Workshop: Innovation in Urban Freight

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Seattle, Washington, USA

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Urban Freight Transport Policies in Rome:

Lessons Learned and the Road Ahead

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Overview

- ✓ Introduction
- ✓ City Logistics Policies Framework
- ✓ Policy Assessment Methodology
- ✓ City Logistics Policies in Rome
- ✓ The surveys
- ✓ Modeling Framework to Assess City Logistics Scenarios
- ✓ Conclusions

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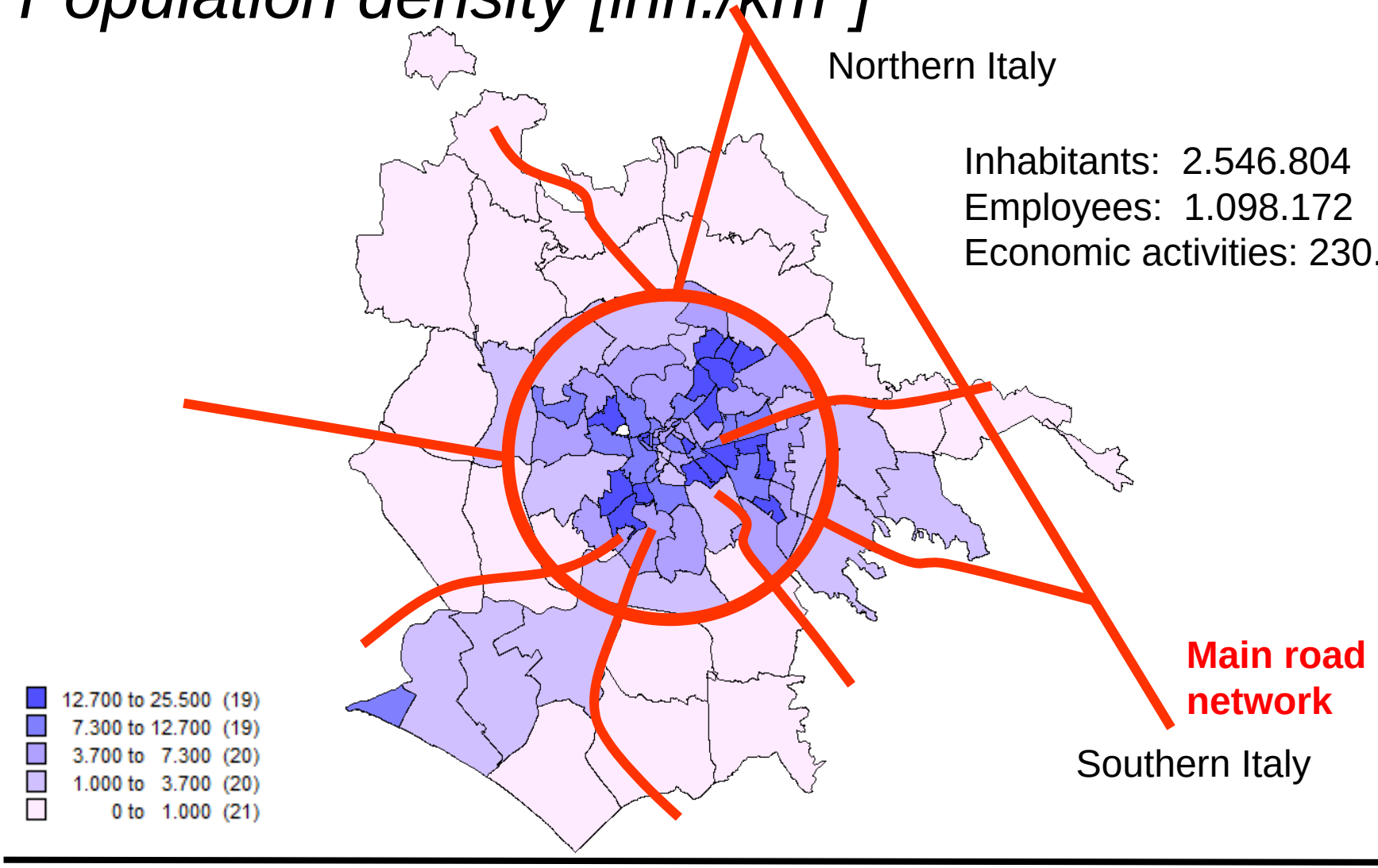
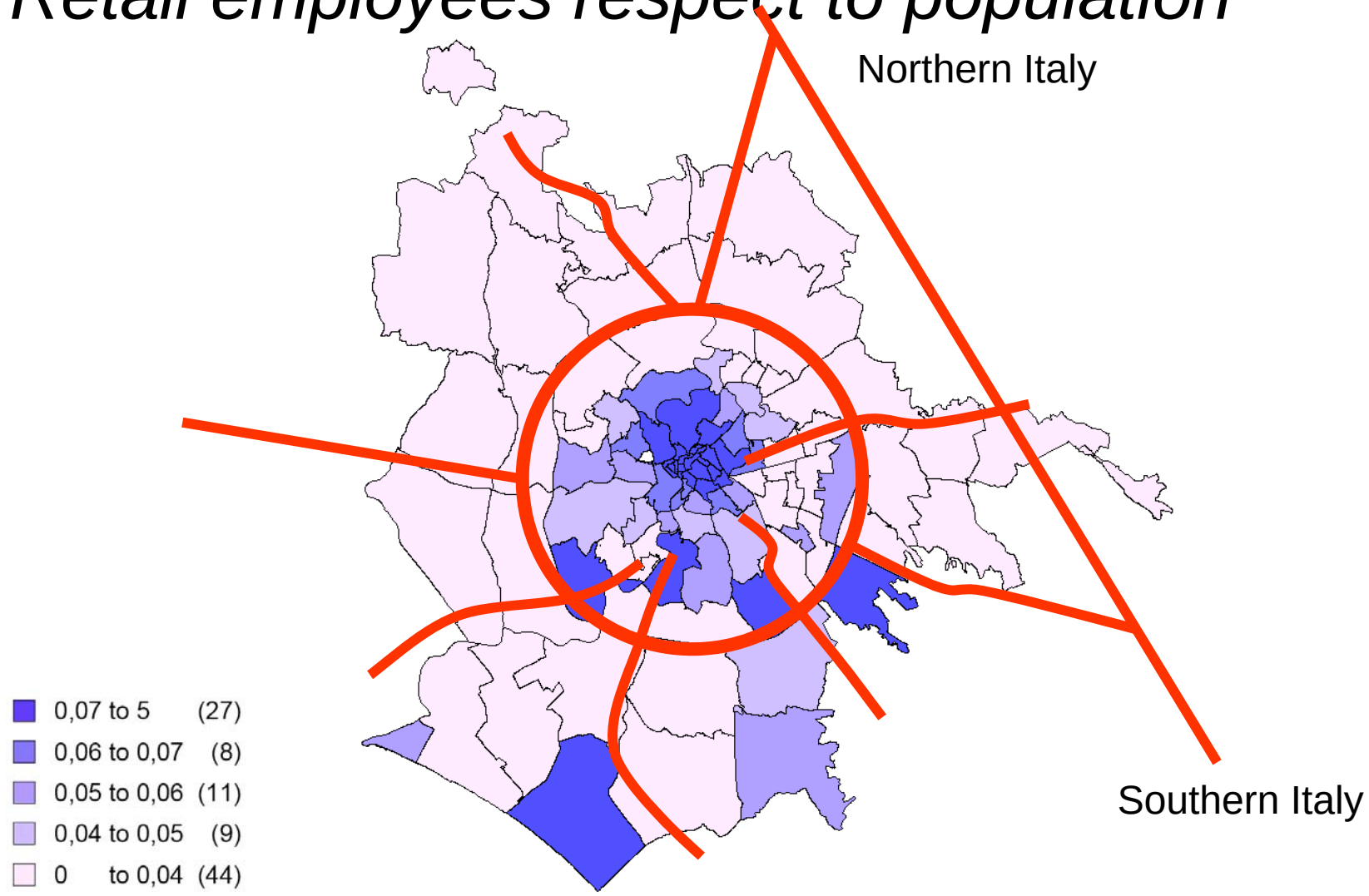
Municipality of Rome

