Integrating direct and reverse logistics in a “living lab” context: evaluating stakeholder acceptability and the potential of gamification to foster sustainable urban freight transport

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OUTLINE

- Introduction and motivation
- Case study
- SP survey
- Econometric results
- Scenario analysis
- Implications
- Future steps
- Conclusion

Introduction and motivation (1/2)

- EU's efforts to develop a sustainable and competitive economy rely on a transition towards circular economy
- Waste management is a major issue for the sustainability of urban areas
- The need to recycle has implications on logistics negatively affecting the environment
  - Door-to-door systems imply a large # of trucks and fragmented collection
  - Using ad-hoc collection points implies costly infrastructure interventions & greater effort/involvement of citizens providing dedicated trips
- Transport management is critical…innovative solution:
  - Integrating direct and reverse logistics flows with the aim of increasing the amount of recycled materials while also minimising the amount of CO2 emissions (closed loop)

Introduction and motivation (2/2)

- To increase the success of a new solution ex-ante behavioural analysis is needed
- Knowing behavioural levers capable of stimulating potential users to participate in the initiative is fundamental
- Stated preference survey to:
  - investigate users' acceptability and behaviour change with respect to UFT solutions
  - identify strategic/operational pre-requisites for the proposed solution to be adopted
  - estimate the amount of recycled materials to be collected
  - estimate the expected environmental benefits

Case study (1/2)

Living laboratories

- Highly fragmented last-mile deliveries in city centres
- Inefficient deliveries to large freight attractors and public administrations
- Urban waste, returns and recycling
- Logistics sprawl

LONDON: New distribution hub concepts and clean vehicles

ROME: Integration of direct and reverse logistics

BRUSSELS: Increasing load factors by utilizing free van capacity

ROTTERDAM: Floating depot

PARIS: Logistics hotel

OSLO: Common logistics functions for shopping centers

SOUTHAMPTON: Joint procurement and consolidation for large public institutions

Case study (2/2)

- The main idea of Rome LL is to involve the national postal operator in the pick-up, via electric vehicles, of recycled materials during the same transportation route.
- As a first step, an innovative process of recycled materials collection (clean waste), integrating direct flows (i.e. mail delivery) with reverse flows (i.e. plastic caps) is tested in a small scale implementation involving large attractors (i.e. University buildings).
- Why plastic caps?
  - Feasibility from the industrial point of view
  - Easily recyclable&economic type of plastic
  - Existing collection system at UR3 not sustainable/efficient

SP survey

- Sample: 597 respondents (students, teachers, administrative staff)
- Preliminary qualitative analysis → 5 qualitative attributes (2 levels each)
- (1) aim of the initiative (to improve UR3 services/charity), (2) caps-throwing mode (one cap/more caps per time), (3) transport system used (environmentally/non environmentally friendly), (4) probability to find boxes full (low/ high), (5) gamification (yes/no).
- Blocking strategy
- 4 choice tasks…

→ full factorial design covered

	Option A	Option B
Aim of the initiative	improve UR3 services	charity
Caps-throwing mode	more caps per time	one cap per time
Transport system used	environmentally friendly	non environmentally friendly
Prob. to find boxes full	high	low
Gamification	no	yes
Choice	◯	◯

Econometric results (1/2)

- Multinomial logit model

MNL results for the whole sample

Variable	Description	Coefficient
IMPROVE	Improve UR3 services	-0.037
ONECAP	One cap per time	0.012
ENVIRON	Environmentally-friendly transport system	0.147***
PROBLOW	Low probability to find boxes full	-0.0147
GAMIF	Gamification yes	0.084***

Significance level: ***=1%; **=5%; *=10%

Econometric results (2/2)

- Multinomial logit models…naïve preference heterogeneity

MNL results per department

Variable	Department 1 (n= 180)	Department 2 (n= 134)	Department 3 (n= 178)	Department 4 (n= 105)
IMPROVE	-0.024	0.094**	-0.012	-0.069
ONECAP	-0.069*	-0.051	-0.044	0.071
ENVIRON	0.081**	0.161***	0.251***	0.088*
PROBLOW	0.073*	-0.048	0.093**	-0.002
GAMIF	0.035	0.162***	0.111***	0.038

Significance level: ***=1%; **=5%; *=10%

Scenario analysis (1/2)

