



Analyzing the **operational** and **cost impacts** of **pick-up points** on **e-commerce's last mile** distribution: the case of São Paulo, Brazil

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E-commerce

- One of the fastest growing marketing channels for consumers
- Some challenges
 - Free shipping 24h delivery same day delivery
 - Return policies Delivery failed
- Consumers behavior => more frequent deliveries.
- Home deliveries is one the crucial aspects in terms of costs and level of service
 - Up to 28% of a product's total transportation cost.

Black Friday on track for record online spending

Black Friday (Nov 23): 6.7 bi USD

Singles Day (Nov 11): 30.8 bi USD

Fonte: <https://www.cnn.com/2018/12/04/how-chinas-singles-day-became-the-worlds-biggest-shopping-holiday.html>

The Singles Day is in China — not the US. Here's how Singles Day became No. 1

Growing urbanization

1900 | 2 out of every 10 people lived in an urban area



1990 | 4 out of every 10 people lived in an urban area



2010 | 5 out of every 10 people lived in an urban area



2030 | 6 out of every 10 people will live in an urban area



2050 | 7 out of every 10 people will live in an urban area

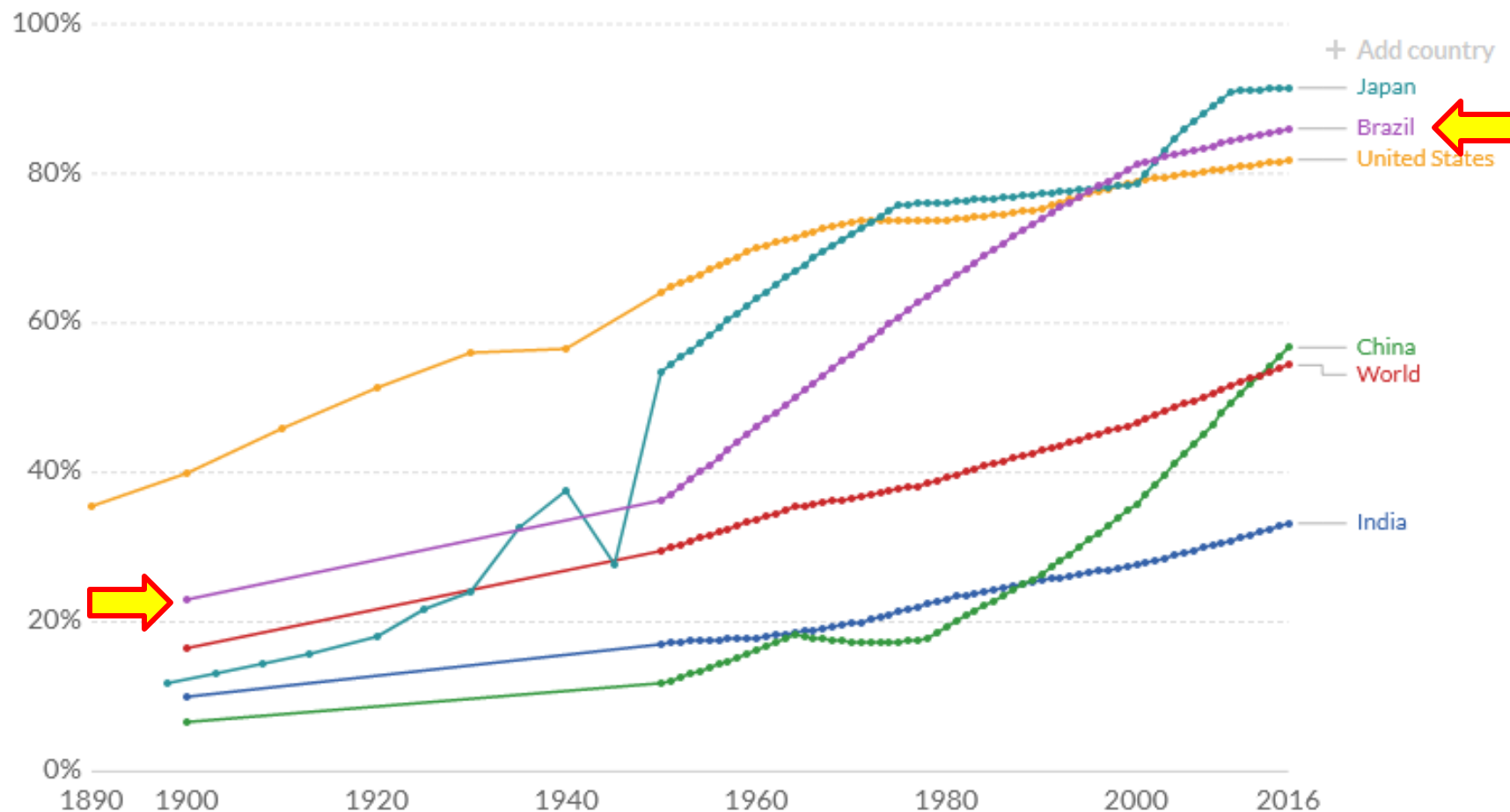


Urbanization growth

Urbanization over the past 500 years

Share of the total population living in urban areas. Urban areas are based on national definitions and may vary by country.