Population density [inh./km²]



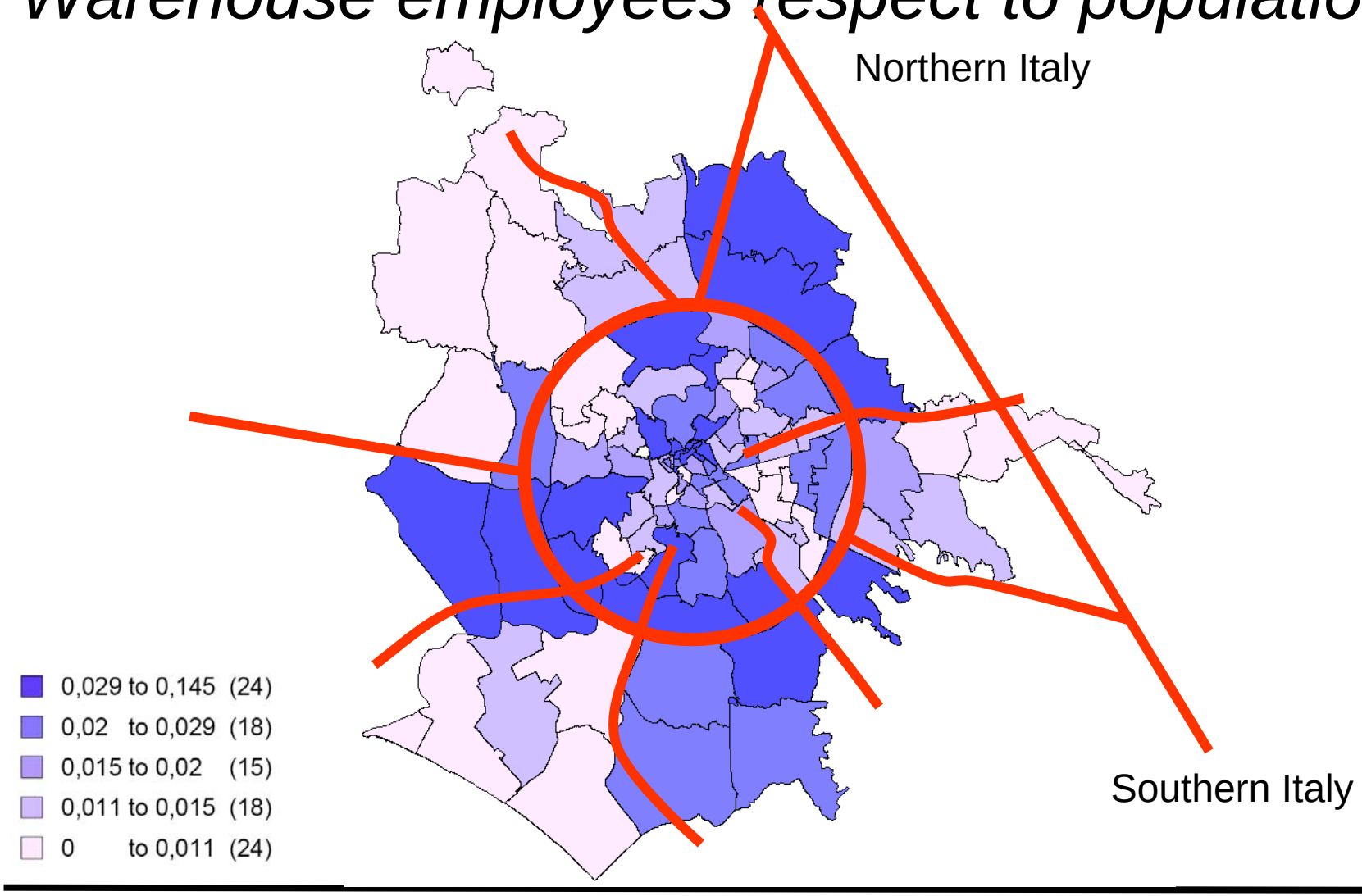
Municipality of Rome

Retail employees respect to population



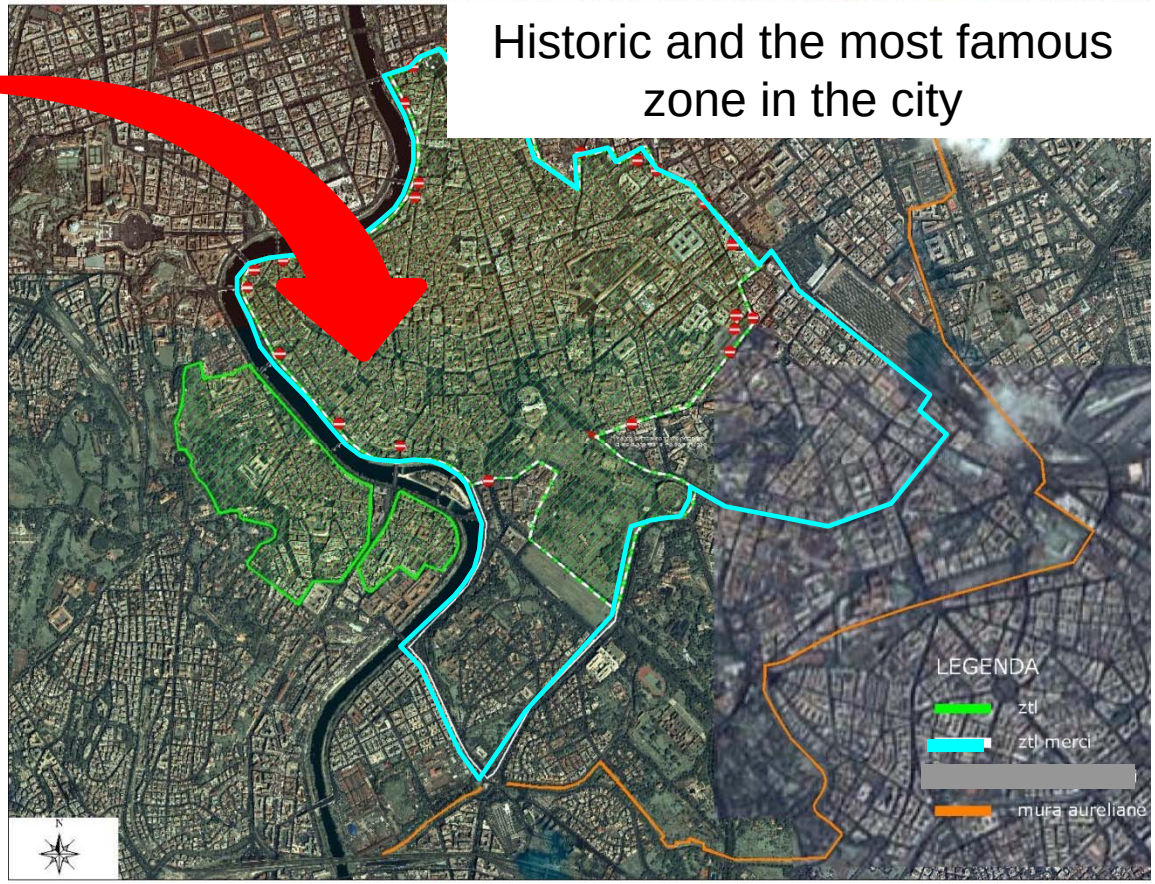
Municipality of Rome

Warehouse employees respect to population



Municipality of Rome

Inner zone



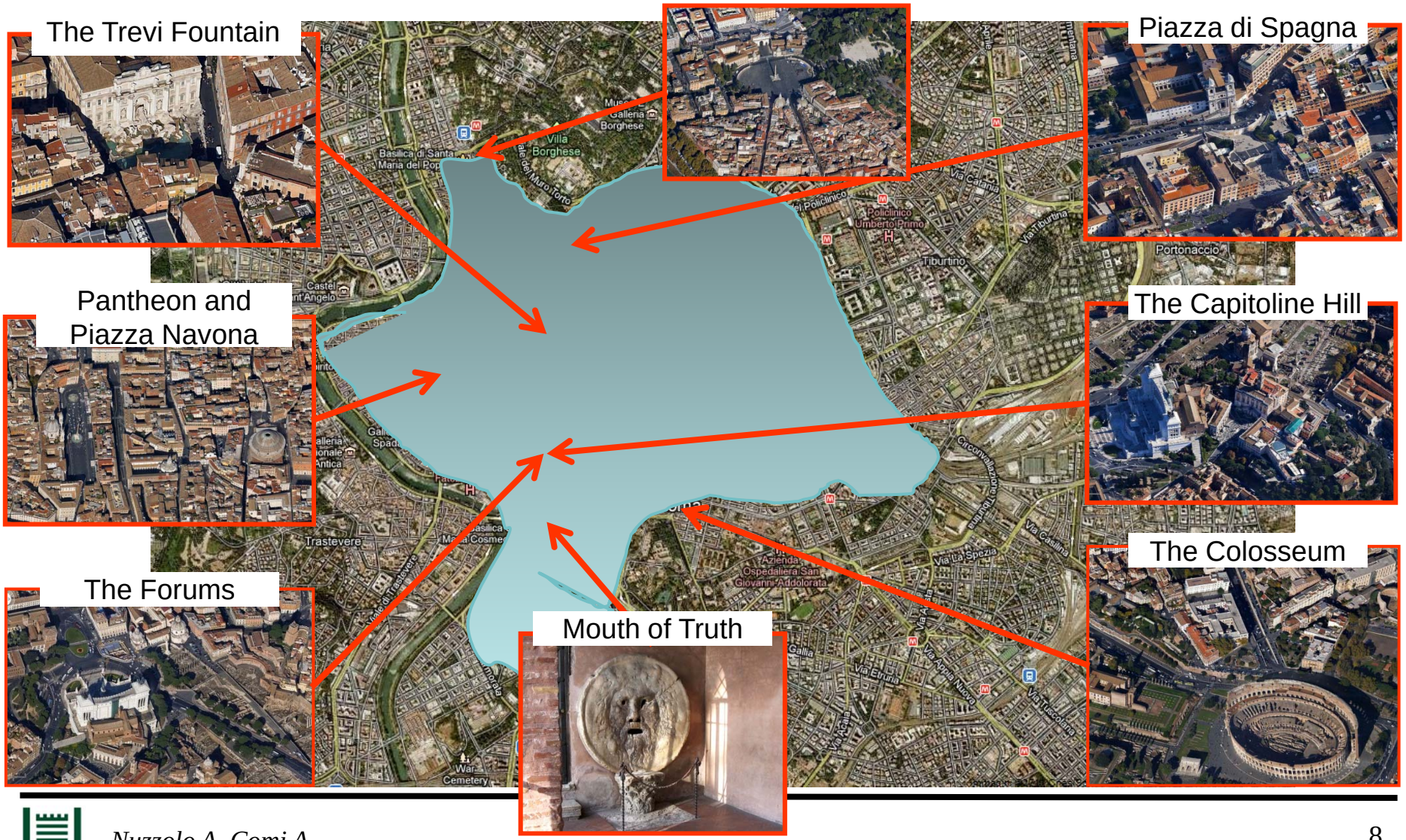
Historic and the most famous zone in the city

Inner area (*freight* LTZ)

- ✓ 6 km^2
- ✓ 51,413 inhabitants
- ✓ 130,000 employees
- ✓ 24,401 trade employees

Municipality of Rome

Inner zone



Introduction

The freight distribution in the inner zone contributes:

- to congestion, air pollution, noise (***environmental*** impacts)
- to have a combination of different types of vehicles on the road that increases the risk of accidents (***social*** impacts)
- to raise logistic costs, and hence the price of products (***economic*** impacts)

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City logistics policies framework

Strategies

- ✓ In order to assure an efficient urban freight distribution system, able to meet the requests of several involved stakeholders and to minimize the externalities, the city administration has been implementing some strategies:

  - ➢ reduction of number of commercial vehicles and increasing of commercial speed (economic/financial sustainability),
  - ➢ use of light and environmental-friendly vehicles (environmental sustainability),
  - ➢ reduction of interferences with other components of city mobility (social sustainability).

City logistics policies framework

Policies/ Measures	Strategies	Planning horizons	Receiver /Sender		Relevant impacts (+/-)			
			3P	*Own Acc.*	*Transp. costs*	*Safety*	*Congestion*	*Envir.*
Weight and dimension constraints	Use of light vehicles	Tactical/ Operative		X	-		+	+
Time windows	Reduction of interference	Operative	X	X	-	+	+	+
Emmision constraints	Use of envirnomental-friendly vehcles	Tactical/ Operative		X	-			+
Electronic Access Control	Reduction of number of vehicles	Tactical/ Operative		X	-	+	+	+
Area-pricing	Reduction of number of vehicles	Strategic/ Tactical	X	X	-	+	+	+
Incentives	Use of environmental-friendly vehicles	Strategic/ Tactical		X	+			+
Nearby Delivery Area	Reduction of number of vehicles	Tactical/ Operative	X	X	-	+	+	+
Urban Distribution Center/ Transit point	Use of light and environmental-friendly vehicles	Strategic		X	-	+	+	+

