



Aalto University
School of Business

Session 5: Urban logistics

35E00750 Logistics Systems and Analytics

Dr. Tri M. Tran
Assistant Professor of Operations Management
University of Groningen
<https://www.rug.nl/staff/tri.tran/>

Course contents

Part 1. Background

1. Understanding supply chains
2. Achieving supply chain fit
3. Mathematical programming for Logistics & SCM
4. Guest lecture: Janne Kilpua (intralogistics)

Part 2. Transportation

5. **Urban logistics**
6. Vehicle routing problems

Part 3. Facilities

7. Warehousing technologies
8. Guest lecture: Vesa Hämetvaara (Konecranes)
9. Facility location problems

Part 4. Data

10. Digital logistics
11. Logistical drivers and metrics

Setting the science

Last mile vs. first mile

Urban Mobility
Perspective



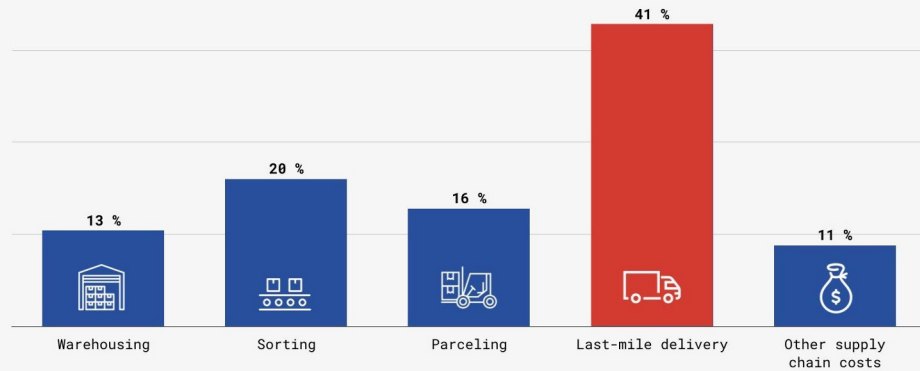
Supply Chain
Perspective



Rising cost of last-mile delivery



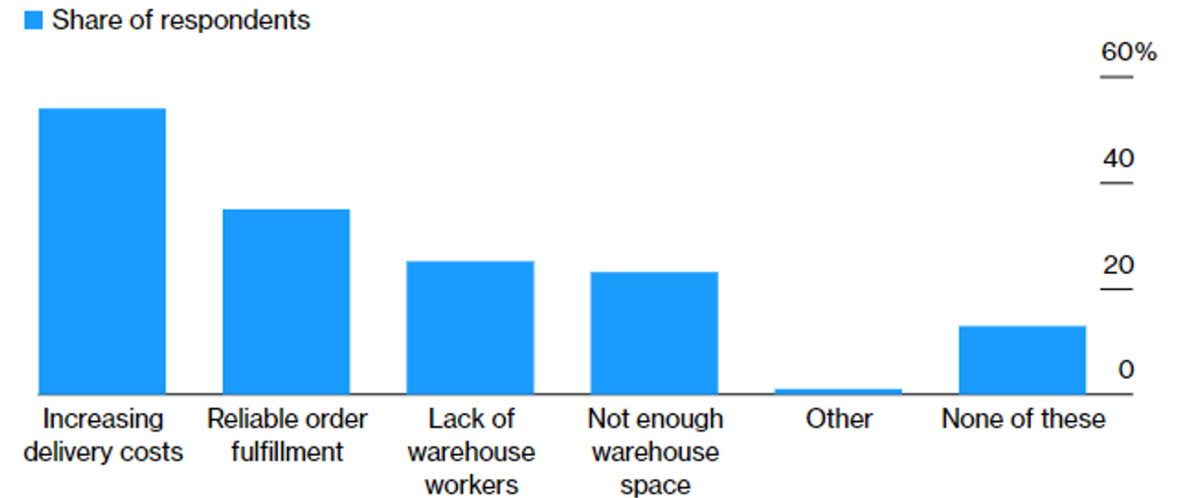
Last-mile delivery is the biggest cost driver in the supply chain.



Source: S Capgemini Research Institute, Last-mile delivery executive survey, October–November 2018, N=500 executives.

Fulfillment Challenges

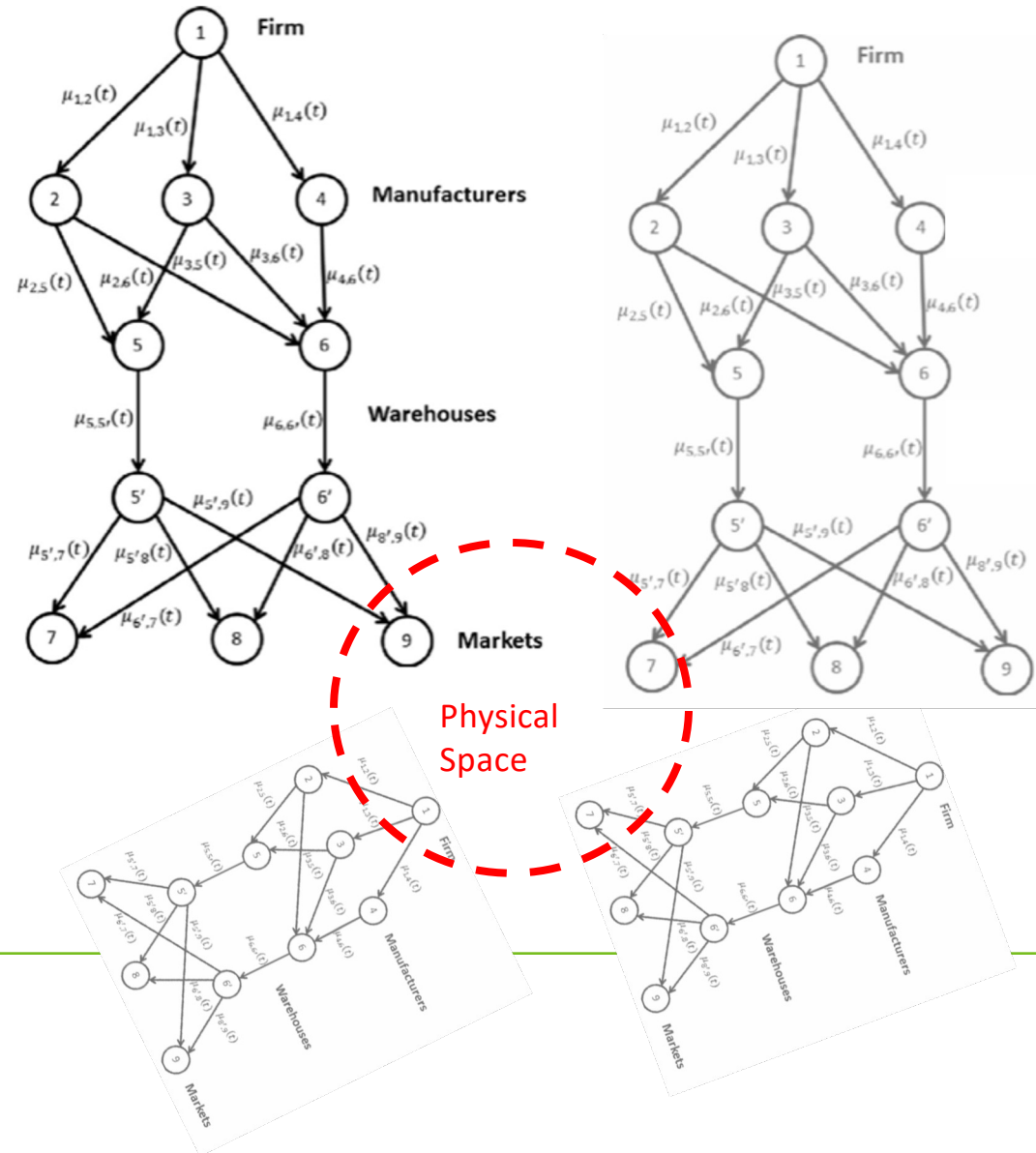
Last mile of supply chain poses hurdles for U.S. retail, e-commerce executives



<https://www.bloomberg.com/news/articles/2020-12-07/delivery-cost-is-top-last-mile-issue-in-retail-logistics-chart>

<https://www.capgemini.com/wp-content/uploads/2019/01/Report-Digital-%E2%80%93-Last-Mile-Delivery-Challenge1.pdf>

Where in the supply chain is city/urban logistics?



City logistics

- City centers are often **challenging** for deliveries and collection due to **narrow streets** and **traffic jams**
- Logistics efficiency was not taken into account in planning **old houses' shops** and **waste rooms**
- City logistics involves planning deliveries in urban areas with **high population density**



City logistics challenges

- **Market challenges (Savelsbergh & van Woensel, 2016)**
 - Growth in urban population
 - Growth in e-commerce
 - The on-demand economy (delivery speed, flexibility, and reliability) and omnichannel retail
 - The sharing economy (gig workers, sharing logistics assets)
- **Challenges related to livability**
 - Climate change
 - Air quality
 - Congestion
 - Noise pollution
 - Safety
 - Use of limited space

City logistics segments



university of
 groningen

faculty of economics
 and business



General cargo and retail



Temperature controlled



Facility goods



Parcel and express delivery



Construction and renovation



Waste logistics

City logistics policy in Groningen



university of
 groningen

faculty of economics
 and business

Larger area time access restrictions for freight transport (from 2022) and zero-emission zone (from 2025)



Time access restrictions (from 2022)

- **5 AM to noon**
 - Cargo bike and LEV: as much as possible
 - Delivery van: only if cargo bike and LEV are inefficient
 - Trucks: allowed for large volumes
- **Noon to 6 PM**
 - Cargo bike and LEV: allowed when needed
 - Delivery van: now allowed
 - Trucks: not allowed
- **After 6 PM**
 - Cargo bike and LEV: allowed when needed
 - Delivery van: under very specific circumstances (+waiver)
 - Trucks: not allowed



Time access restrictions (from 2022)



university of
 groningen

faculty of economics
 and business

- **Strict enforcement using Automatic Number Plate Recognition (ANPR)**



Time access restriction

- **Strict enforcement using Automatic Number Plate Recognition (ANPR)**
- **Consistent waiver policy**



