TRANSPORT RESEARCH LAB

ROMA TRE UNIVERSITÀ DEGLI STUDI

Integrating passenger & freight transport via public transport-based crowdshipping for sustainable last-mile deliveries

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Introduction (1/3)

- Sustainable Urban Freight Transport (UFT) Solutions

Introduction (2/3)

Crowdshipping: an innovative solution to UFT

"…is a sharing mobility service that foresees delivering goods via the crowd" (McKinnon, 2016)

ADVANTAGES	DISADVANTAGES
• Low delivery cost	• Trust issues
• Flexibility	• Privacy concerns
• Eco-friendly	• Service reliability
• Sense of community	

❓ Can it reduce congestion and polluting emissions?

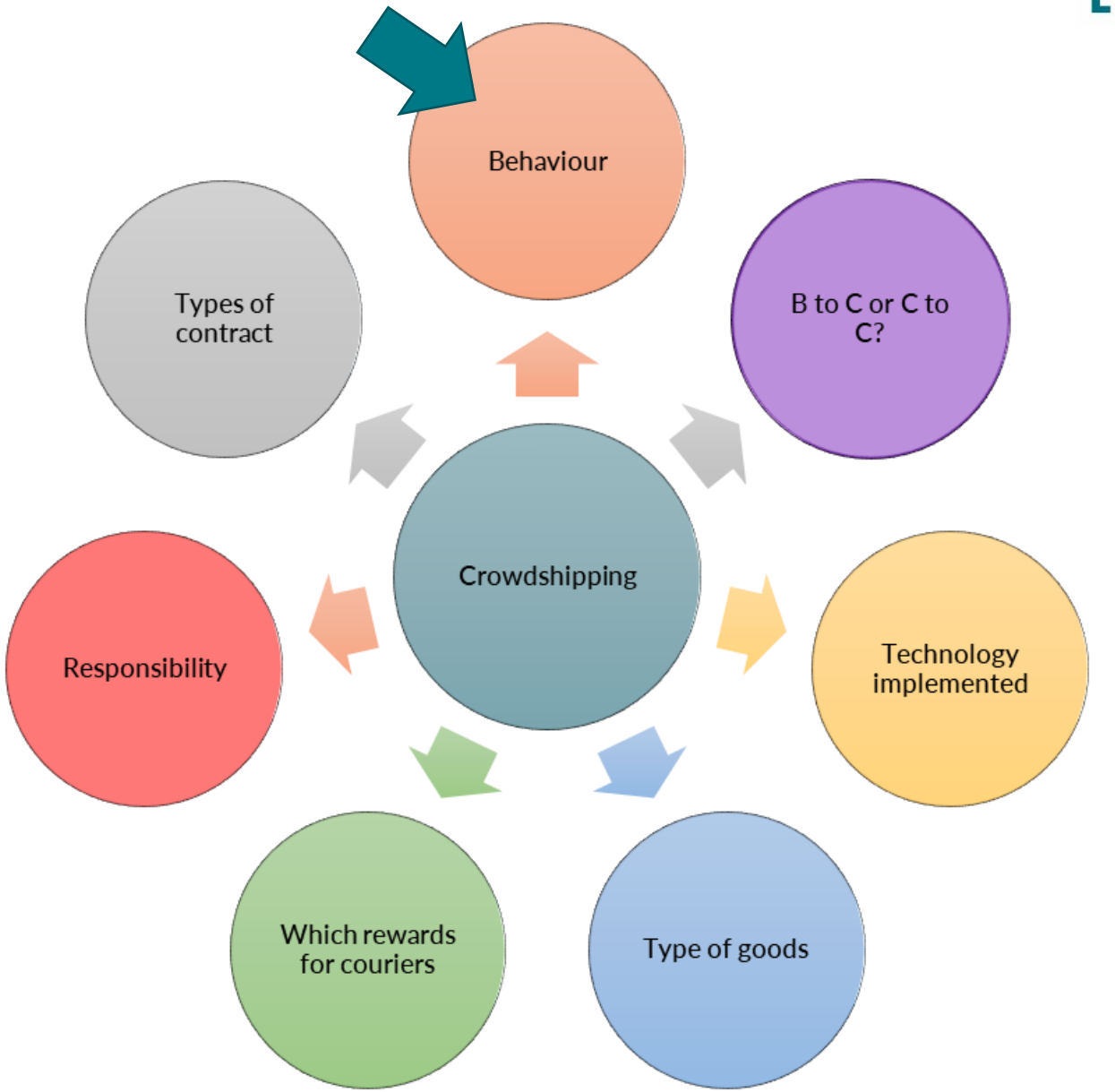
→ usually relies on **dedicated** trips with **private motorized vehicles**!