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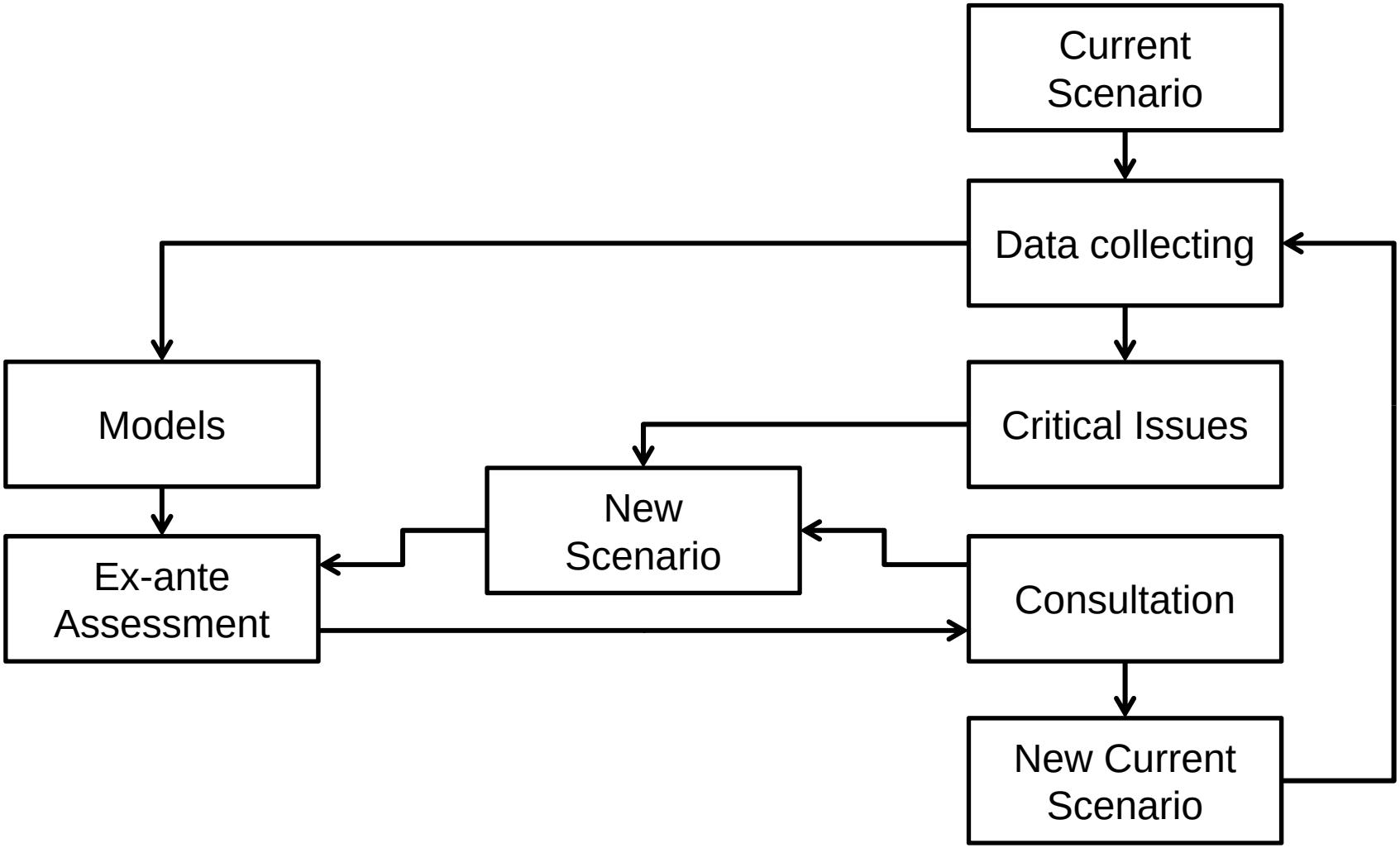
Policy assessment methodology

- ✓ The urban goods movements are the results of a set of choices made by:
  - Inhabitants/customers
  - Retailers
  - Wholesalers, logistics operators and distributors
  - City administrations

analysis and selection of implementable policies/measures has to consider such actors and find an optimal compromise between all interests of the involved actors

Policy assessment methodology



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City logistics policies in Rome

Regulation over the last 10 years

Measures/ Policies	before 2001		2001 – 2011		after 2011	
	Less than 3.5 t	*More than 3.5 t*	*Less than 3.5 t*	*More than 3.5 t*	*Less than 3.5 t*	*More than 3.5 t*
Time windows	Access: • 9.30am–11am • 2.30pm – 4pm *Exemptions for valuables, pharmaceuticals, newspapers, and vehicles carrying out maintenance activities*	Access: Specific path and time permissions	Access: • 8pm–10am • 2pm – 4pm *Exemptions for third account vehicles, valuables, pharmaceuticals, newspapers, and vehicles carrying out maintenance activities* *Electronic Access Control*	Access: • 8pm – 7am and subject to specific path and time permissions	Access (Euro 2 and 3): • 8pm–7am • 10am – 4pm Access (Euro 4, 5 and 6): • 8pm–5.30pm *Exemptions for electric, LPG, CNG, hybrid vehicles less than 6.5 t complying the gauge of light goods vehicles (less than 3.5 t).* *Electronic Access Control* *Max loading and unloading time: 30 minutes*	Access: • 8pm–7am and subject to specific path and time permissions
Emission constraints	none	none	no access to Euro 0 and 1 freight vehicles		no access to Euro 0, 1, 2 (from 2012), 3 (from 2013) freight vehicles	
Road-pricing	none	none	570 €/year *discounts for Low Emission Vehicles (-20% CNG, LPG hybrid, -50% electric)*		Depends on vehicle emission standards	

City logistics policies in Rome

Regulation before 2001

Measures/ Policies	before 2001	
	Less than 3.5 t	*More than 3.5 t*
Time windows	Access: • 9.30am–11am • 2.30pm – 4pm *Exemptions for valuables, pharmaceuticals, newspapers, and vehicles carrying out maintenance activities*	Access: Specific path and time permissions
Emission constraints	none	none
Road-pricing	none	none

Due to the high number of exemptions and the low enforcement, this regulation had **little effects** in terms of reducing freight traffic in the inner area and of improving its environmental sustainability.

In 1999, the municipality carried out some surveys aiming at

- **identifying** the **problems** of freight transport
- **supporting** the **decisions** on the actions to be implemented

City logistics policies in Rome

Regulation before 2001

✓ **Main 1999 survey results**

- presence of **through freight** traffic representing the **34**% of all freight trips
- the high share of **transport in own account (54%)** and of commercial vehicles **more than 1.5 tons (74%)**
- **problems of loading and unloading**, especially because of **insufficient parking space**

  (**34%** of retailers evidenced this problem, and only the **5%** of interviewed truck drivers have declared to use the legal space for loading and unloading operations)

City logistics policies in Rome

Regulation between 2001 and 2011

In 2001, a **new regulation** for freight traffic with restrictions on access to and parking in the inner area was in place. In addition, for a large portion of the inner area an **electronic system** of access control has been implemented for both passenger and freight vehicles.

Main objectives:

- Increasing of 3P
- to reduce the share of most pollutant vehicles
- to reduce the share of heavy vehicles

Measures/ Policies	**2001 – 2011**	
	Less than 3.5 t	*More than 3.5 t*
Time windows	Access: • 8pm–10am • 2pm – 4pm *Exemptions for third account vehicles, and specific freight types*	Access: • 8pm – 7am and subject to specific path and time permissions
Emission constraints	no access to Euro 0 and 1 freight vehicles	
Electronic Access Control		
Road-pricing	570 €/year *discounts for Low Emission Vehicles (-20% CNG, LPG hybrid, -50% electric)*	

City logistics policies in Rome

Regulation between 2001 and 2011

✓ **Main 2008 survey results**

- to create **incentives for 3P:**
  Time windows and charging scheme allowed to reduce the transport in own account from 54% to 21%

- to **reduce** the share of most **pollutant vehicles**:
  New regulation pushed to use more environment-friendly vehicles (83% were at least Euro 3 or 4)

- to **reduce** the share of **heavy vehicles**:

  New regulation pushed to use light vehicles (from 44% to 65%)

City logistics policies in Rome

Regulation between 2001 and 2011

✓ **Persisting problems from 2008 surveys**

- the **frequency** of restocking has **increased** and there are more retailers receiving goods one or more times a day
- the number of freight vehicles in the area has increased from 1999 to 2008 by about **24**%
- **pollutant level** in the inner area is still **too high** and often the standard environmental limits are exceeded
- the share of retailer considering very important problems related to the space for loading and unloading operations has increased (**69%**)

City logistics policies in Rome

Regulation after 2011

In 2008, the evaluations highlighted that good but **not too satisfactory results** have been obtained

New actions have been planned from 2012 for reaching higher levels of sustainability

Measures/ Policies	**after 2011**	
	Less than 3.5 t	*More than 3.5 t*
Time windows	Access (Euro 2 and 3): • 8pm–7am • 10am – 4pm Access (Euro 4, 5 and 6): • 8pm–5.30pm *Exemptions for electric, LPG, CNG, hybrid vehicles less than 6.5 t complying the gauge of light goods vehicles (less than 3.5 t)* *Electronic Access Control* *Max loading and unloading time: 30 minutes*	Access: • 8pm–7am and subject to specific path and time permissions
Emission constraints	no access to Euro 0, 1, 2 (from 2012), 3 (from 2013) freight vehicles	
Road-pricing	Depends on vehicle emission standards	

City logistics policies in Rome

Regulation after 2011

Phase I (implemented from November 2011)

New access limits for commercial vehicles (both vehicles for freight distribution and services) have been introduced

- ✓ no access to vehicles do not comply the Euro 2 standards;

- ✓ environmental-friendly vehicles (i.e. CNG, LPG, hybrid and electric) have a reduced charge for accessing within study area.