Innovative solutions



Aalto University
School of Business

Historic trends in logistics

Consolidation



university of
 groningen

faculty of economics
 and business

- Combine shipments when possible



Consolidation



university of
 groningen

faculty of economics
 and business

- **Combine shipments when possible**
 - Volume per trip goes up
 - Economies of scale emerge
 - Per unit transportation costs go down



Increasing scale



university of
 groningen

faculty of economics
 and business

1956: Ideal X (58 containers)



1966: Fairland (226 containers)



1872: Kurama Maru (2400 TUE)



1995: OOCL California (5300 TUE)



2005: Cosco Guangzhou (9400 TUE)



2022: Ever Alot (24004 TUE)

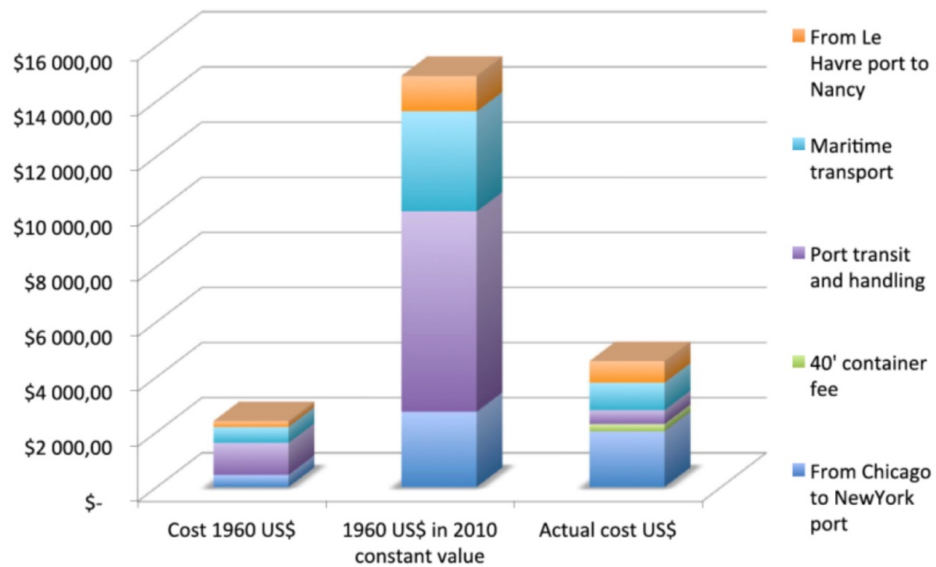
Source (in Dutch): <https://www.nt.nl/scheepvaart/2022/08/10/dit-zijn-de-grootste-containerschepen-van-de-afgelopen-66-jaar/?gdp=accept>

Economies of Scale

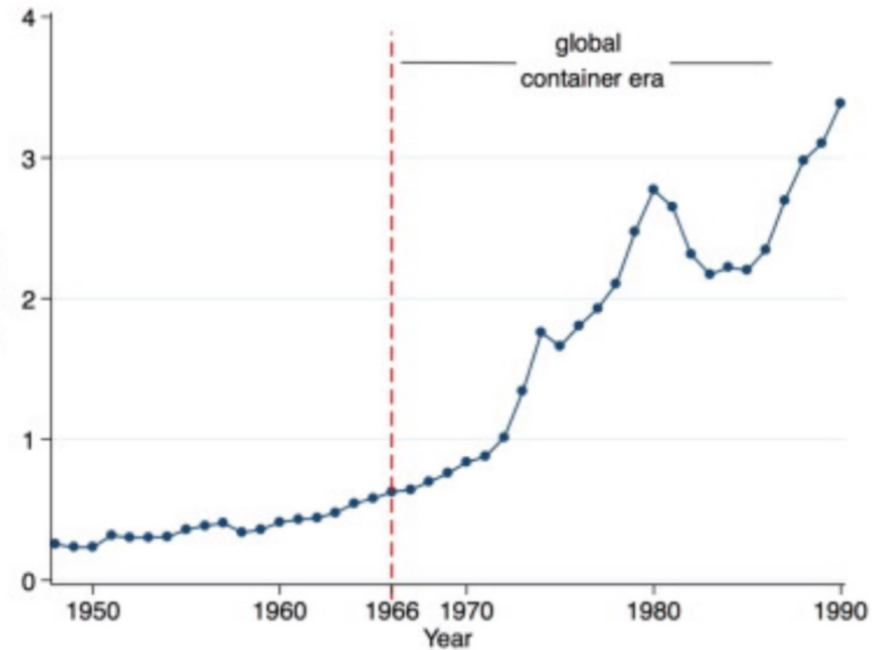


university of
 groningen

faculty of economics
 and business



Source: The Box, HAROPA & JB Hunt



Source: Bernhofen, D.M., El-Sahli, Z. and Kneller, R., 2016. Estimating the effects of the container revolution on world trade. *Journal of International Economics*, 98, pp.36-50.

Automation



university of
 groningen

faculty of economics
 and business



Source: <http://www.physicalinternetinitiative.org/>



Aalto University
School of Business

How the on-demand economy challenges historic trends

On-demand economy

On-Demand Economy is defined as the economic activity created by **technology companies** that fulfill consumer demand via the **immediate provisioning of goods and services**



On-demand economy

On-Demand Economy is defined as the economic activity created by **technology companies** that fulfill consumer demand via the **immediate provisioning of goods and services**

- Platform economy?
- Gig economy?
- Sharing economy?

On-demand economy

- **Mobility and travel**
 - Uber / Lyft / etc.
 - Go Sharing / Felix / etc.
 - Airbnb
- **Food delivery**
 - Just Eat Takeaway / Doordash / etc.
 - AH / Picnic
- **Professional services**
- ...



university of
 groningen

faculty of economics
 and business

OPINION

Let's Uberize The Entire Economy

Capital Flows Contributor @

Guest commentary curated by Forbes Opinion. Avik Roy, Opinion Editor.

Follow

POST WRITTEN BY

Brian M. Carney

Mr. Carney is a senior vice president at Rivada Networks.



Oct 27, 2014, 05:23pm EDT

Challenges of fast and flexible delivery



university of
 groningen

faculty of economics
 and business



Smaller shipment sizes



Shorter delivery times

Challenges with vehicle sizes



university of
 groningen

faculty of economics
 and business



Large vehicles don't fit urban space



1 large vehicle = many smaller ones

Challenges with vehicle emissions



university of
 groningen

faculty of economics
 and business



Emitting vehicles no longer
 desired/allowed



Zero-emission vehicles often smaller
 and with limited range

Summarizing the main challenges

- **Sustainability**
 - Climate change and other environmental concerns with internal combustion engines
- **Social**
 - Aging workforce, shortage of truck/van drivers
 - Safety issues and public space usage involved with road-freight
- **Economic**
 - Increasingly difficult to consolidate freight and deliver using full truckloads
 - Expanding the fleet is costly
 - 1 to 1 replacement (emitting to zero-emission) are not always available and are often more expensive
 - Wages of truck/van drivers are the largest part of the total cost of transportation

A framework for innovative city logistics

What is the future of urban logistics?



university of
 groningen

faculty of economics
 and business

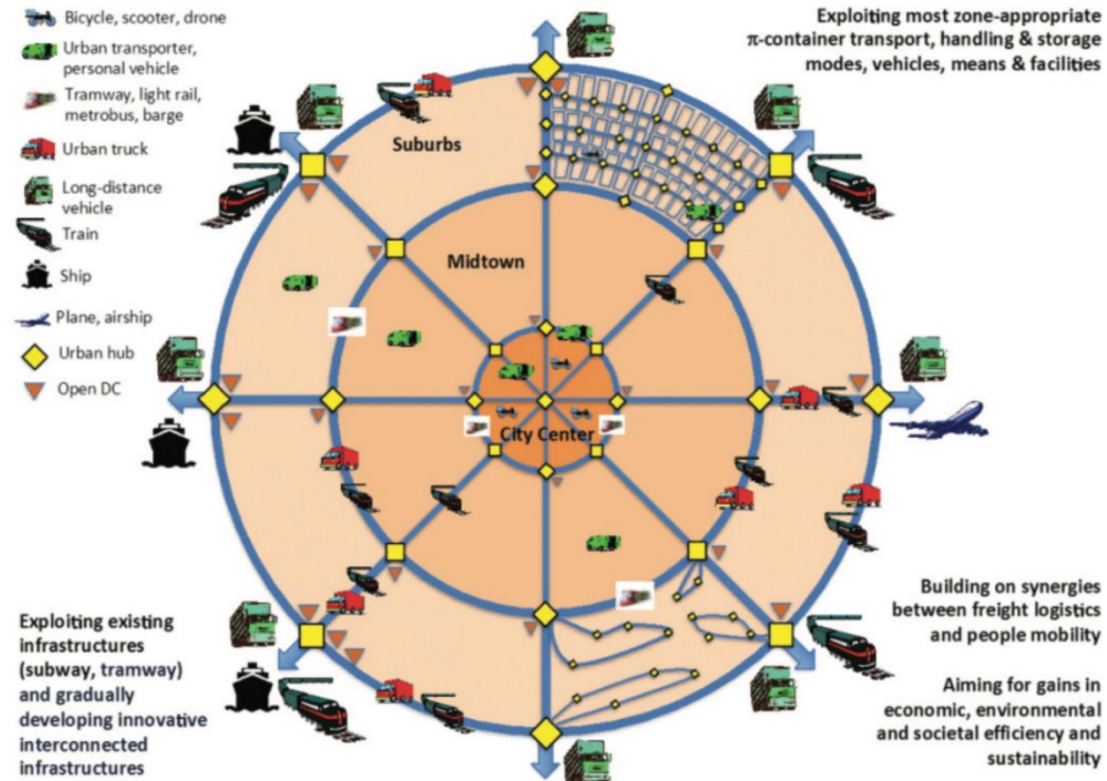


Multi-tier city logistics system



university of
 groningen

faculty of economics
 and business



Multi-tier city logistics system

- **Multi-tier systems consist of**
 1. different modes of transport (i.e., vehicle technology) at different tiers of the system
 2. nodes (i.e., facilities) connecting the different tiers
 3. information technology to design, plan, and control logistics operations in the system