Variable/Scenario	Status quo (worst)	Scenario 1	Scenario 2	Scenario 3 (best)
IMPROVE	no	no	no	**yes**
ONECAP	yes	yes	yes	**no**
ENVIRON	no	**yes**	**yes**	**yes**
PROBLOW	no	no	no	**yes**
GAMIF	no	no	**yes**	**yes**

- Info on *min* and *max* of #plastic caps respondents would collect
- A simple measure of satisfaction degree has been used to estimate #plastic caps potentially collected for each scenario

$$S_{dep_i}(\%) = \frac{U_{scenario} - U_{dep_i}^{min}}{U_{dep_i}^{max} - U_{dep_i}^{min}}$$

Scenario analysis (2/2)

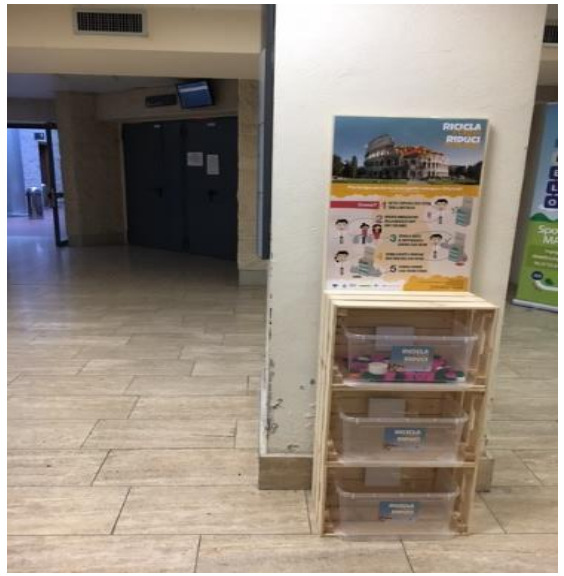
Variable/Scenario	Status quo (worst)	Scenario 1	Scenario 2	Scenario 3 (best)
IMPROVE	no	no	no	**yes**
ONECAP	yes	yes	yes	**no**
ENVIRON	no	**yes**	**yes**	**yes**
PROBLOW	no	no	no	**yes**
GAMIF	no	no	**yes**	**yes**

Scenario	Expected caps (kg per year)	Expected trips (boxes per year)	Saved CO2eq (kg per year)
Status quo (worst)	1222.4	611	0
Scenario 1	1651.4	826	457.3
Scenario 2	1730.3	865	499.3
Scenario 3 (best)	2005.1	1003	556.1

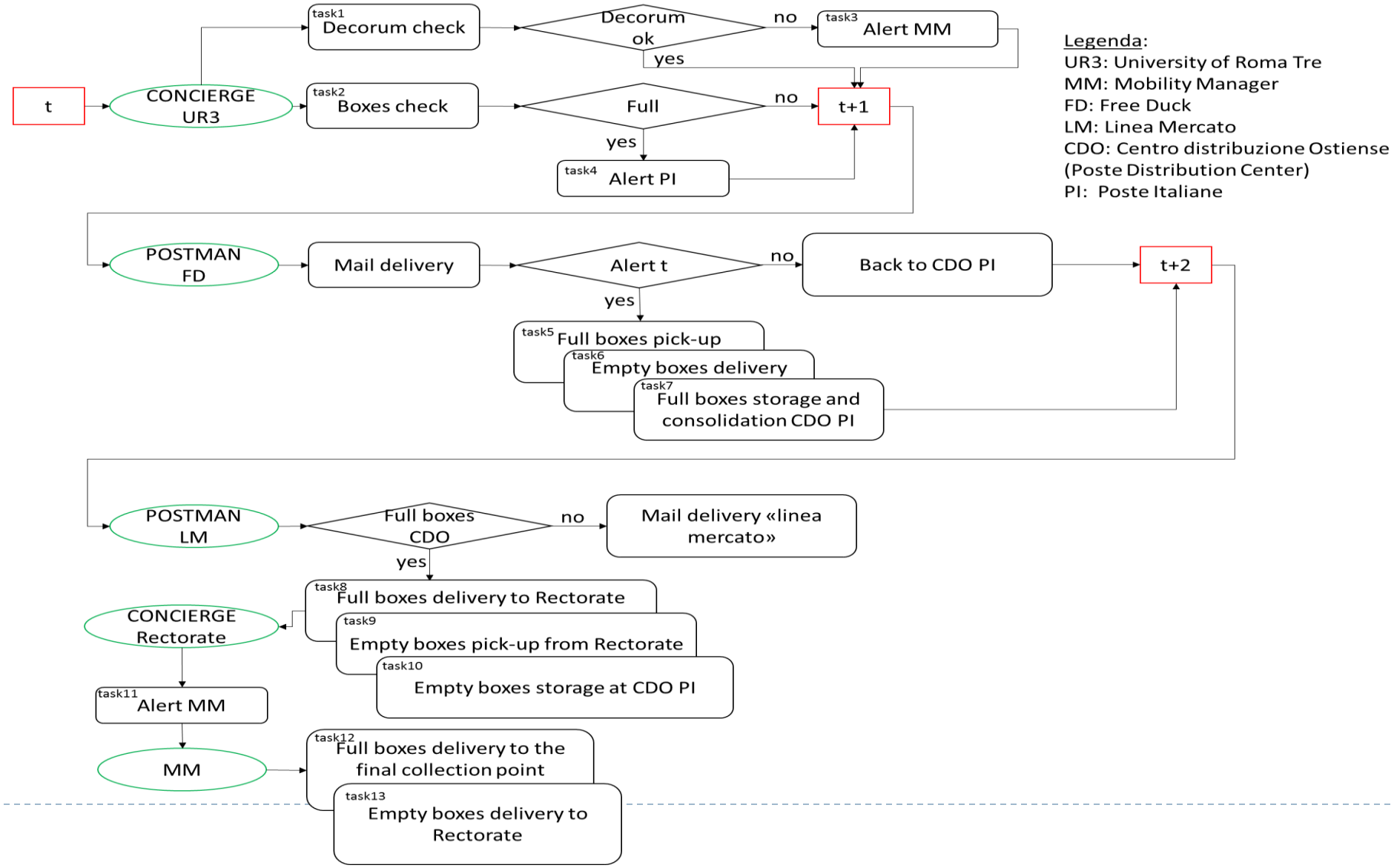
- ↑Recycled materials and ↓negative impact on environment