Our World
in Data



Source: OWID based on UN World Urbanization Prospects 2018 and historical sources (see Sources)

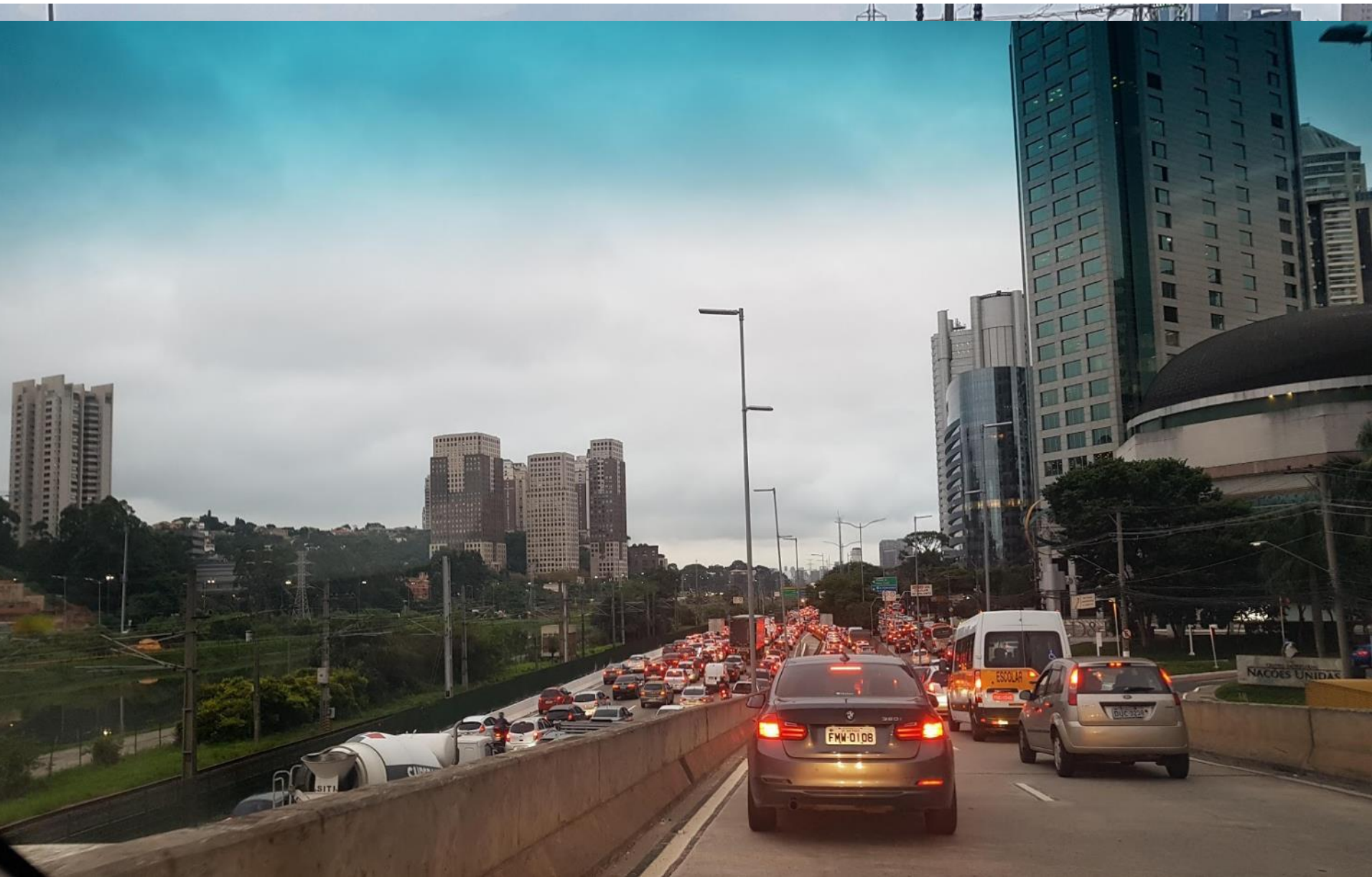
São Paulo, Brazil

21 million inhabitants



► 10% of the country's population

Traffic congestion



Not exactly new....