1. Vehicle technology

- **Zero-emission vehicle technology**
- **Smaller-scale vehicle technology**
- **Autonomous vehicle technology**



**university of
 groningen**

faculty of economics
 and business

(Autonomous) vehicle technology



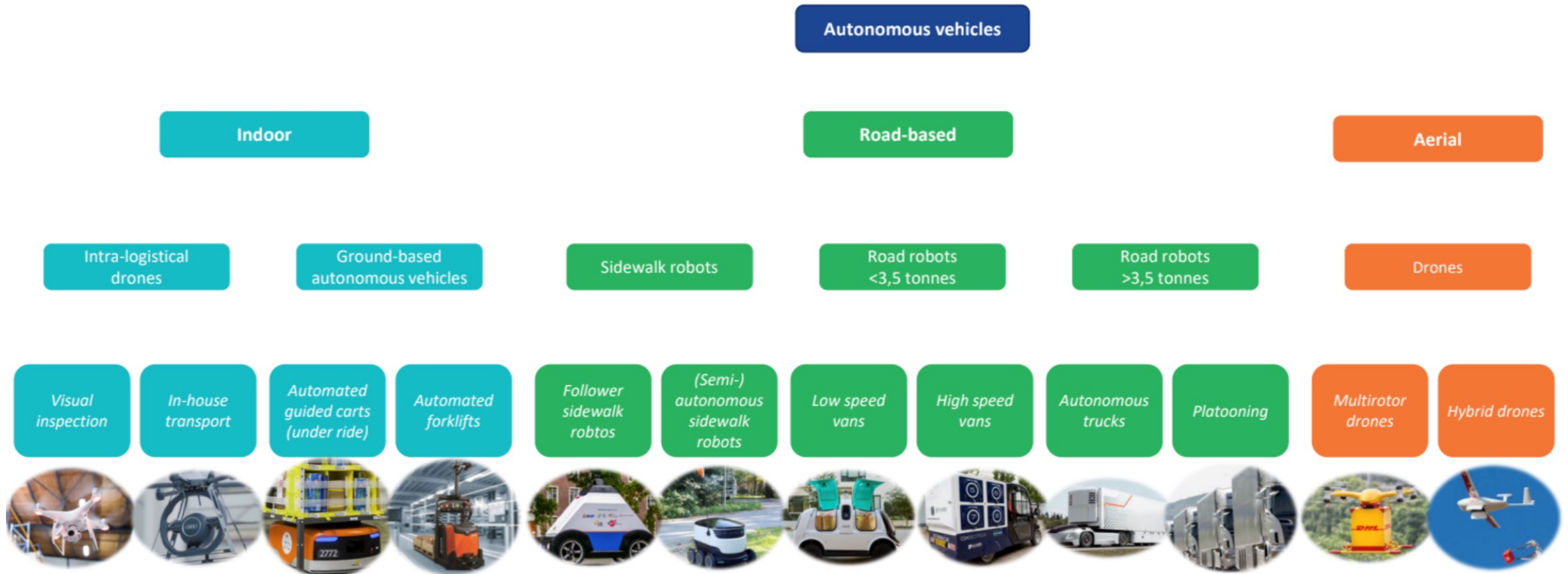
university of
 groningen

faculty of economics
 and business

Autonomous vehicles



(Autonomous) vehicle technology



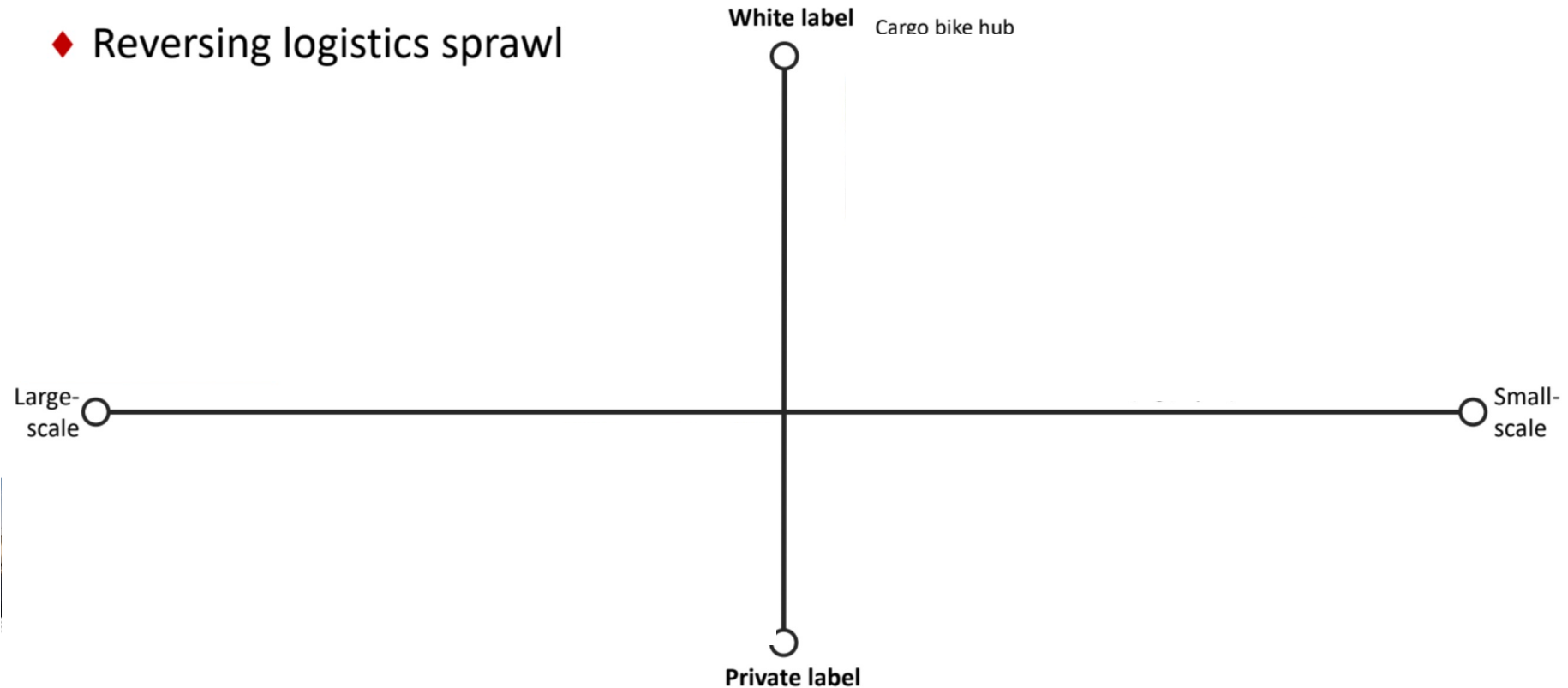
2. Facilities in multi-tier system



university of
 groningen

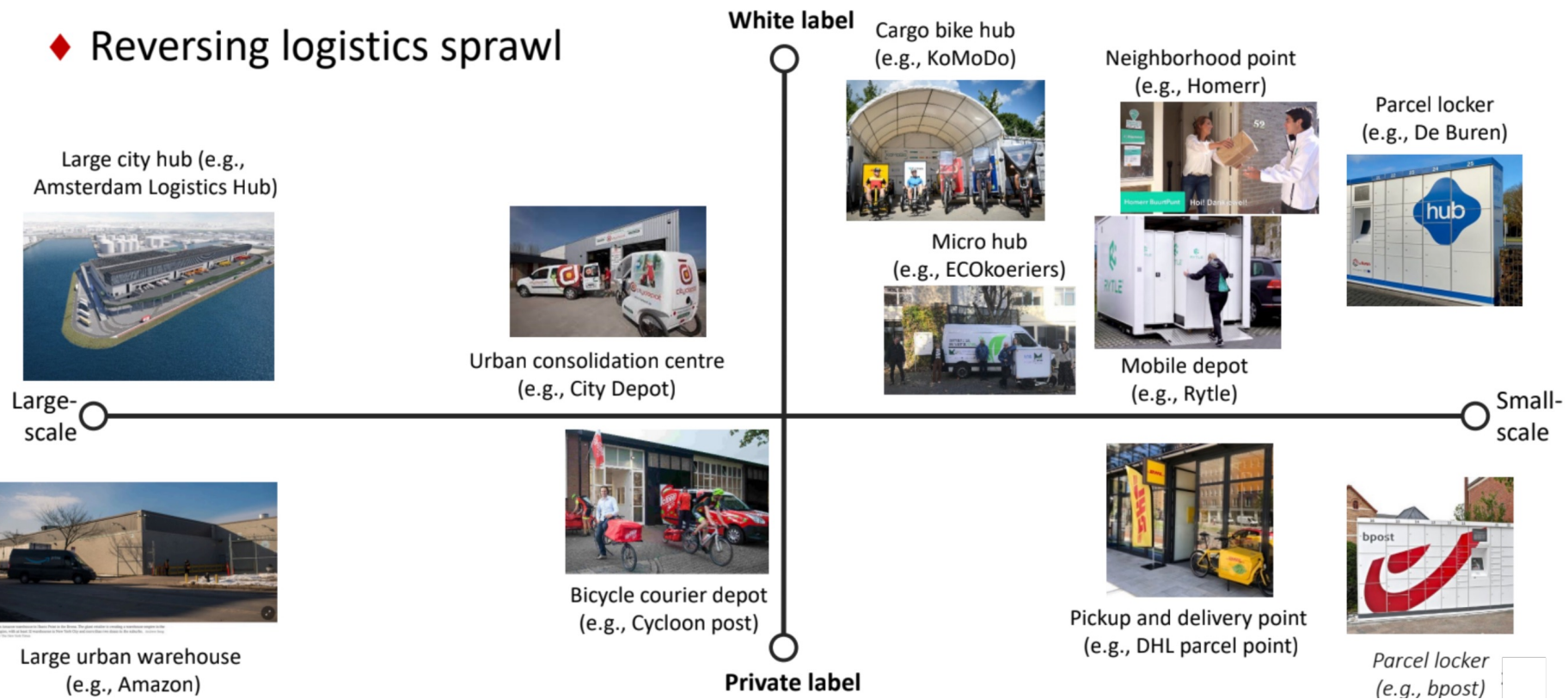
faculty of economics
 and business

◆ Reversing logistics sprawl



2. Facilities in multi-tier system

◆ Reversing logistics sprawl



3. Information technology

- **Commercial platforms, such as:**
 - Crowd-sourced (bike) couriers
 - Renting logistics space (warehouse)
- **City-initiated platforms, such as:**
 - Find a (un)loading bay
 - Track traffic load
- **Community-owned and operated platforms, such as:**
 - Cargo bike sharing

Now, let's delve into each of them



Aalto University
School of Business

Zero-emission vehicle technology

Uptake of zero-emission vehicles

How widespread are zero-emission vehicles of the following type?