City logistics policies in Rome

Regulation after 2011

✓ **Fase I design and preliminary *ex-ante* assessment**

- to adjust the fees in order to obtain revenues which could support the new integrative measures (e.g. control of loading and unloading zones)

- good results can be obtained in terms of pollutant reductions, e.g. the matter particulate could be reduced of 6% in 2012, and 33% from 2013

City logistics policies in Rome

Regulation after 2011

Phase II (to be implemented in 2013)

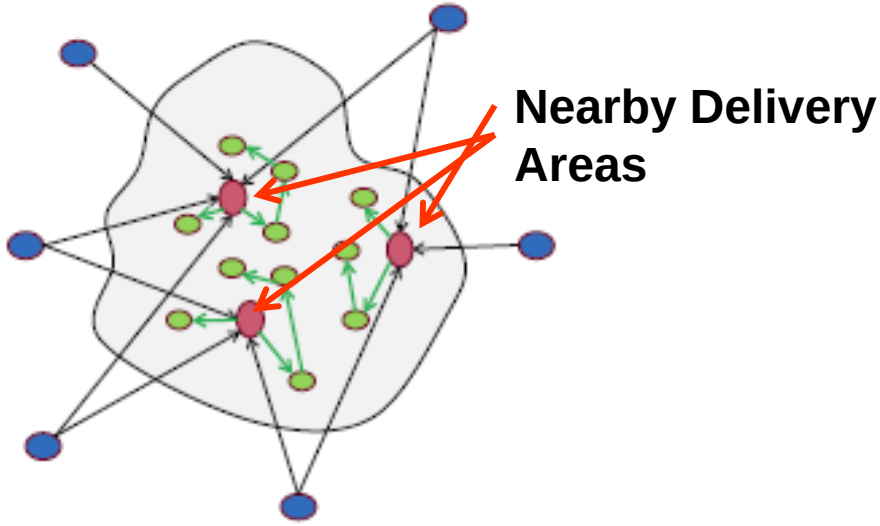
- ✓ from 2013 no access to vehicles do not comply the Euro 3 standards;
- ✓ incentives to buy new environmental-friendly vehicles,
- ✓ enforcing for verifying the correct use of loading and unloading zones.

City logistics policies in Rome

Regulation after 2011

Measures to be verified

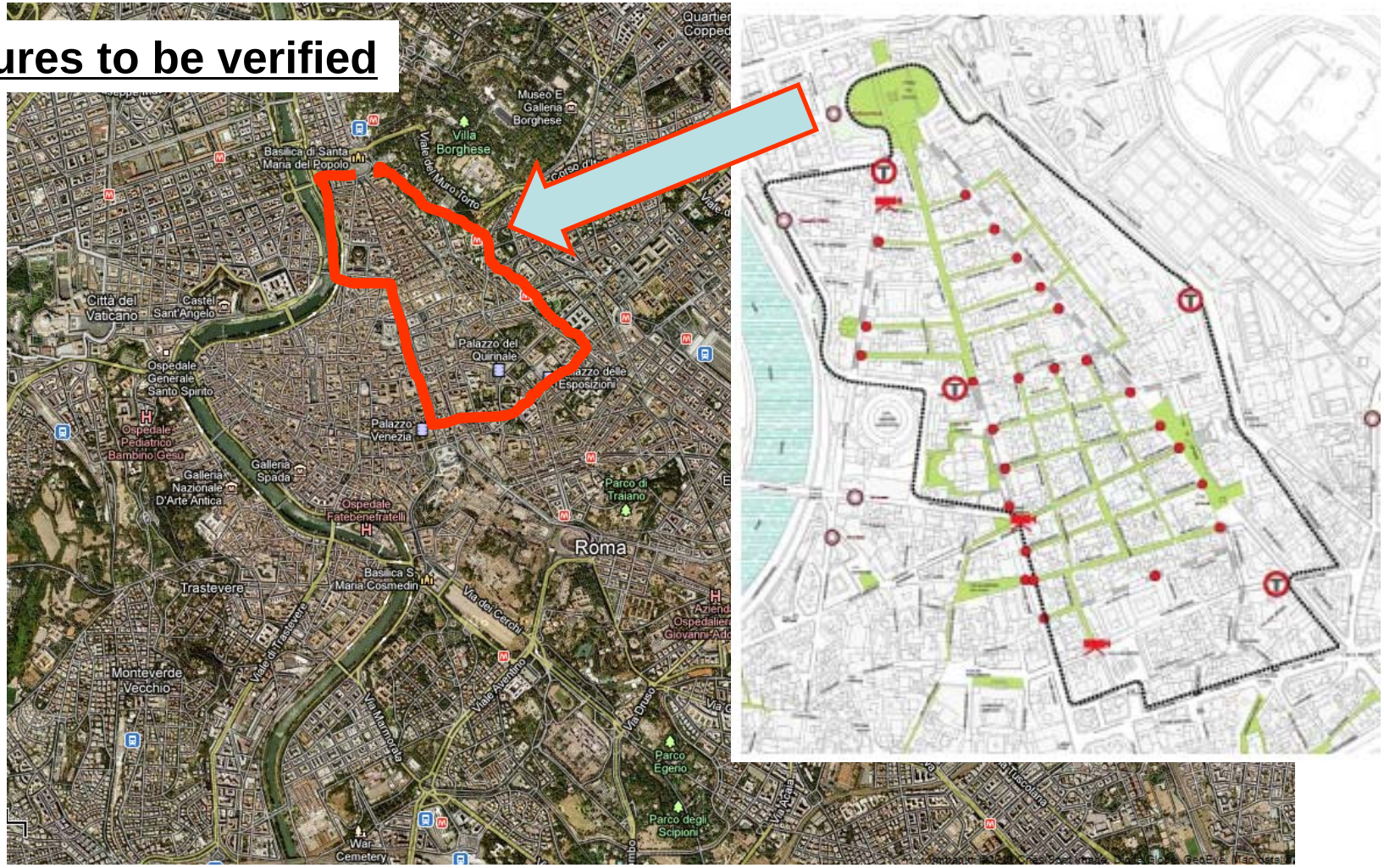
- ✓ Ban access to all vehicles (both private and commercial)
- ✓ Implementation of Nearby Delivery Area for commercial activities of the inner area