Downtown São Paulo, 60's

The boom of package delivery

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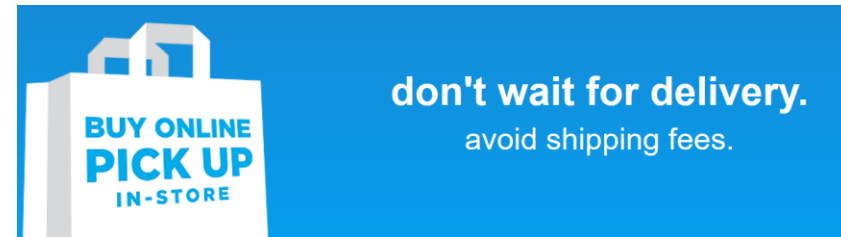
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Curbside increasing complexiy



Pick-up in store



The role of sellers

Marketplace **Pulse** 

OCTOBER 10, 2019

Amazon Has Added Three Million Sellers Since
2017

**Amazon Squeezes Sellers to Optimize Warehouse
Space**

CFO JOURNAL

Argentinian Company Wants to Build the Amazon of Latin America

Buenos Aires-based e-commerce company is working to strengthen its foothold in the region and fend off Amazon and Alibaba



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THE E-COMMERCE PARCEL DELIVERY MARKET AND THE IMPLICATIONS OF HOME B2C DELIVERIES VS PICK-UP POINTS

IVAN DARIO CARDENAS[★] · WOUTER DEWULF^{★★}

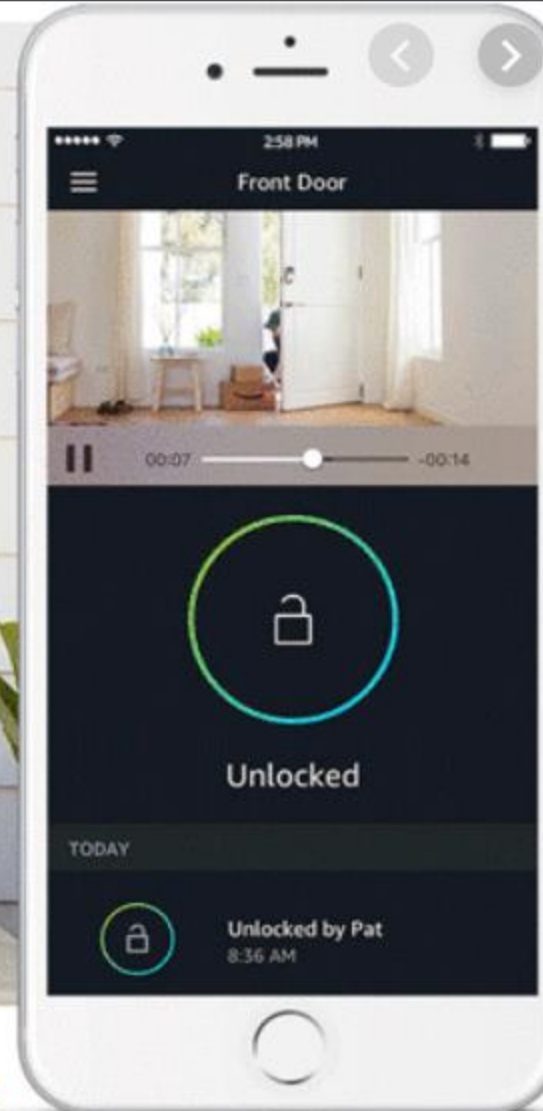
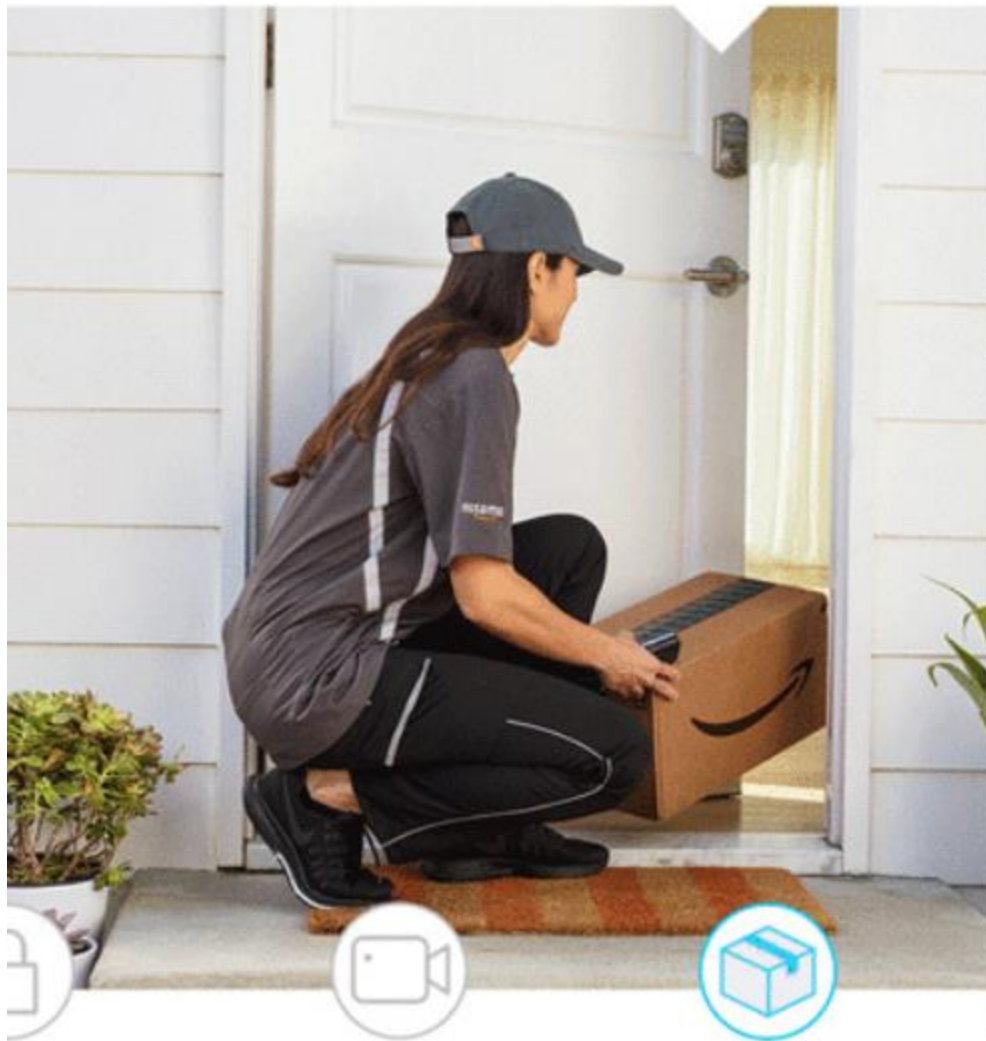
THIERRY VANELSLANDER^{★★★} · CHRISTOPHE SMET^{★★★★}