💡 **Green Crowdshipping**

(use of **non-dedicated public transport** trips)

Introduction (3/3)

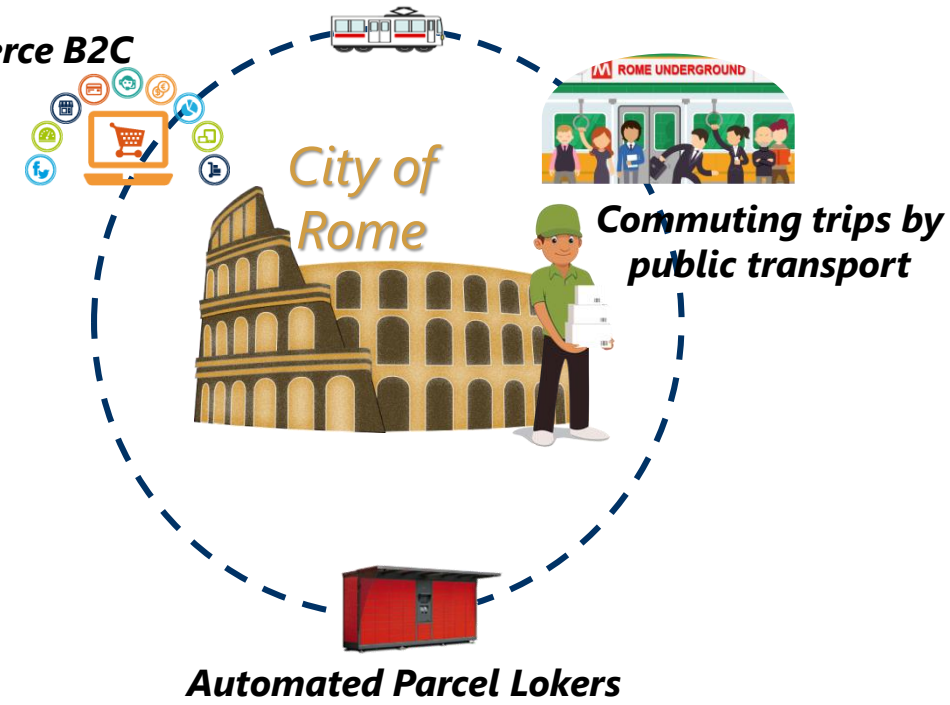
- The need for an interdisciplinary approach



Research question

- **Under which conditions green crowdshippers will produce the service and the customers buy it?**

Research project: green crowdshippers using the metro during their regular home-to-work trips in the city of Rome



Stated Preference Surveys

Demand-side

Demand-side survey	
Features	Levels
Shipping fee (with respect to current national shipping companies)	• Lower (+1) • Typical (-1)
Shipping time (with respect to current national shipping companies)	• Lower (+1) • Typical (-1)
Parcel tracking	• Available (+1) • Not available (-1)
Delivery date and Time schedule flexibility	• Yes (+1) • No (-1)

Supply-side

Supply-side survey	
Features	Levels
Location of APL	• Inside metro stations (+1) • Outside metro stations/adjacent buildings (-1)
Remuneration	• 3 €/delivery (+1) • 1 €/delivery (-1)
Delivery booking	• Real-time booking (+1) • Off-line booking (-1)
Bank crediting modes	• Single delivery (+1) • Every 5 deliveries (-1)