- Cargo bikes
- (Light) electric commercial vehicles
- (Battery and Hydrogen) electric trucks

Cargo bikes



university of
 groningen

faculty of economics
 and business

- Approximations suggested about 100,000 cargo bikes and delivery bikes in 2020 in the Netherlands
- Growing to about 400,000 in 2025?

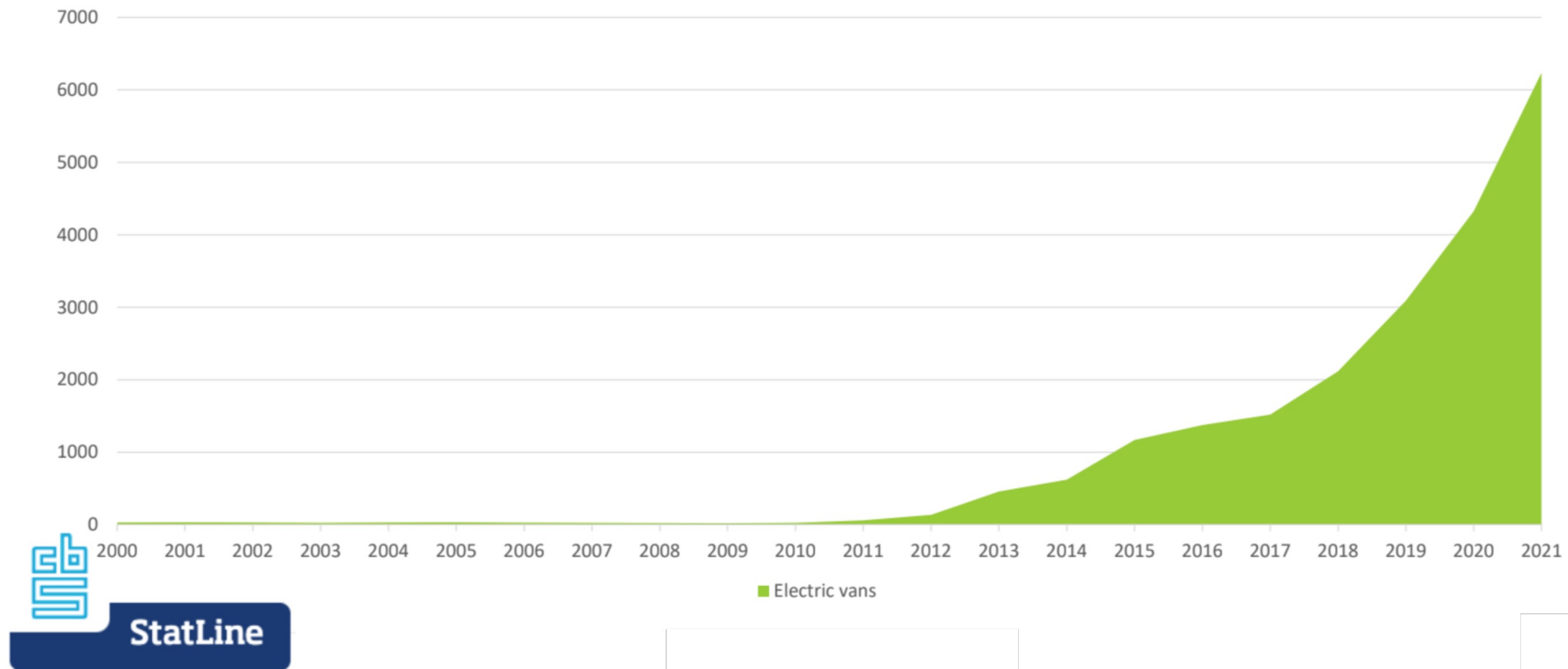


Uptake of electric vans



university of
 groningen

faculty of economics
 and business

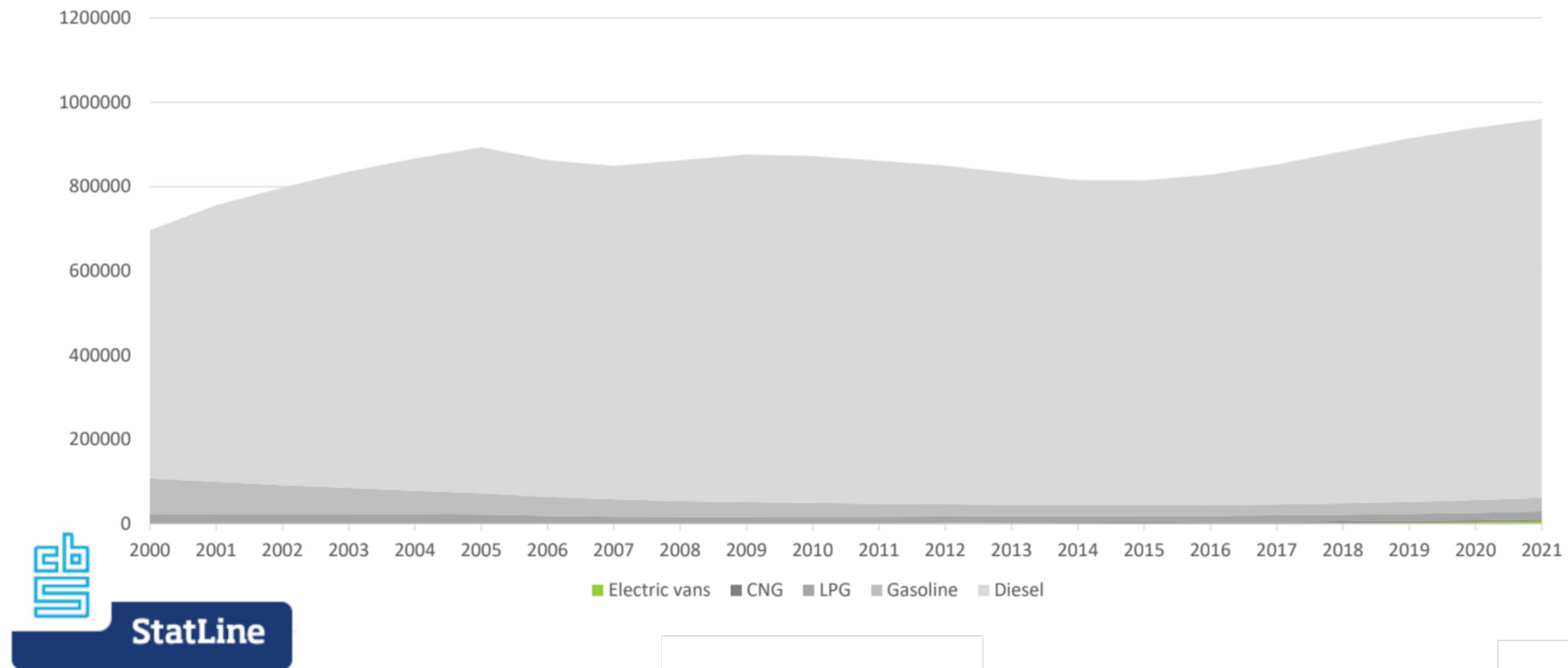


Uptake of electric vans



university of
 groningen

faculty of economics
 and business



Uptake of electric trucks



university of
 groningen

faculty of economics
 and business

Trucks (rigid) in 2021					
Total	Diesel	Gasoline	LPG	CNG	Electric
62491	60964	875	285	168	155
100%	97,6%	1,4%	0,5%	0,3%	0,2%



Semi-trailer trucks in 2021					
Total	Diesel	Gasoline	LPG	CNG	Electric
81179	80195	47	124	176	22
100%	98,8%	0,1%	0,2%	0,2%	0,03%

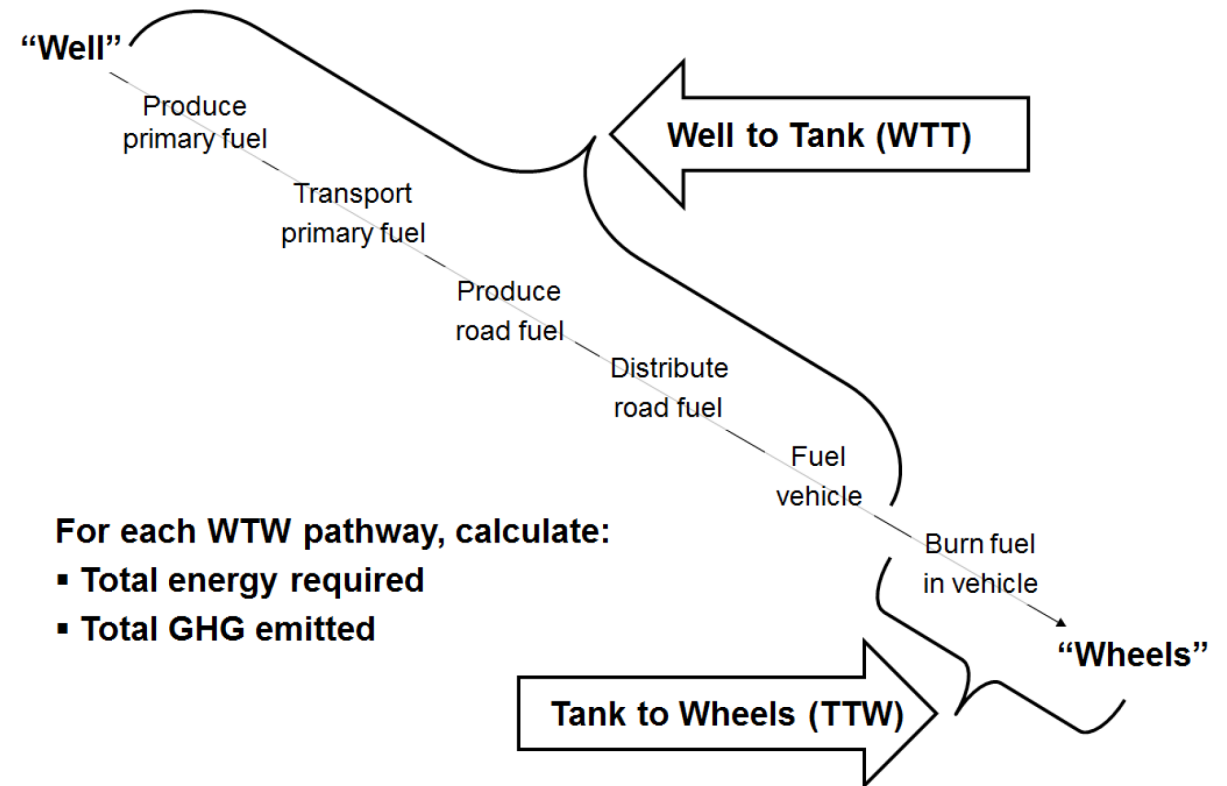


StatLine

Life cycle impact Battery Electric Vehicles (BEVs)