JORIS BECKERS^{★★★★★}

Distribution Costs Drivers	Handling Costs Drivers
<ul style="list-style-type: none">• Failed Deliveries• Time Windows• Returns• Density• Consolidation• Vehicles• Congestion	<ul style="list-style-type: none">• Failed Deliveries• Returns• Consolidation• Peak Seasons

FIGURE 3. Main cost drivers in the e-commerce parcel delivery market.
Own composition, adapted from (Gevaers 2013).

Unattended home delivery



1. Amazon authorizes the delivery person to turn on Cloud Lock and unlock your door.

2. You'll get confirmation that your package was safely delivered.

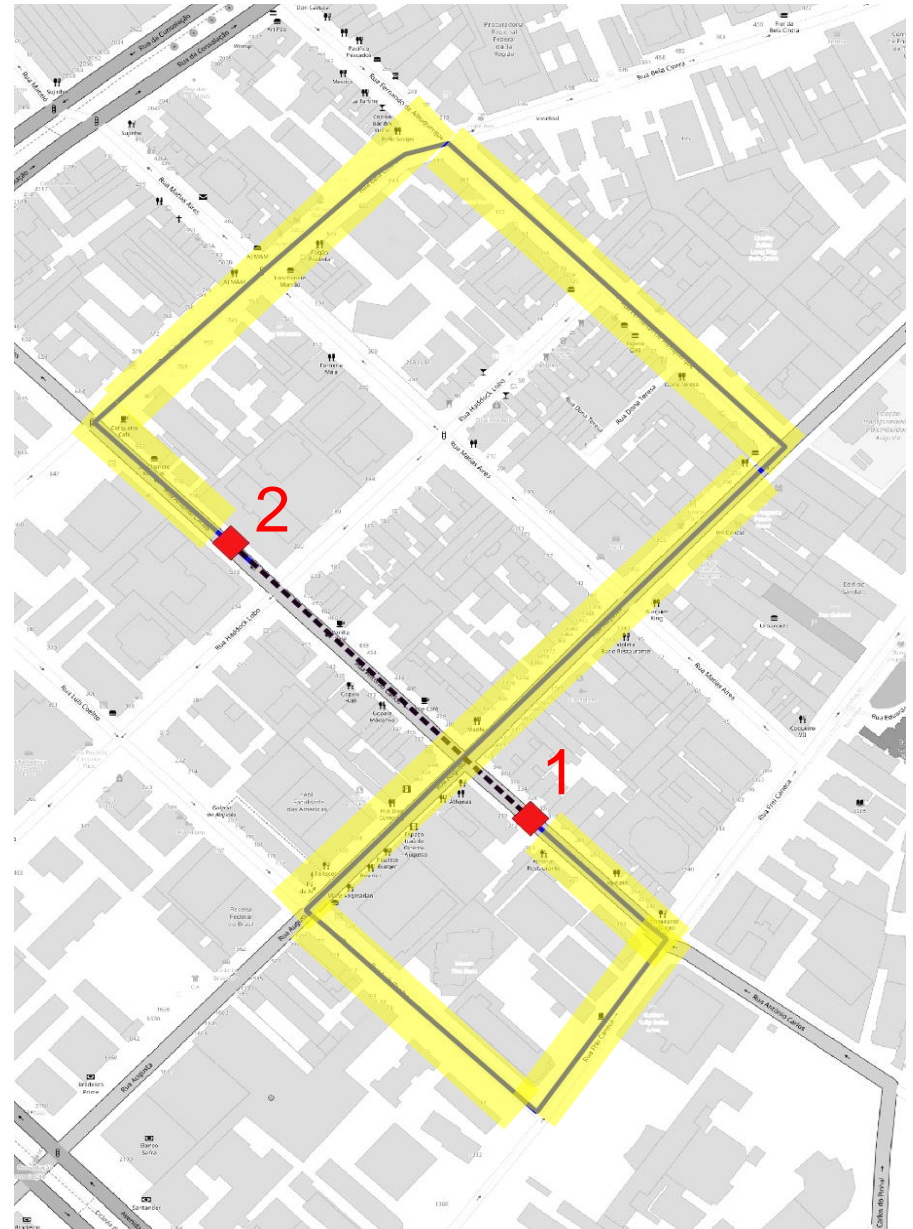
3. You can watch the delivery live or view a video clip of it after.