≈750 observations

✓ inhabitants of the city of Rome (demand-side survey)

✓ metro users (supply-side survey)

Demand-side

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Utility specifications

MNL1 demand-side model:

$$V_A = \beta_1 * \text{Shipping Fees}_A + \beta_2 * \text{Shipping Times}_A + \beta_3 * \text{Parcel Tracking}_A + \beta_4 * \text{Delivery Planning}_A$$
$$V_B = \beta_1 * \text{Shipping Fees}_B + \beta_2 * \text{Shipping Times}_B + \beta_3 * \text{Parcel Tracking}_B + \beta_4 * \text{Delivery Planning}_B \quad (1)$$
$$V_{\text{no choice}} = \beta_5 * \text{Age} + \text{ASC}$$

MNL2 supply-side model:

$$V_A = \beta_1 * \text{Location of APL}_A + \beta_2 * \text{Remuneration}_A + \beta_3 * \text{Delivery booking}_A + \beta_4 * \text{Bank Credit Mode}_A$$
$$V_B = \beta_1 * \text{Location of APL}_B + \beta_2 * \text{Remuneration}_B + \beta_3 * \text{Delivery booking}_B + \beta_4 * \text{Bank Credit Mode}_B \quad (2)$$
$$V_{\text{no choice}} = \beta_5 * \text{Age} + \text{ASC}$$

Econometric results: Demand-side

		Coeff. (β)	T-test
Attributes	Age	0.0905	7.65
	Shipping fees* [a] Lower	0.6750	6.76
	Shipping time** [a] Lower	0.5870	6.65
	Parcel tracking***Present	0.6980	7.38
	Delivery date/time flexibility ****Yes	0.7860	8.87
	"no choice" [ASC]	-5.2300	-8.90

*base level: "Typical"; **base level: " Typical"; ***base level: " Not available"; ****base level: "No".

[a] with respect to current national shipping companies

Adjusted rho-square 0.299

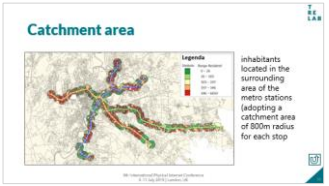
Econometric results: Supply-side

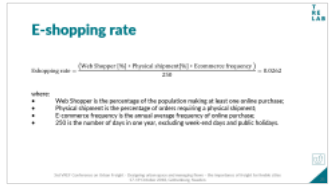
		Coeff. (β)	T-test
Attributes	Age	0.0473	4.25
	Location of APL* Inside metro stations	0.5940	8.42
	Remuneration** 3 €/delivery	0.4890	8.02
	Delivery booking*** Real-time booking	0.3350	4.90
	Bank credit mode**** Single delivery	0.5330	7.64
	"no choice" [ASC]	-3.390	-7.03

*base level: "Outside metro stations/adjacent buildings"; **base level: "1 €/delivery"; ***base level: "Off-line booking"; ****base level: "Every 5 deliveries".

Adjusted rho-square: 0.281

Implications





Demand SCENARIOS	Metro users* [users _ peak hour]	Inhabitants**	Probability to adopt crowdshipping service		Potential demand [orders/day]
SCENARIO 1	113'347	647'154	66.10%	*E-shopping rate*	14'100
SCENARIO 2			59.70%		12'730
SCENARIO 3			16.40%		3'500
SCENARIO 4			12.40%		2'640

Supply SCENARIOS	Metro users* [users _ peak hour]	Probability to act as crowdshippers		Potential crowdshippers [crowdshippers/day]
SCENARIO 1	113'347	84.6%	*Freq=2/week*	38'350
SCENARIO 2		54.8%		24'840
SCENARIO 3		46.0%		20'850
SCENARIO 4		12.8%		5'800

*Users of the Rome's metro lines during the peak hour (Roma Mobilità, STATUS 2016).
**Inhabitants in the 800'meters catchment area (elaboration from census data ISTAT 2011, https://www.istat.it/it/archivio/104317).