City logistics policies in Rome

Regulation after 2011: Nearby Delivery Area

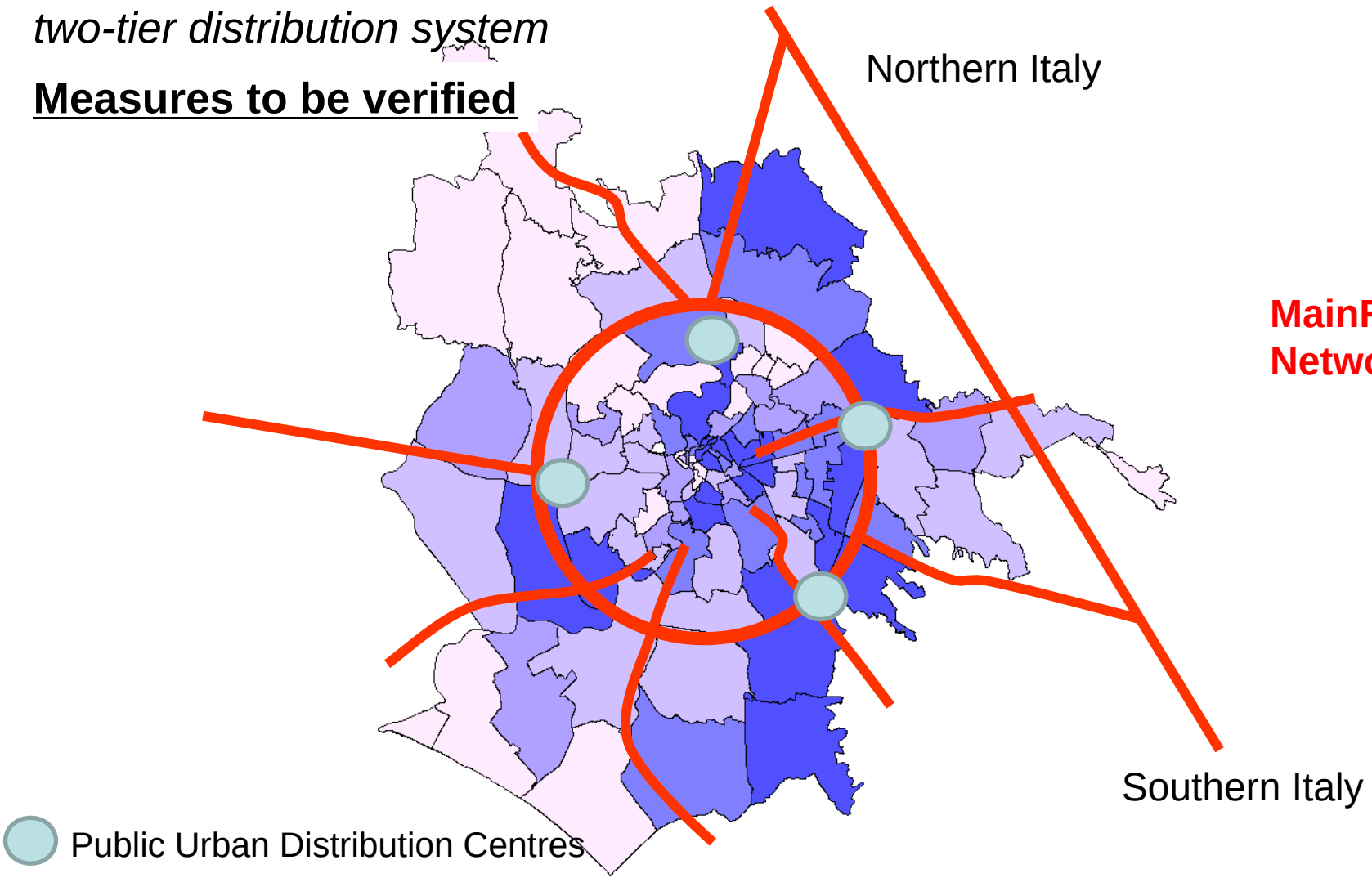
Measures to be verified



City logistics policies in Rome

Regulation after 2011: Public Urban Distribution Centres for improve the two-tier distribution system

Measures to be verified



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The surveys

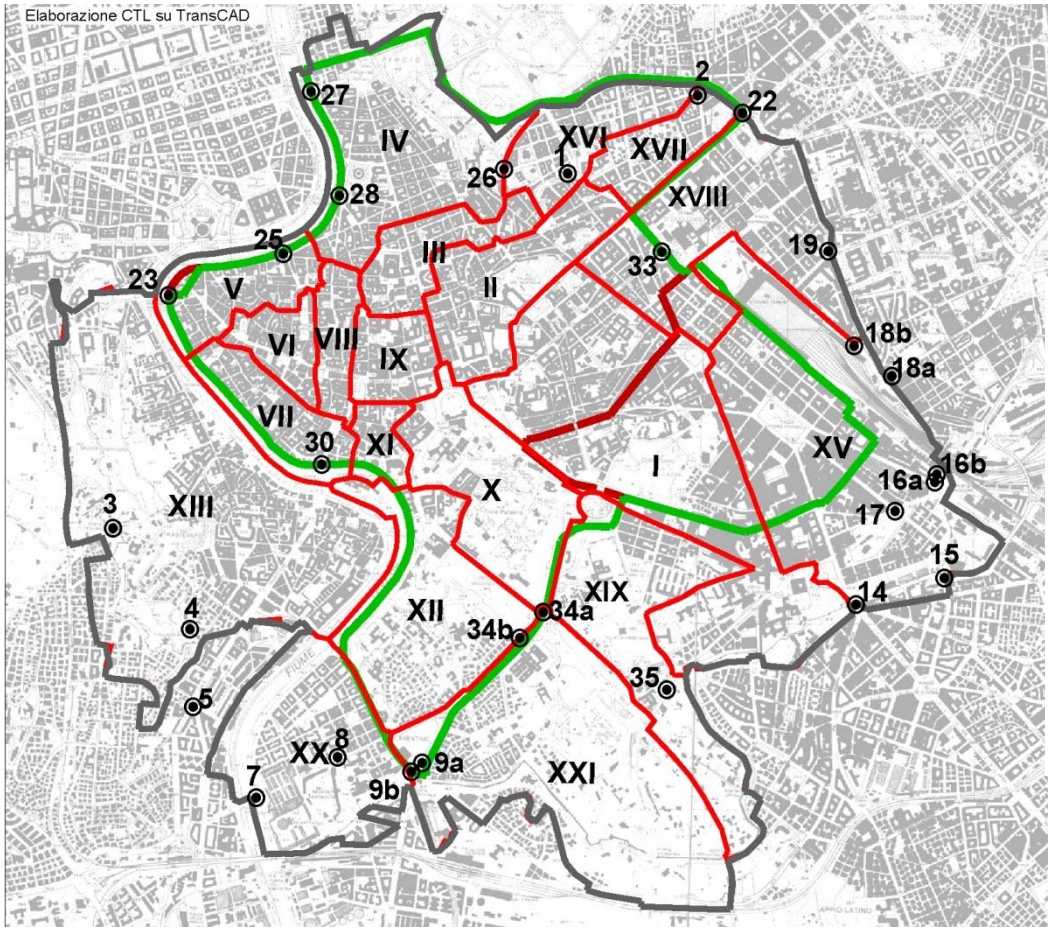
Structure

- ✓ traffic counts of commercial and private vehicles
- ✓ telephone interviews to retailers
- ✓ interviews to truck drivers

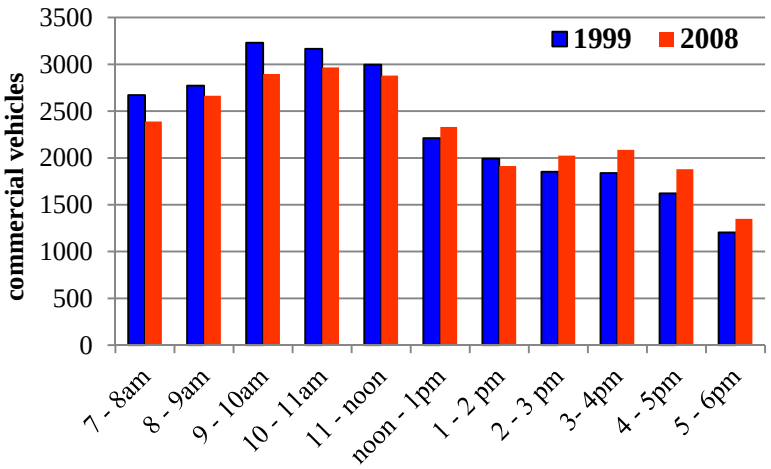
	Traffic counts	**Telephone interviews**	
		Retailers	*Truck-drivers*
1999	28 sections	250 *(12%)*	779
2008		575 *(38%)*	502