Life cycle phases

- Production phase
- Use phase
 - Fuel/energy consumption (well-to-tank & tank-to-wheel)
 - Maintenance
- Recovery



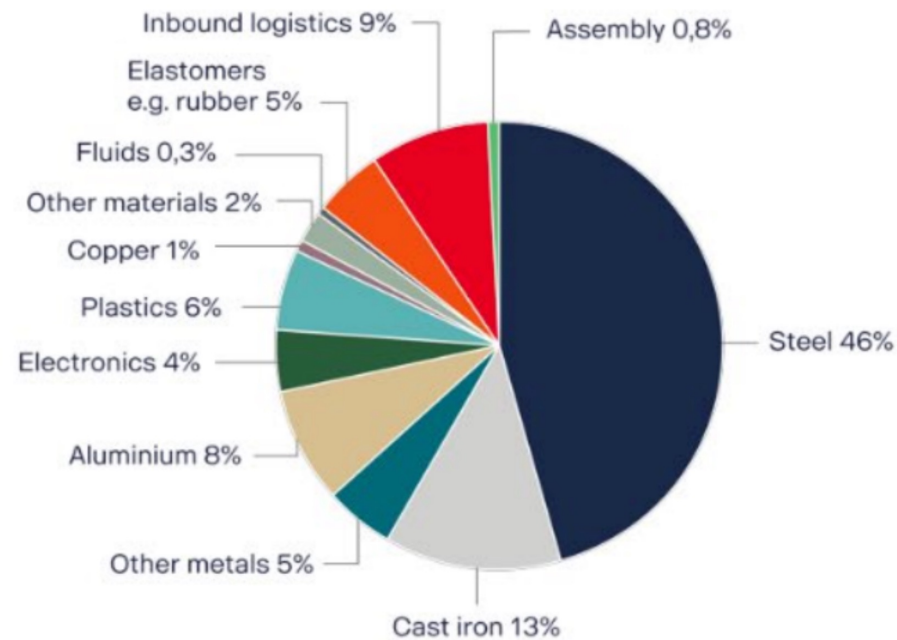
Production phase



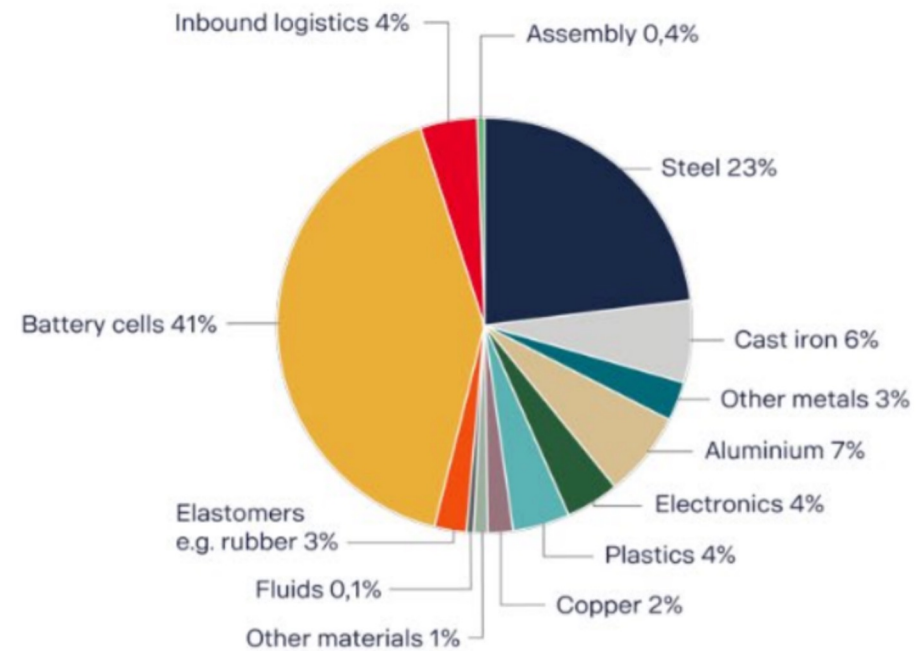
university of
 groningen

faculty of economics
 and business

ICEV



BEV



Use phase



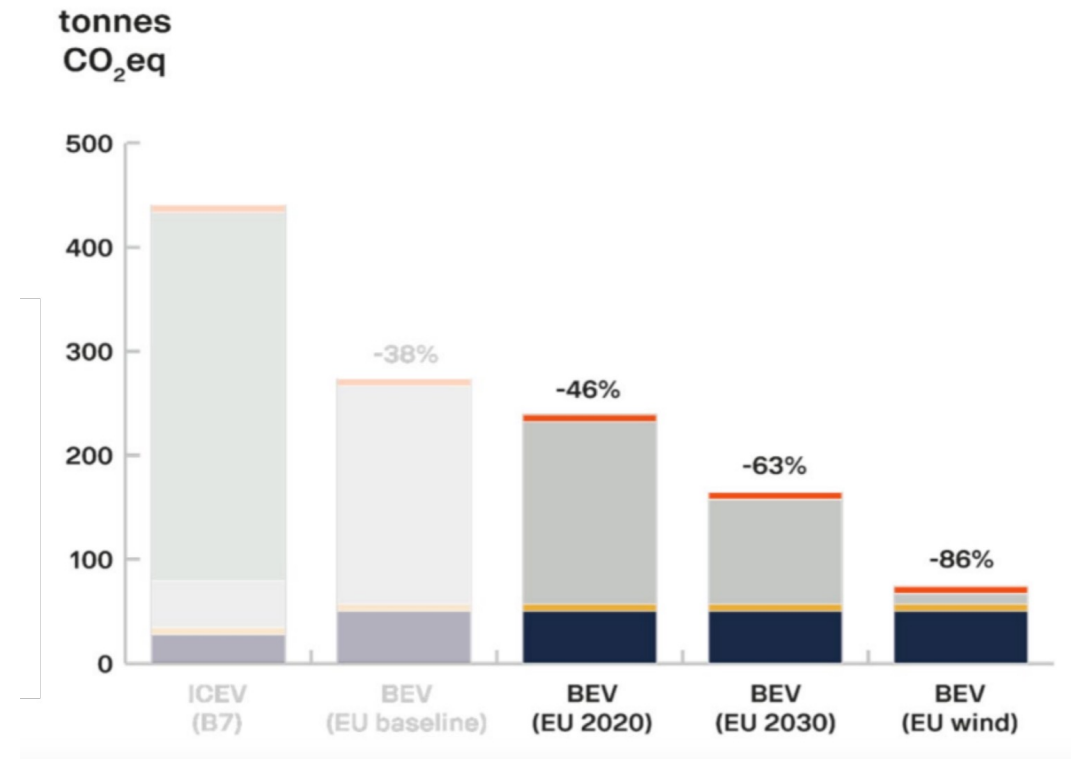
university of
 groningen

faculty of economics
 and business

Life cycle comparison

- Similar vehicles ICEV vs BEV
- 500 000 km
- 6.1-ton avg payload

Vehicle	Production	Maintenance	Use WtT	Use TtW	Recovery
ICEV (B7)	27,5	2,4	44,9	354,3	2,1
BEV (EU baseline)	53,6	2,4	209,5	0,0	2,1
BEV (EU 2020)	53,6	2,4	175,0	0,0	2,1
BEV (EU 2030)	53,6	2,4	100,2	0,0	2,1
BEV (EU wind)	53,6	2,4	4,7	0,0	2,1





Aalto University
School of Business

Facilities: Pickup points

Source: Buijs, P. and Niemeijer, R. "A Greener Last Mile: Reviewing the Carbon Emission Impact of Pickup Points in Last-Mile Parcel Delivery". Available at <http://dx.doi.org/10.2139/ssrn.4169737>