Failed deliveries to home addresses




Consequences of failed deliveries


- ▶ More mileage
- ▶ Less deliveries per vehicle
- ▶ More vehicles



Pick-up points (non-automated)

Rue du Dr Charles Nancel Penard
Bordéus, Nova-Aquitânia

 Google
AGO 2015

 Cartridge World

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amazon.fr

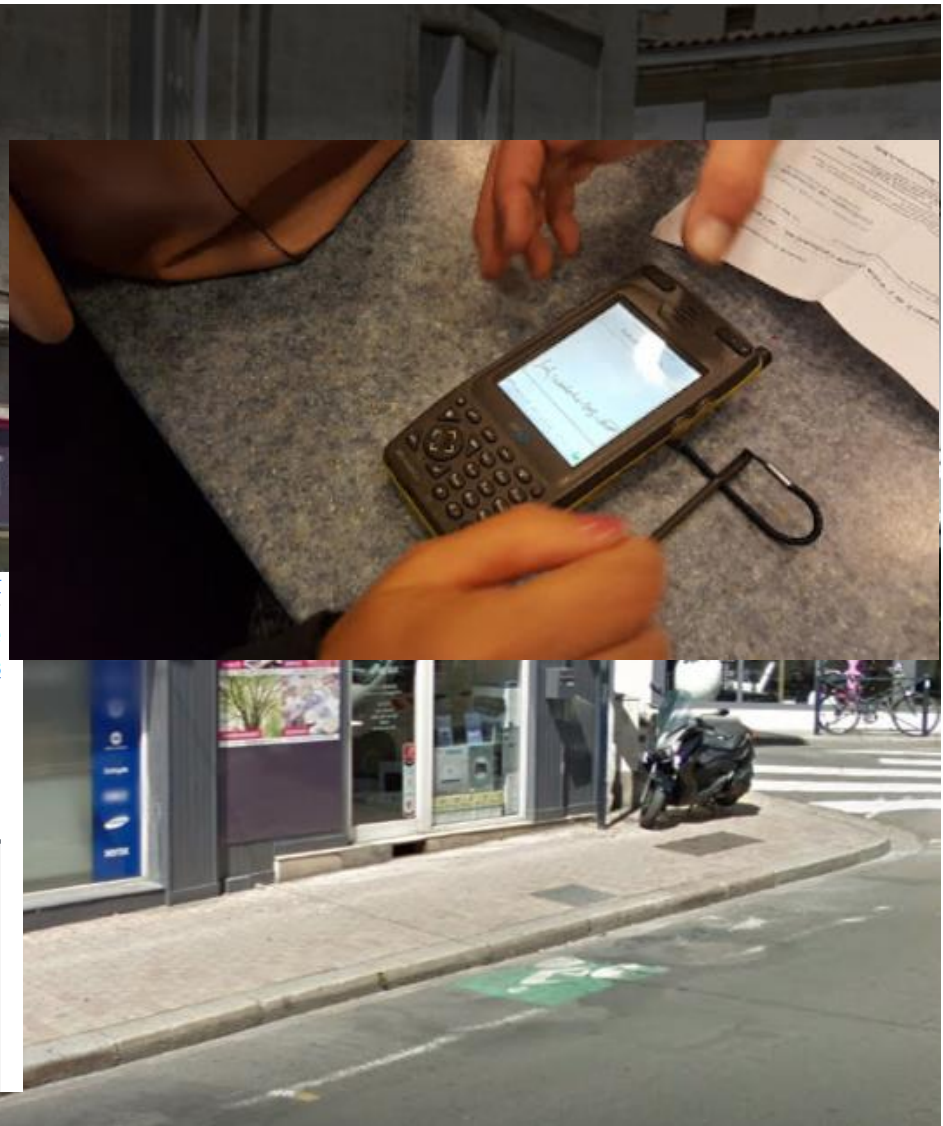
Confirmation de commande
Commande n° [404-3827003-5369128](#)