(-) response rate

Traffic counts



7am – 6pm	*Cars*	*Commercial vehicles*
1999	195,190	25,556
2008	216,922	25,382



Daily incidence of freight vehicles:

- ✓ 12% (1999)
- ✓ **9**% (2008)

Traffic counts

Considering that in 2008 **through freight traffic** can be assumed **zero**

The freight traffic attracted by the zone **has grown of about 24%**

Vehicle type	**2008**	**1999**
Gross laden weight less than 1.5 tons	**57%**	26%
Gross laden weight within 1.5 and 3.5 tons	33%	50%
Gross laden weight within 3.5 and 8.5 tons	10%	22%
Other vehicles		2%
Total	**100%**	**100%**

Retailer interviews

Sale surface

	2008	**1999**
Less than *100* m^2	68%	82%
Between *100* and *200* m^2	27%	15%
More than *200* m^2	4%	3%
Total	**100%**	**100%**

Average number of employees

Activity type	**2008**	**1999**
Retailers and public concerns	2.98	2.40
Craftsmen	2.37	2.70

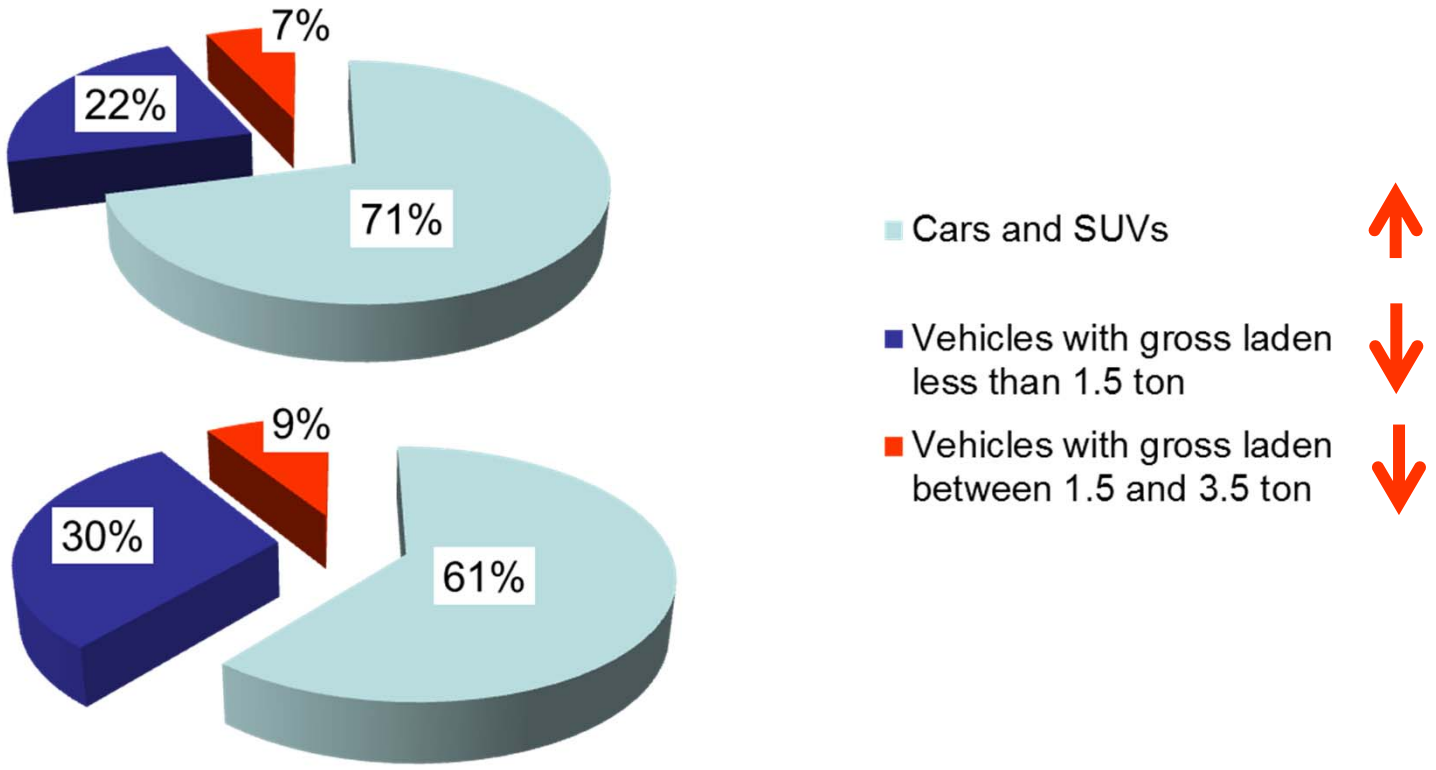
Retailer interviews

Transport in own account

✓ In 1999, 54% of businesses transported in own account, in 2008 only **21**%.

2008

1999



Truck driver interviews

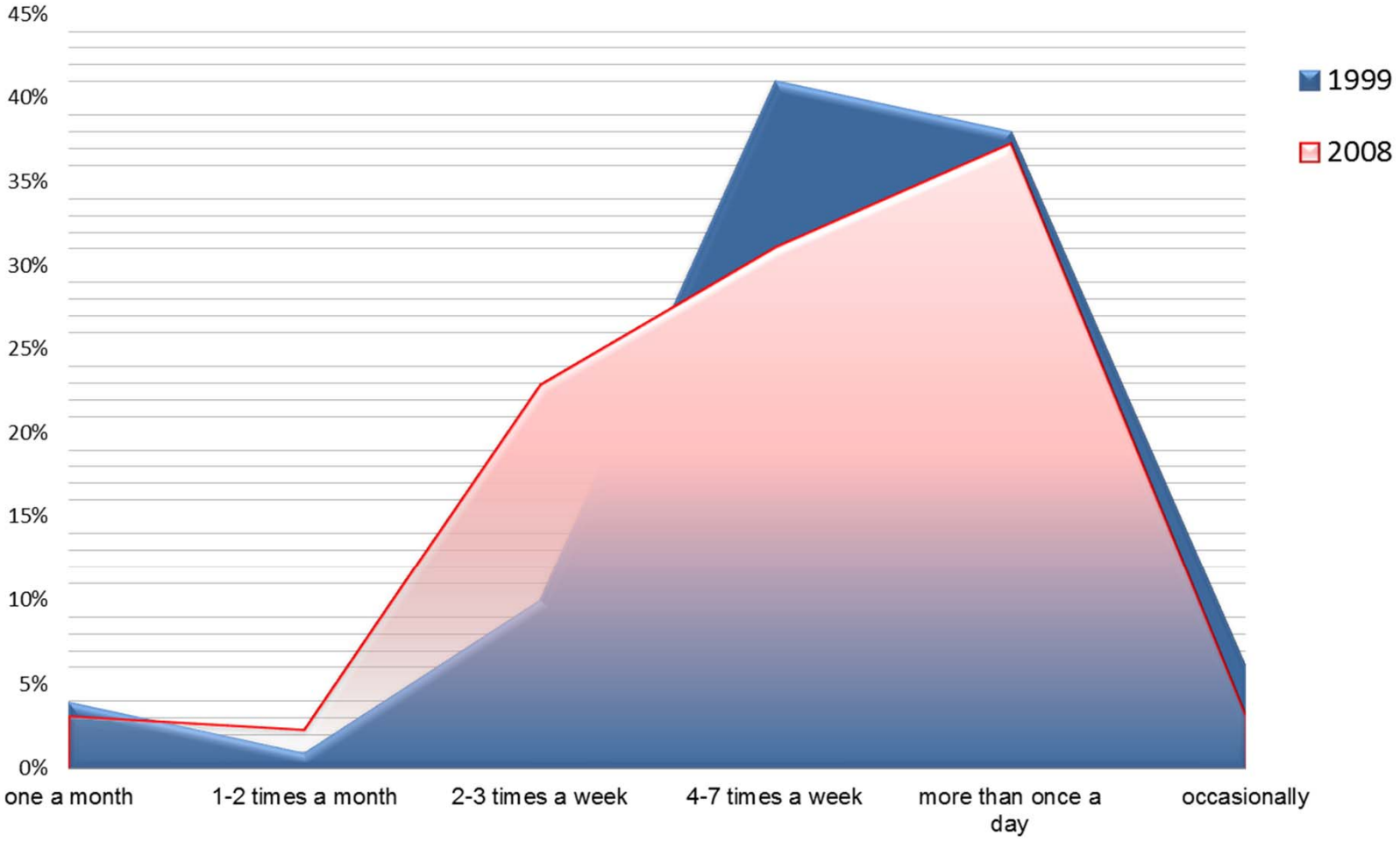
Fuel	2008			1999		
	Less than 1.5 t	More than 1.5 t	Total	Less than 1.5 t	More than 1.5 t	Total
Gasoline	8%	1%	**8%**	10%	3%	**13%**
Diesel	56%	34%	**90%**	33%	53%	**86%**
LPG	1%	0%	**1%**	1%		**1%**
CNG	0%	1%	**1%**			**0%**
Total	**65%**	**35%**	**100%**	**44%**	**56%**	**100%**