Pickup points (customer-pickup)



university of
 groningen

faculty of economics
 and business



Efficiency gains for courier



university of
 groningen

faculty of economics
 and business



Efficiency gains for courier



university of
 groningen

faculty of economics
 and business

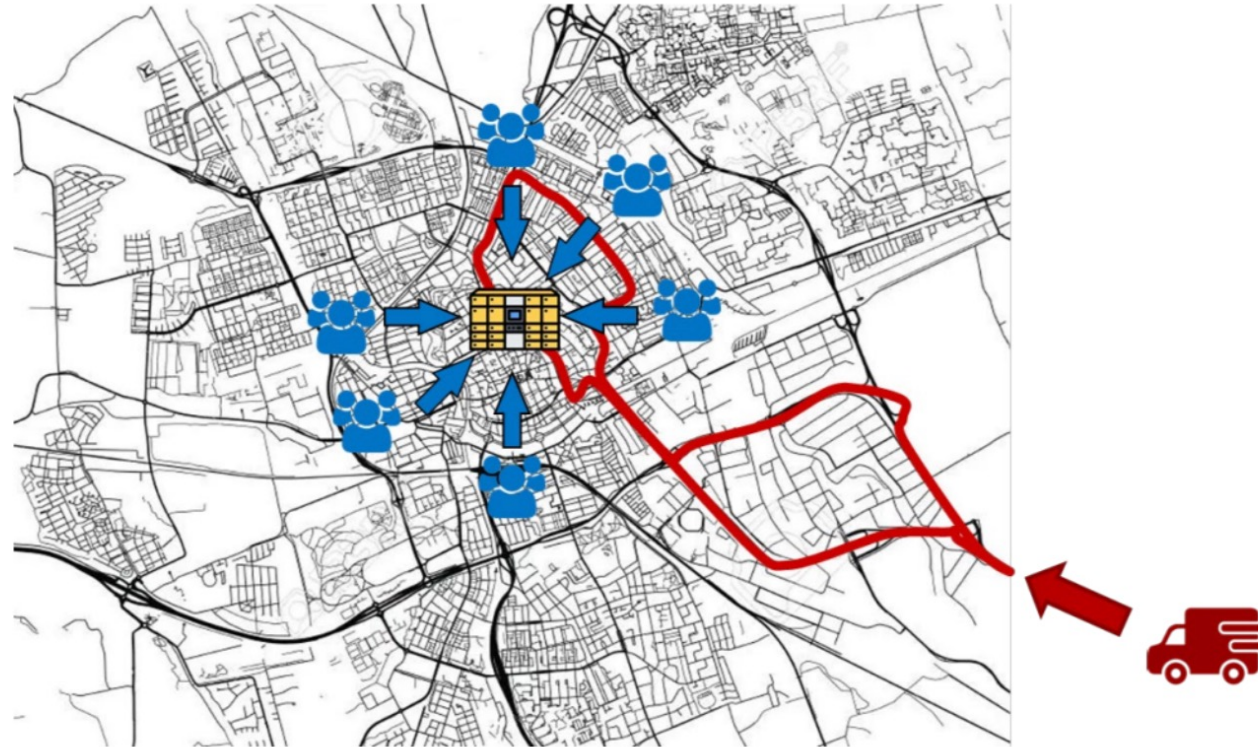


Efficiency gains for courier



university of
 groningen

faculty of economics
 and business

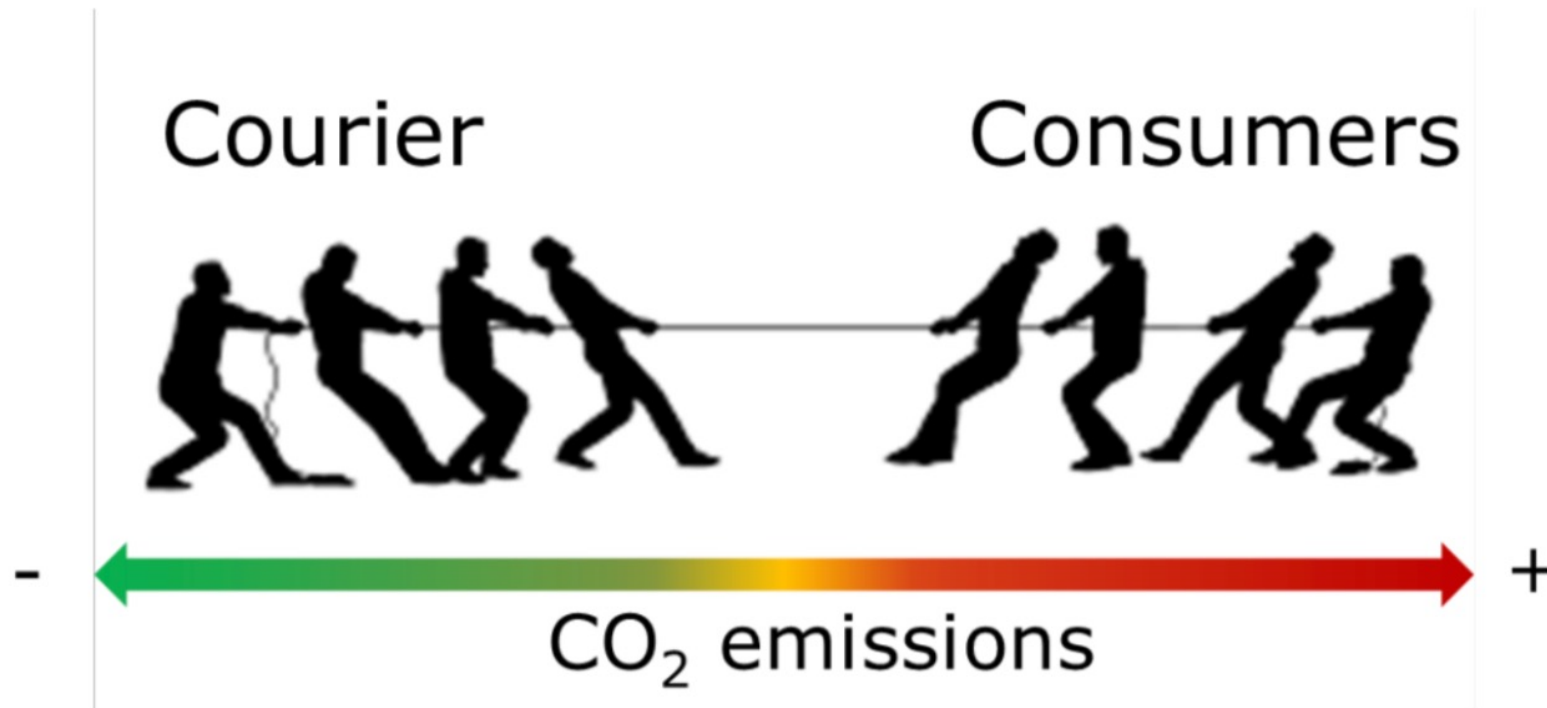


Greenhouse gas (GHG) emission impact?



university of
 groningen

faculty of economics
 and business



Greenhouse gas (GHG) emission impact?



university of
 groningen

faculty of economics
 and business



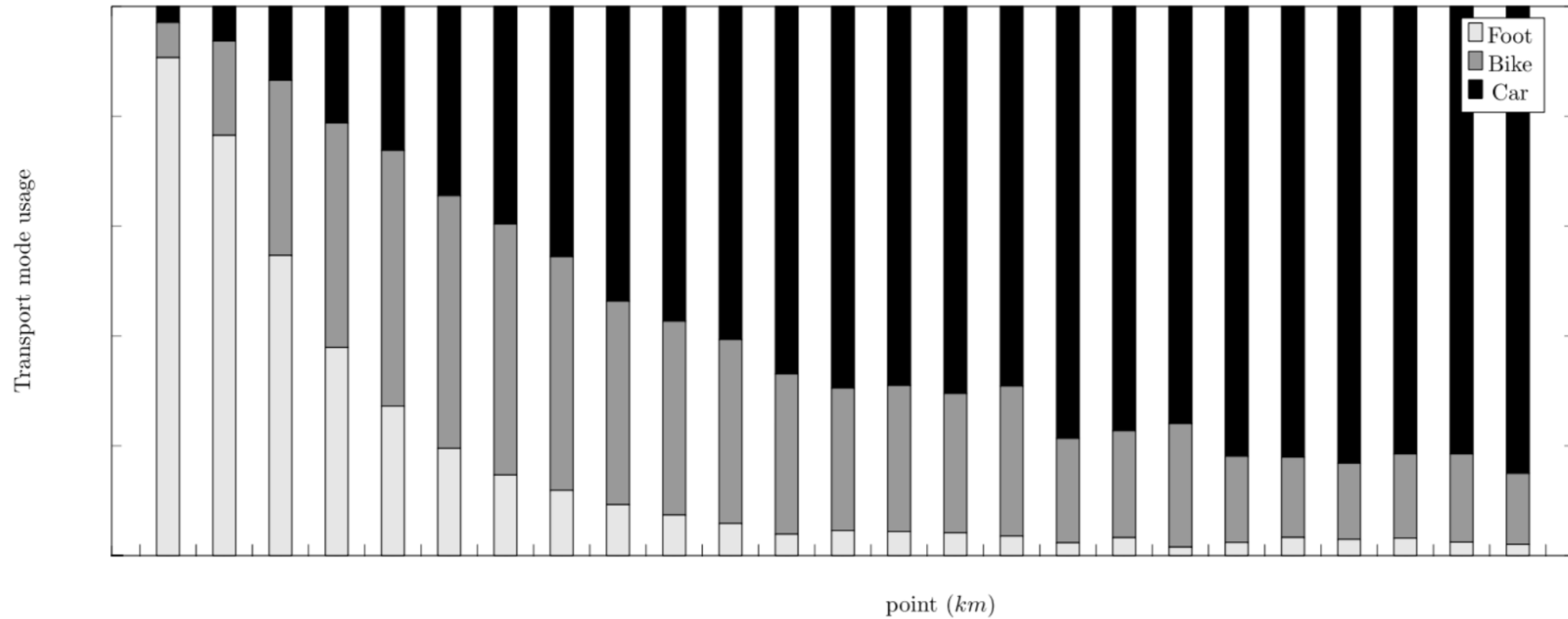
61

Greenhouse gas (GHG) emission impact?



university of
 groningen

faculty of economics
 and business



Greenhouse gas (GHG) emission impact?