Bonjour,

Nous vous remercions de votre commande. Nous vous tiendrons informés par e-mail lorsque les articles de votre commande auront été expédiés. Votre date de livraison estimée est indiquée ci-dessous. Vous pouvez suivre l'état de votre commande ou modifier celle-ci dans [Vos commandes](#) sur Amazon.fr.

Livraison : Samedi 28 mai - Mercredi 1 juin	Votre commande sera expédiée à : LP - CARTRIDGE WORLD 25 RUE DR CHARLES NANCEL PENARD BORDEAUX, 33000 France
Votre mode de livraison : Retrait en point relais	Destinataire au point relais : Beatriz Madalena Volpe da Motta

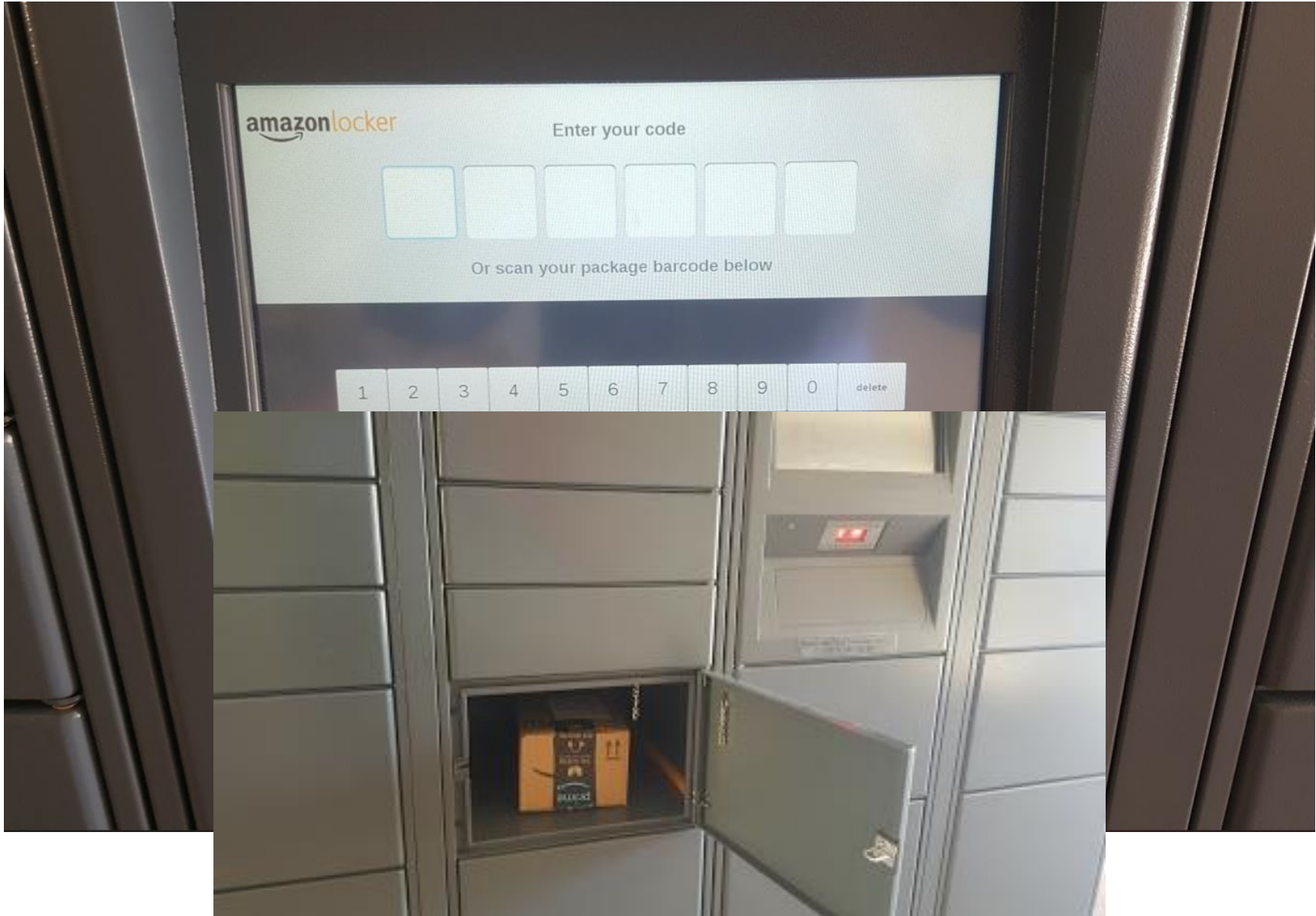
[Détails de la commande](#) 