Environmental impacts

Individual orders
↓
vehicle equivalent units

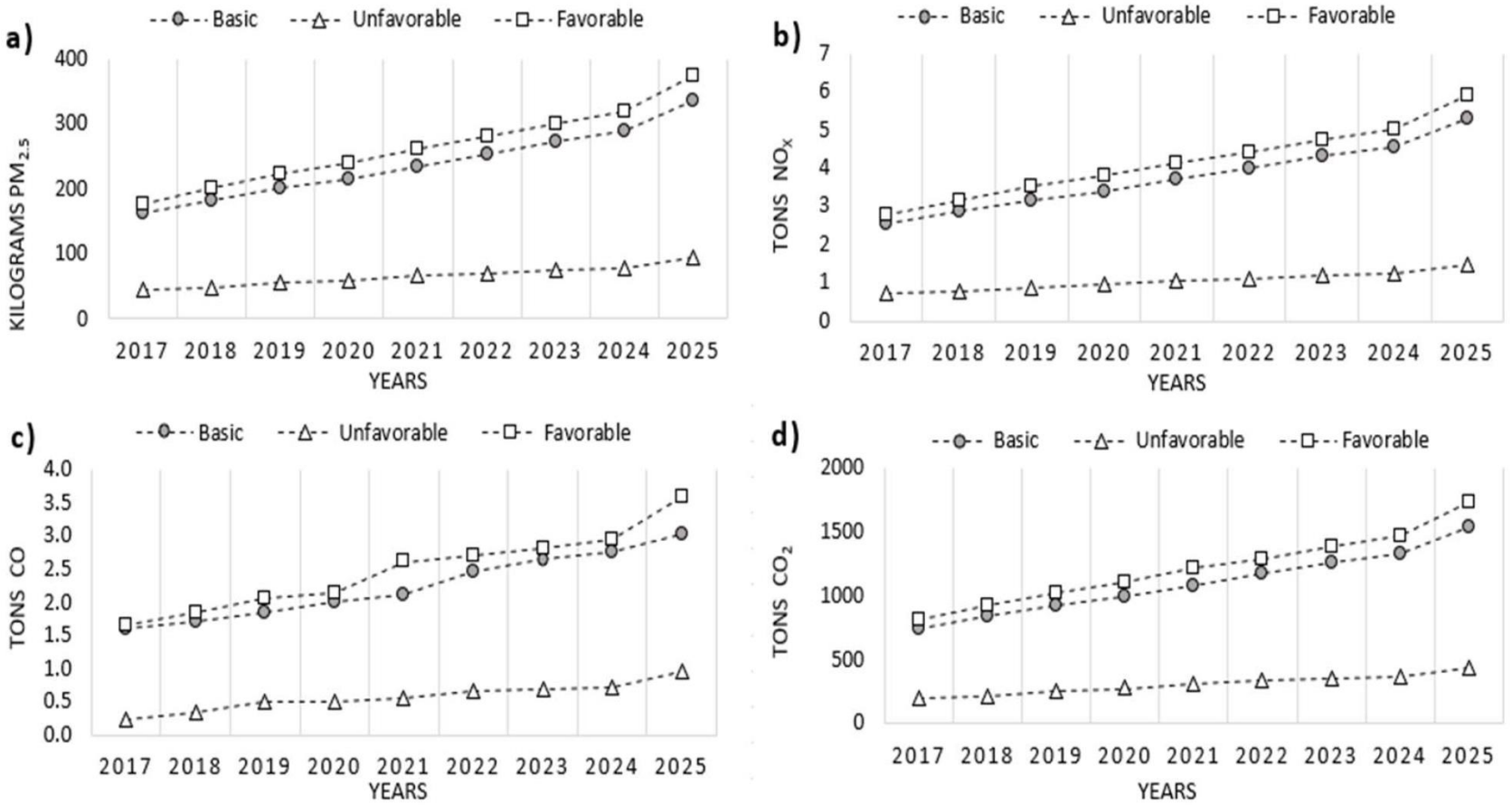


Figure 2. Estimation of pollution emissions saved: particulate (**a**), nitric oxide (**b**), carbon monoxide (**c**), carbon dioxide (**d**).