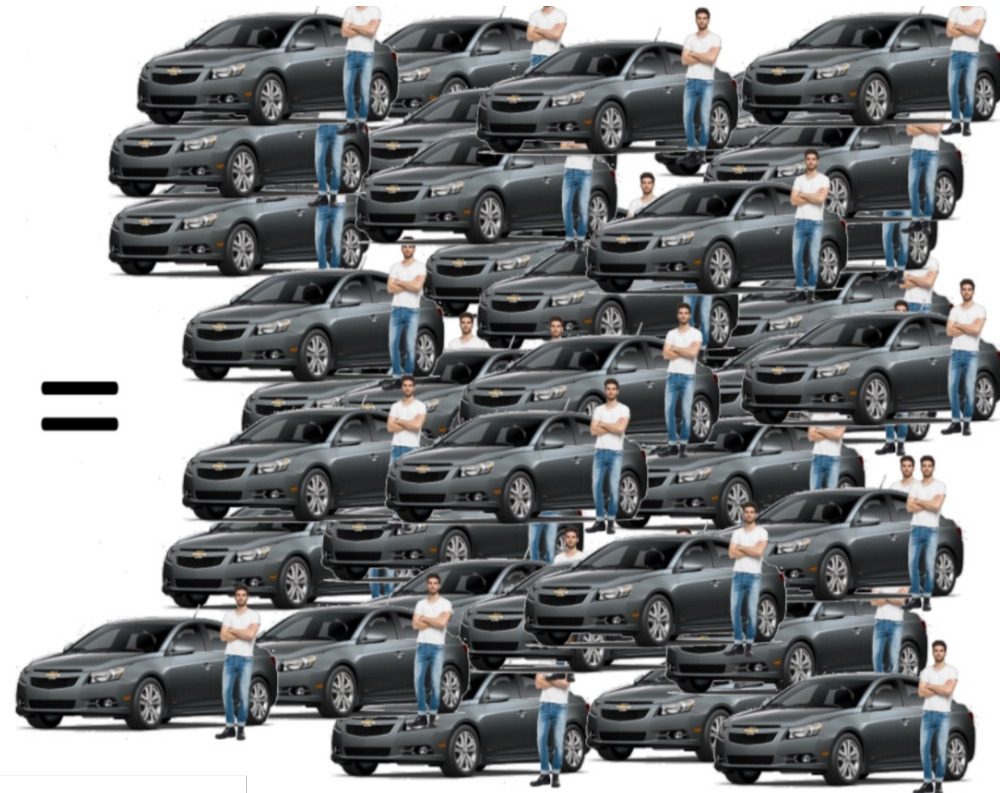


university of
 groningen

faculty of economics
 and business



=



63

Greenhouse gas (GHG) emission impact?



university of
 groningen

faculty of economics
 and business

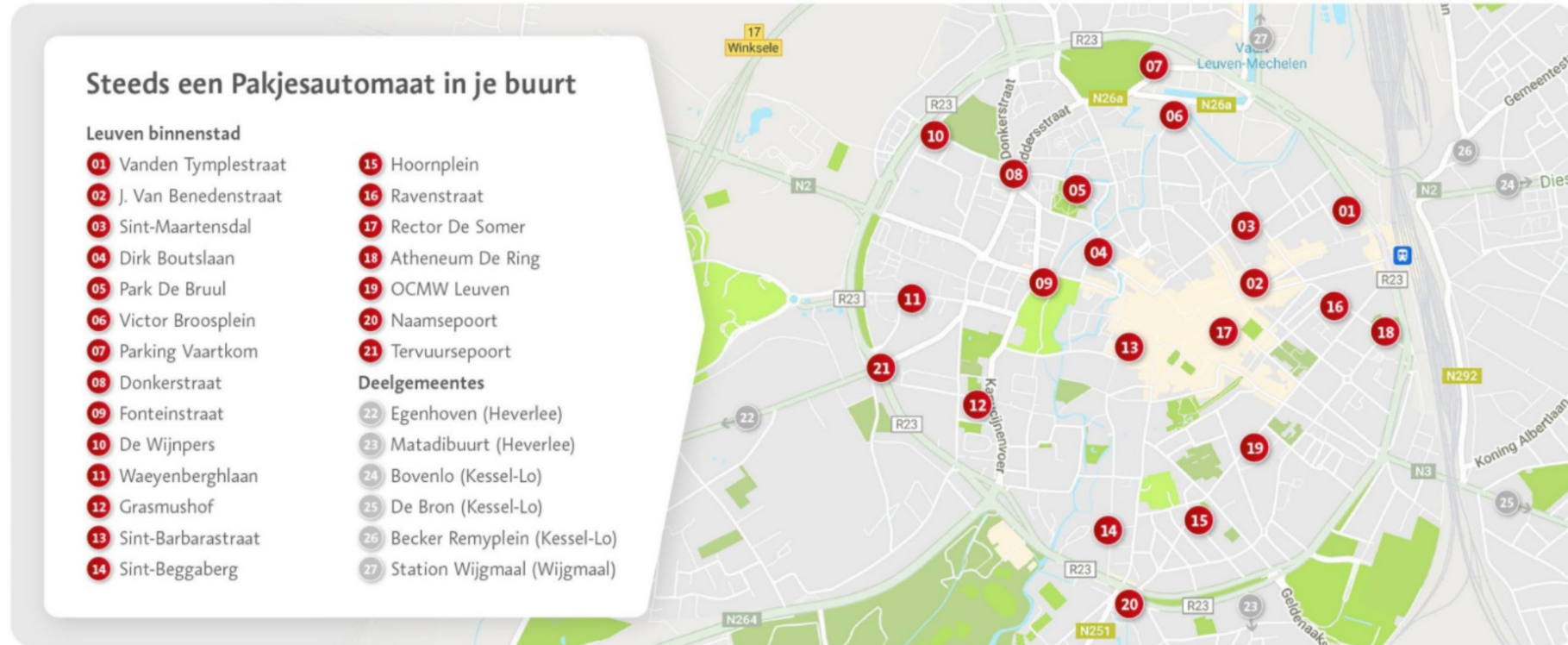


Solution? Dense network!



university of
 groningen

faculty of economics
 and business





Aalto University
School of Business

Facilities: (mobile) (micro) depots

Source: Verlinde, S., Macharis, C., Milan, L., & Kin, B. (2014). Does a mobile depot make urban deliveries faster, more sustainable and more economically viable: results of a pilot test in Brussels. Transportation Research Procedia, 4, 361-373.

Vehicle efficiency



- **Parcel delivery courier activities:**
 - Loading (at depot)
 - Driving to beginning of route
 - En-route (parcel deliveries)
 - *Diving time*
 - *Stop time*
 - Driving back to depot
 - Unloading at depot
 - (Breaks/wait time/other)

Mobile depots



university of
groningen

faculty of economics
and business



Mobile “depots”



university of
 groningen

faculty of economics
 and business





Aalto University
School of Business

Platform technology

Tapping into big player's logistics



university of
 groningen

faculty of economics
 and business

fulfillment by amazon PROCESS



You Send Products
 to Amazon



Amazon Stores
 Your Products



Customers Purchase
 Your Products



Amazon Picks
 and Packs Products



Amazon
 Ships Products
 to Customers

To employ gig workers



- **Models for scheduling matching**
 - Pure self-scheduling (Postmates, Doordash, Uber Eats)
 - Hybrid or centralized scheduling (Amazon Flex)
 - En-route matching (Flitsmeister)
 - Bulletin-board matching (DHL myways)

Let's take a more techno-centric view!

10 emerging future transport innovations

How technologies and ideas shape the future of transport

1. Micro-retail

- Small-scale pop-up shops and boutique storefronts that leverage a variety of innovative downsized activities
- Mimicking the small entrepreneur concept



2. Self-service marketplaces



university of
 groningen

faculty of economics
 and business

Self-service market



The Automat 1936



3. Virtual Restaurants / Ghost kitchens



university of
 groningen

faculty of economics
 and business



4. Mobile depots



5. Drone logistics



university of
 groningen

faculty of economics
 and business

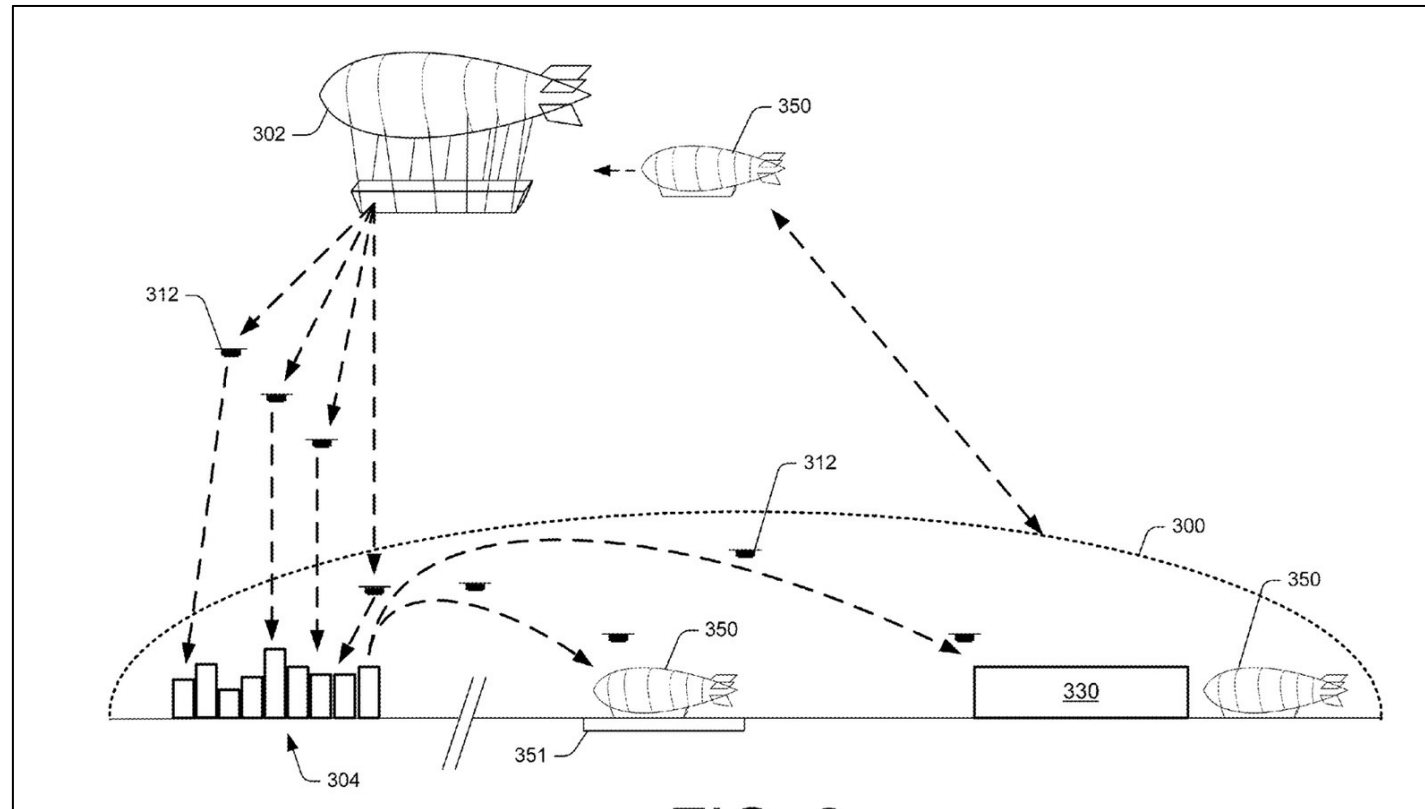


6. Amazon's patented airborne warehouses



university of
 groningen

faculty of economics
 and business



7. Pollution control zones




France's Cannes to Ban Polluting Cruise Ships



Norway proposes ban on heavy fuels and scrubbers in world heritage fjords



Low emission zones for cars in the

-  Low emission zones (LEZ)
-  Diesel ban
-  Other cities with LEZ



8. Warehouse automation



university of
 groningen

faculty of economics
 and business



<https://www.youtube.com/watch?v=e31UqBT5bKE>

9. Public-private infrastructure sharing



university of
 groningen

faculty of economics
 and business



In 2019, Amazon India partnered with Indian Railways for inter-city transportation of e-commerce packages on 13 lanes and also set up pickup kiosks for customers in Kolkata and Mumbai



