TECHNOLOGY | BUSINESS | INFRASTRUCTURE

INNOVATION

*Foundations of the Physical Internet, Montréal*

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The 5 Principles of Lean Thinking - James J. Womack and Daniel T. Jones
Background: Why Drones

In the 4th IPIC we presented how to improve Logistic using Lean Manufacturing with PI.

After using the model, we needed to reduce the lead time of the deliveries of goods in cities.

VSM results that the current method of transport should change.
Method of transport should change
Underground transport: Elon Musk

https://youtu.be/24yqz0jZVaw
Airtransport: Dezeen (Mark Dytham)
Drones in our current life

The use of drones in the future is another emerging factor and seen from the point of view of the life cycle of an industry it is at the creation and diffusion of knowledge phase
Life cycle of an industry
Life cycle of an industry
General reasons to introduce drones for logistics I

We must add that in recent years there has been an increase in e-commerce.
Top 25 Most Trending Products to Sell Online in 2017
Top 25 Most Trending Products to Sell Online in 2018
<table>
<thead>
<tr>
<th>General reasons to introduce drones for logistics II</th>
</tr>
</thead>
<tbody>
<tr>
<td>...increase in e-commerce,</td>
</tr>
<tr>
<td>with this requiring a large deployment to reach the end clients.</td>
</tr>
<tr>
<td>Businesses have been fighting to be the best and fastest in their deployment for last mile deliveries</td>
</tr>
</tbody>
</table>

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How drones will change cities I

Mark Dytham architect in Dezeen

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Patent of logistics building of Amazon

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The process to introduce it

Initially we don’t propose that the buildings of the cities have to change so fast

But we raised an earlier step, through airways that reach intermediate delivery points

The evolution from the present to our proposed could be:
7 Intermediate stations to delivery products
7 Intermediate stations to delivery products II
The reality nowadays: 14 companies delivery this kind of package (7+7)
The reality nowadays: 14 companies delivery this kind of package
Why Cadiz is ideal for this simulation?

There are two main reasons

The designation of Cadiz to simulate flight paths for last mile deliveries:

1.- Own physiognomy of the City
2.- The highest population density in Andalusia (Spain)
Own physiognomy of the City
The highest population density in Andalusia 1
10,399 inhabitants per square kilometer

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Lived density in Europe 1

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<td>505,682</td>
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But only 13% of them are lived in. This means that the ‘lived density’ for Spain is in fact 737 people per km². Cádiz is in the top twenty in the country, with 10,399 inhabitants per square kilometer.

### Lived density in Europe II

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Methodology to create the airways

It does this in order to be more competitive and to comply with the challenges of Europe 2030.

The model is described using the ODD standard (general design information) which is commonly used for model description in fields such as ecology, sociology and economics.

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Global UML level of agents (ODD)
The model is described using the ODD standard.

We have adopted this approach when developing a simulator that allows us to design a network of flight paths in the improvement of the last mile deliveries.
3 points outside the Residential area to receive the goods

1.- Company Total Logistic Services
2.- Free place in the port of Cadiz
3.- Port of Cadiz free zone
To design the flight paths we had to answer three main questions
What is the starting information to gather for this type of studies?
Question 2

Which are the factors that would need to be determined prior to the in-depth work with the multi-agent model?
The current legislation prohibits drones flying over urban centers, how could the authorities be convinced to implement the necessary legal modifications?
Question 1 (part 1)

What is the starting information to gather for this type of studies?

1. Maximum weight of merchandise up to 3kg
2. Maximum load size of 150x150cm
3. Maximum flight time of up to 30 minutes or 2 hours with a hybrid vehicle
4. Cruising speed of 53km/h at full load
5. Fueled using an electric battery (for hybrid plus a mixed auxiliary tank petrol/oil)
Question 1 (part 2)

What is the starting information to gather for this type of studies?

6. Drone maintenance every 50 hours of flight
7. Point-to-point flight plans (up to 100 waypoints)
8. Transmission of video and control from up to 50km using 3g/4g (120ms latency)
9. Autonomous takeoff and landing
10. Drone diameter of 200cm
Question 2 (part 1)

Which are the factors that would need to be determined prior to the in-depth work with the multi-agent model?

1. Approximate size of the fleet operating simultaneously
2. Expected number of deliveries per hour
3. Minimum recommended safety distance between drones in flight
4. Approximate size of the launch pads and/or their distribution
Question 2 (part 2)

Which are the factors that would need to be determined prior to the in-depth work with the multi-agent model?

5. Cruising speed factoring in wind speed
6. Range of heights at which the drones would fly (maximum and minimum)
7. Parameter for quantifying route deviations due to gusts of wind
8. Areas of the map that should be avoided (public squares, marketplaces, etc.)
Question 3

How could the authorities be convinced to implement the necessary legal modifications?

We are part of an expert committee of different institutions (public and private, police, fire department, security companies, universities) which tries to give advice to the National Agency (Agencia Española de Seguridad Aérea “AESA”) regarding air security to modify the current air norms about urban areas
Conclusion

After the design we confirm that the technical viability is possible. We will finish work on airway at the end of this year.

But is it economically beneficial? Also will the cost to send the merchandise by drone be less than to send it by the current methods of transport?
Future Work

Show the design of the airways

Economically beneficial. Is it viable?

We have to convince our authorities of the desirability of drones in the urban logistics

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Thank you very much!

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