Economic impacts

Assumptions:

- Crowdshipping platform retains a 10% margin on the fee paid to the crowdshipper for the service produced.
- Investment costs refer to the purchase of APLs and the creation of an IT platform to manage the service.
- APLs are based on the daily demand and assuming each order is collected the same day.
- Operating costs include APLs maintenance and software updates.
- Purchasing and management costs have been derived from different sources (e.g. articles, interviews, manufacturers' brochures and websites).

Economic impacts

	UNFAVORABLE SCENARIO	BASE SCENARIO	FAVORABLE SCENARIO
NPV with environmental benefits	208,779 €	1,682,241 €	1,898,610 €
NPV without environmental benefits	-978,622 €	-2,627,591 €	-2,871,319 €

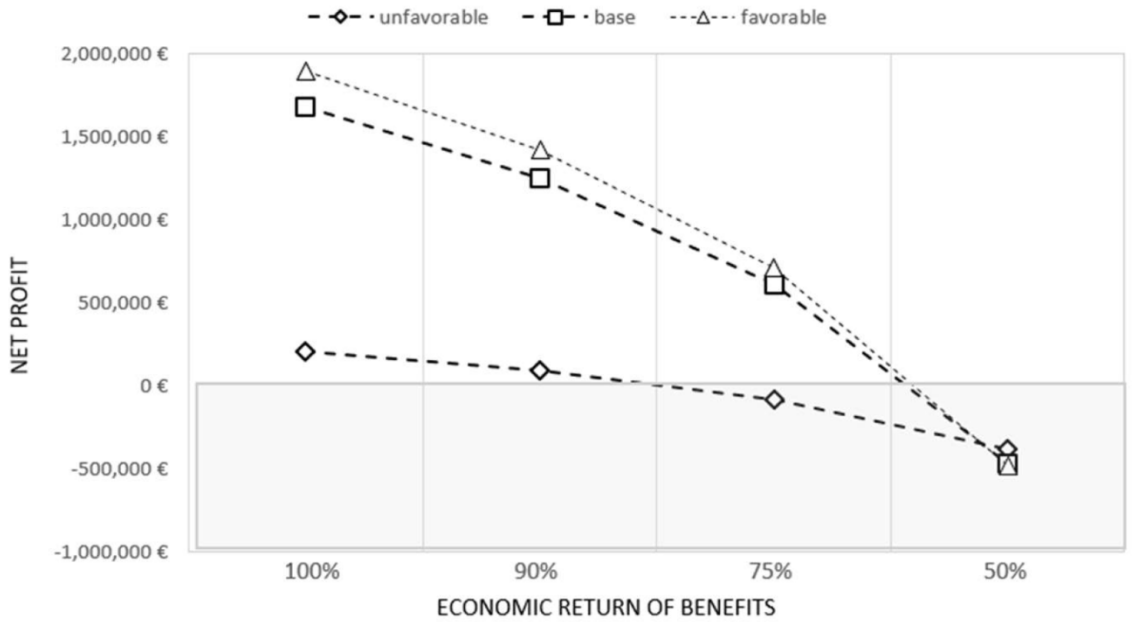


Figure 4. Net income as subsidies change.

Conclusions

- APLs location is the most relevant feature (more than remuneration)
- The possibility to plan the delivery date and its time schedule has the highest impact on consumers' utility
- Comparing demand/supply → the service can rely on a sufficiently large base of potential crowdshippers so to be able to manage a substantial number of delivery requests
- There is a potential market for the new service and it is important to pay attention to its design
- Green crowdshipping is not THE solution but it can help reducing UFT negative impacts
- The biggest challenge policy-makers have to face is the redistribution of costs and benefits among stakeholders

On-going and further research steps

- Quantifying environmental effects via Traffic Simulation Modelling
- APL investigation (location, characteristics, ownership, etc.)
- Including Crowdshipping in the SUMP-logistic in Rome
  - Test a real-life pilot study

…

- Optimisation criteria
- Matching

Thanks for your attention

For more information, please visit: www.trelab.it

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