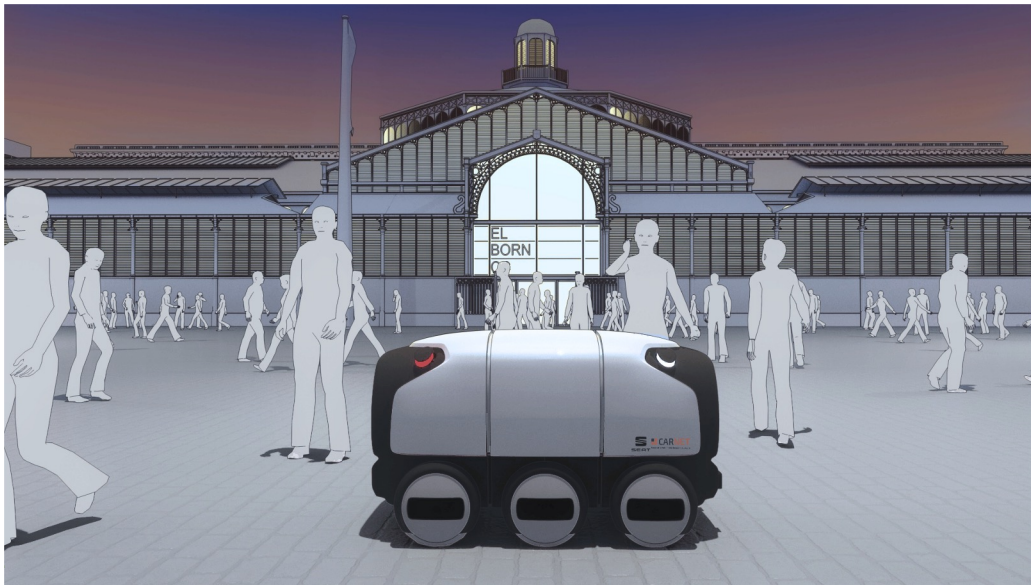
10. Autonomous delivery vehicles



university of
 groningen

faculty of economics
 and business

- Developed by CARNET (VW, Seat and UPC)
- Launched in city of Esplugues (Barcelona)
- Pilot includes Hamburg (Germany) and Debrecen (Hungary)



Exploring the future of logistics

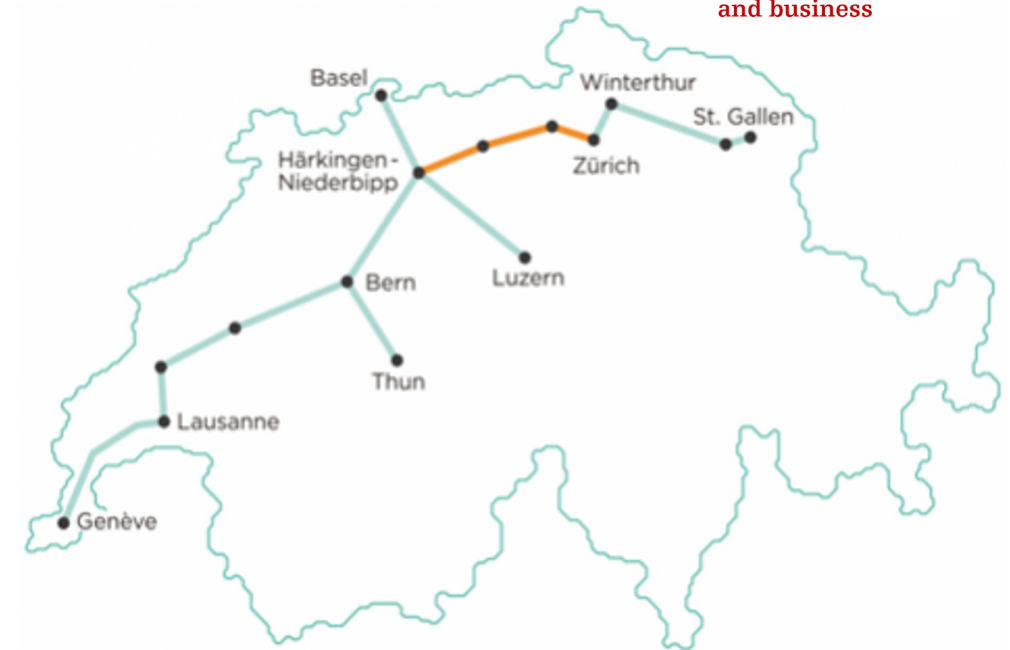
Technology improving material flows



university of
 groningen

faculty of economics
 and business

- Cargo sous terrain (CST) project
- To be completed by 2045
- 500-kilometer network of tunnels
- 30 billion euros
- Transport freight between Switzerland's busiest cities



Space logistics



university of
 groningen

faculty of economics
 and business



#1

HOW WILL SUPPLY LINES
 BE PLANNED AND
 MANAGED?

#2

HOW CAN WE MAKE
 TRANSPORTING OBJECTS
 INTO SPACE MORE
 SUSTAINABLE?

#3

HOW CAN GOODS BE
 PACKAGED TO SURVIVE
 EXTREME FORCES OR THE
 EXPOSURE TO HIGH
 RADIATION?

#4

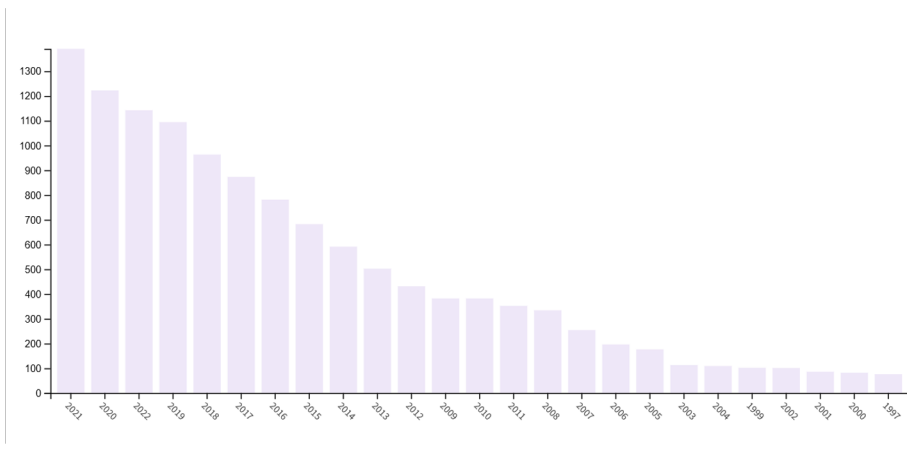
HOW CAN WE CURB AND
 REVERSE THE
 ACCUMULATION OF SPACE
 DEBRIS?

CALL FOR PARTNERS 

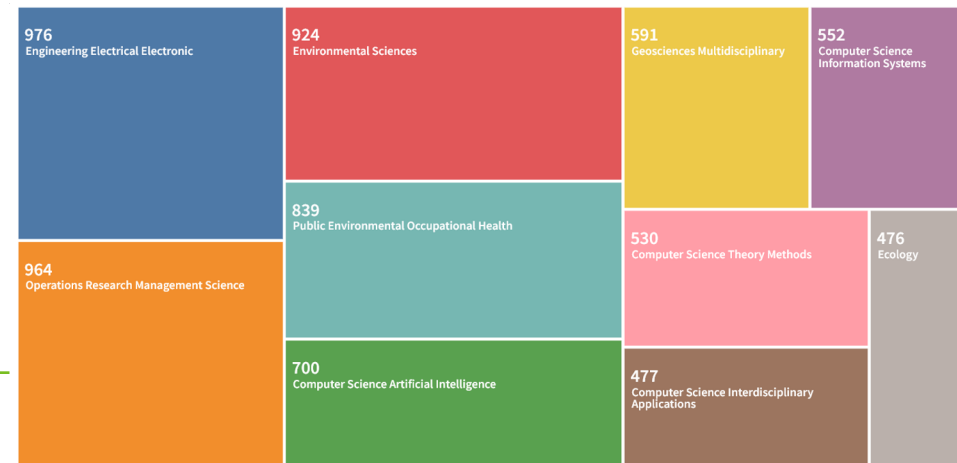
DO YOU WANT TO BE PART OF
 THE EUROPEAN SPACE LOGISTICS
 ECOSYSTEM?

#Ecosystem #SpaceTech #ProofOfConcept
 #IOD #Contest #SpaceLogistics #HubAndSpoke
 #Prime #InSpaceTransportation #Subcontractor

12,760 publications found from Web of Science Core Collection



12,760 publications by top 10 disciplines (Note SCM/Logistics is missing!)



European Space Agency Open Call <https://commercialisation.esa.int/2022/09/building-the-european-space-logistics-ecosystem-for-in-space-transportation/>

DHL Space Logistics <https://www.dhl.com/global-en/delivered/globalization/space-logistics-satellite-transportation.html>

Lyft vs. Uber case

Individual assignment

- **Due in around one week (Sunday, midnight #midnightslikethis)**
- **Case description is available on MyCourses**
- **Questions? Concerns?**



Aalto University
School of Business

Thank you!

Questions?

Dr. Tri M. Tran
tri.tran@aalto.fi