Automated Parcel Stations (APS) - Lockers





It works in a very straightforward way





Potential benefits of pick-up points

- ▶ Promote consolidation of final deliveries
- ▶ Increase the number of successful first-time deliveries
- ▶ Increase vehicle efficiency
 -  stops
 -  mileage
- ▶ Reduce congestion and emissions (GHG)
- ▶ Reduce last mile distribution costs

Research questions

- ▶ In what conditions are PP/APS more efficient than home deliveries for B2C e-commerce? (operational)
 - Demand density
 - Distance and willingness to retrieve package (customer)
 - Location of the depot from where delivery vehicles depart
- ▶ How many vehicles and VMT can be reduced?
- ▶ How many PP/APS should there be?
- ▶ Dedicated routes to delivery to PP/APS?

Our approach



Select a central urban área (high population density)

Randomly generate daily home deliveries

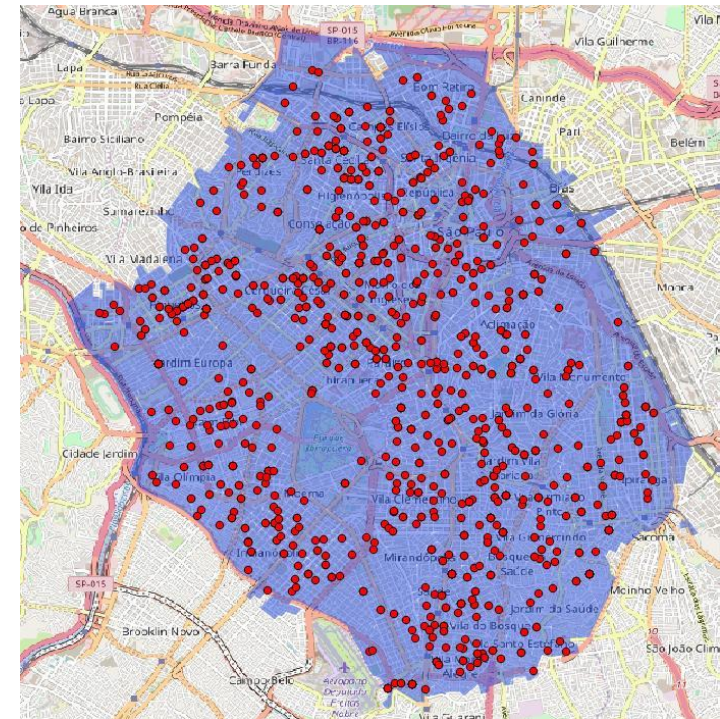
Determine the number and best locations for PP/APS

- Set covering MIP optimization formulation
- Willingness to walk: 0.5 mile (10 min), $\frac{3}{4}$ mile (15 min)
- Existing commercial establishments: gas stations, supermarkets, malls,...

Solve fleet size and mix vehicle routing problem

Selected rea and delivery locations

- ▶ Based on real data from a major online shopping retailer
- ▶ Central region of the megacity of São Paulo, Brazil
 - Area: 93.2 km²
 - Population: 1.2 million
 - Density: 12,560 people/km².
- ▶ Deliveries
 - Item average weight: 4.3 kg (10 pounds)



PP/APS Location Model



Set Covering Model

Parameters:

i = customer

j = locker candidate

d = max distance that the customer is willing to travel

$$a_{ij} = \begin{cases} 1, & \text{if the customer } i \text{ is in less than} \\ & d \text{ km from candidate } j \\ 0, & \text{otherwise} \end{cases}$$

Variables:

$$x_j = \begin{cases} 1, & \text{if the candidate } j \text{ will be used} \\ 0, & \text{otherwise} \end{cases}$$

Constraints:

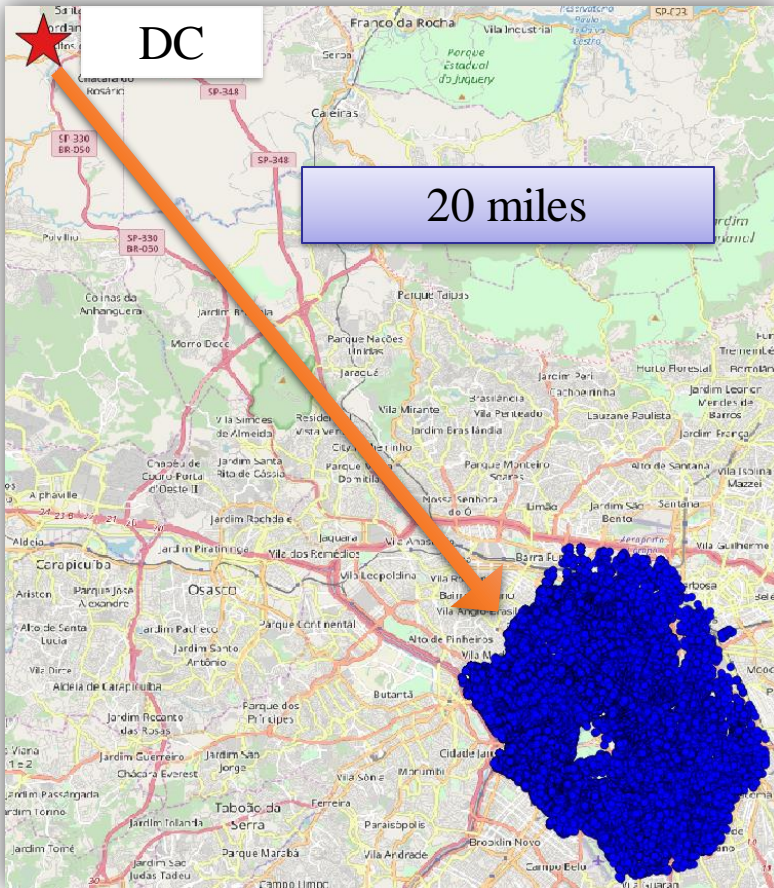
$$\sum_{j=1}^n a_{ij} x_j \geq 1, \forall i = 1, \dots, n$$

$$x_j \in \{0,1\}, j = 1, 2, \dots, n$$

Objective Function:

$$\min \sum_{j=1}^n x_j$$

Location of the DC



- Impact of different locations (distances)

What is the best time of vehicle to use



	Motorcycle	Light Van	Van
Fixed Cost (BRL/day)	123.05	168.59	207.16
Variable Cost (BRL/km)	0.15	0.44	0.43
Weight capacity (kg)	30	650	1.620
Maximum route length (h)	10	10	10
Fixed time (per stop)	00:01:30	00:04:30	00:06:00
Variable time (per package)	00:00:36	00:00:36	00:00:36
Speed (km/h)	35	25	15

Results: costs, distances and fleet

% of PP deliveries	Total cost (\$)			Total distance (km)			Required Fleet		
	0.5 miles	3/4 miles	Independent routes	0.5 miles	3/4 miles	Independent routes	0.5 miles	3/4 miles	Independent routes
0%	4009			2045			2 Vans 16 Light vans		
20%	4030	3997	4454	2006	2017	2045	3 Vans 15 Light vans	2 Vans 16 Light vans	2 Vans 18 Light vans
40%	3772	3609	4077	1888	1816	2289	2 Vans 15 Light vans	3 Vans 13 Light vans	3 Vans 15 Light vans
60%	3377	3265	3657	1672	1545	2113	3 Vans 12 Light vans	6 Vans 8 Light vans	4 Vans 12 Light vans
80%	2911	2614	3080	1337	1214	1840	8 Vans 4 Light vans	6 Vans 5 Light vans	6 Vans 7 Light vans
100%	2027	2005	2027	860	809	860	8 Vans	8 Vans	8 Vans

Results: average times and vehicle utilization

	Avg route time (h)			Avg veh occupation vol (%)		
% of PP deliveries	0.5 miles	3/4 miles	Independent routes	0.5 miles	3/4 miles	Independent routes
0%	9.5			90.3%		
20%	9.2	9.1	8.9	86.3%	88.5%	82.7%
40%	8.9	9.2	9.2	94.7%	93.8%	86.1%
60%	8.8	9	8.8	96,0%	85.7%	85.5%
80%	9.2	9	9	84,0%	94.7%	80.6%
100%	8.9	7.9	8.9	93,0%	93,0%	93,0%

Concluding remarks

► PP/APS are efficient

- Yields to reduced cost, fleet required, total distance traveled
- only becomes effective if the % of deliveries $\geq 40\%$
- Otherwise only a few home deliveries per vehicle (in some cases just one) are replaced by a delivery to a pick-up point.

► Work in progress

- New delivery densities, other distances from the origin DC
- Improvements in our VRP algorithm
- Comparing our VRP algorithm against benchmark instances



Thank you!

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<http://cislog.poli.usp.br/>