Implications

- The results obtained were useful to fine-tune the solution proposed according to users' preferences:
  - System pre-dimensioning (e.g. box dimension and placement, vehicles to be used, full box alerting system, etc.)
  - Define the operational procedure

Eco-totems at the buildings' hall	Electric "Free Duck" vehicle for boxes pick-up
	

Operational procedure



Legenda:
UR3: University of Roma Tre
MM: Mobility Manager
FD: Free Duck
LM: Linea Mercato
CDO: Centro distribuzione Ostiense (Poste Distribution Center)
PI: Poste Italiane

Future steps

- The second LL cycle will explore the opportunity to:
  - (1) upscale the implementation in terms of flows involved, sites and alternative waste recycled
  - (2) include the solution proposed in the actual logistics process for urban waste management in Rome
- Possible extensions are in line with the recently passed (March 2017) action plan of the Department of the Environment.
  - the solution developed in the first LL cycle will be considered to deal with the logistic needs "re-use factories" have.
- Deploy a real-case user-centered gamification process to stimulate engagement/participation in the recycling initiative.

Conclusion

ROME LIVING LAB

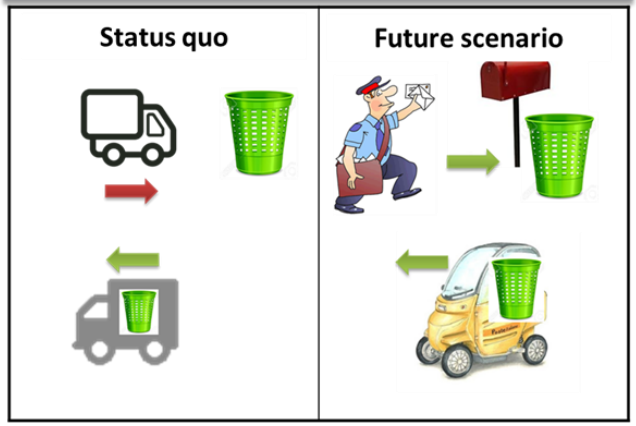
ROMA CAPITALE · ROMA TRE UNIVERSITÀ DEGLI STUDI · Posteitaliane · Meware

PLAN

INTERVENTION AXIS: URBAN WASTE, RETURN TRIPS AND RECYCLING

EXTEND THE SOLUTION

INTEGRATE DIRECT & REVERSE LOGISTICS



IMPLEMENT

PLASTIC CAP RECYCLING

EVALUATE

IMPACTS

- Decrease **number of trips**
- Increase **load factor**
- **CO_2** reduction/less pollutant vehicles
- More materials recycled

ACT