Truck owners

✓ 61% (1999) → 39% (2008)

Truck driver interviews

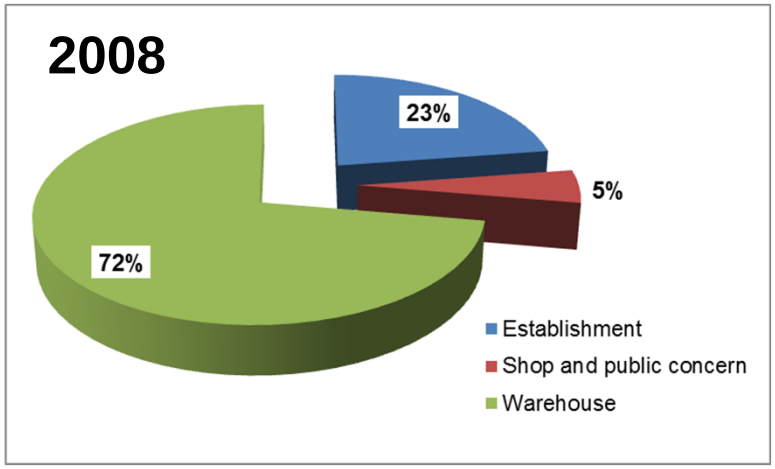
Delivery frequency

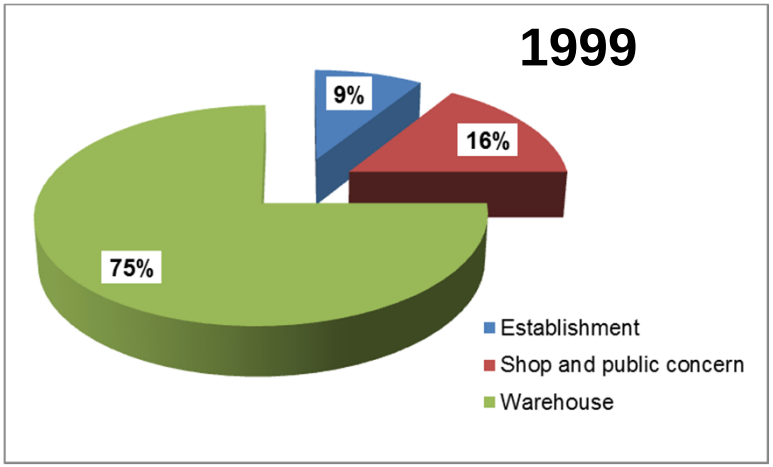


Truck driver interviews

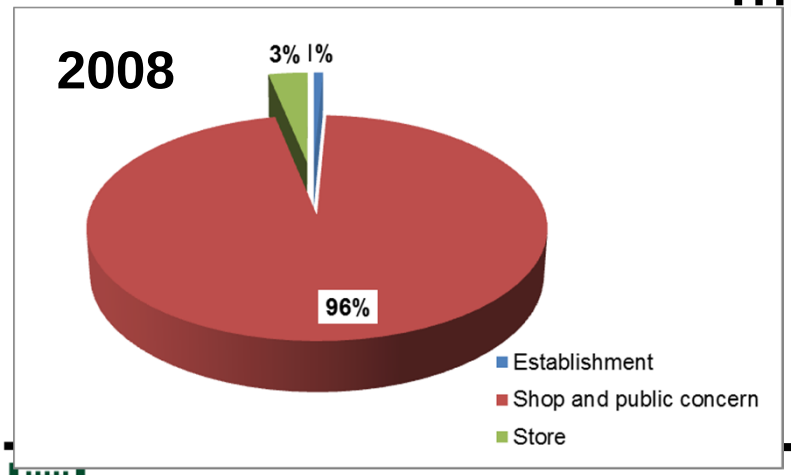
Trip origin and destination

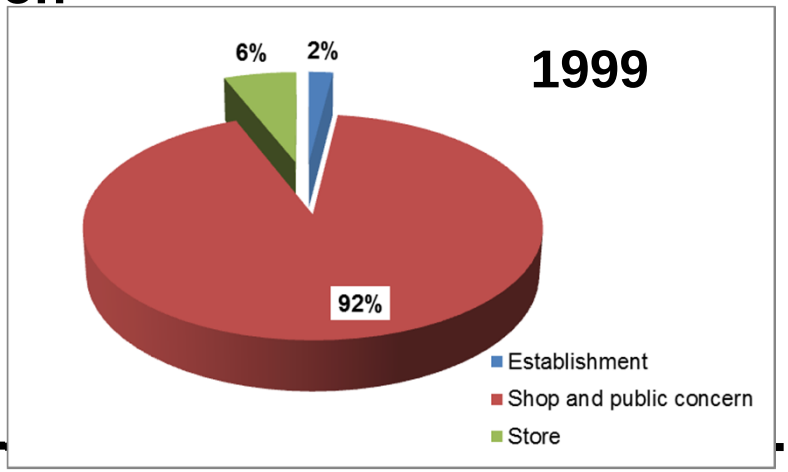
Trip origin





Trip destination





Truck driver interviews

Delivery time and number of deliveries

Delivery time and number of deliveries

	2008		1999	
Freight type	**Delivery time [minutes]**	**Number of deliveries**	**Delivery time [minutes]**	**Number of deliveries**
Books and musical products	22	2.2	27	1.9
Building materials	32	1.8	37	1.2
Clothing	24	2.0	38	1.5
Flower	24	1.8	28	1.1
Foodstuffs	28	2.6	22	2.1
Home accessories	40	1.8	45	1.2
Household or electrical appliance	23	2.2	33	1.3
Hygiene products	21	1.8	23	1.6
Laundry	16	2.5	21	2.1
Pharmaceutical	13	2.1	23	1.9
Stationery	25	2.0	23	1.5
Other goods	21	2.6	29	1.6
Average	**24**	**2.1**	**29**	**1.6**

Truck driver interview

Quantity flows (2008)

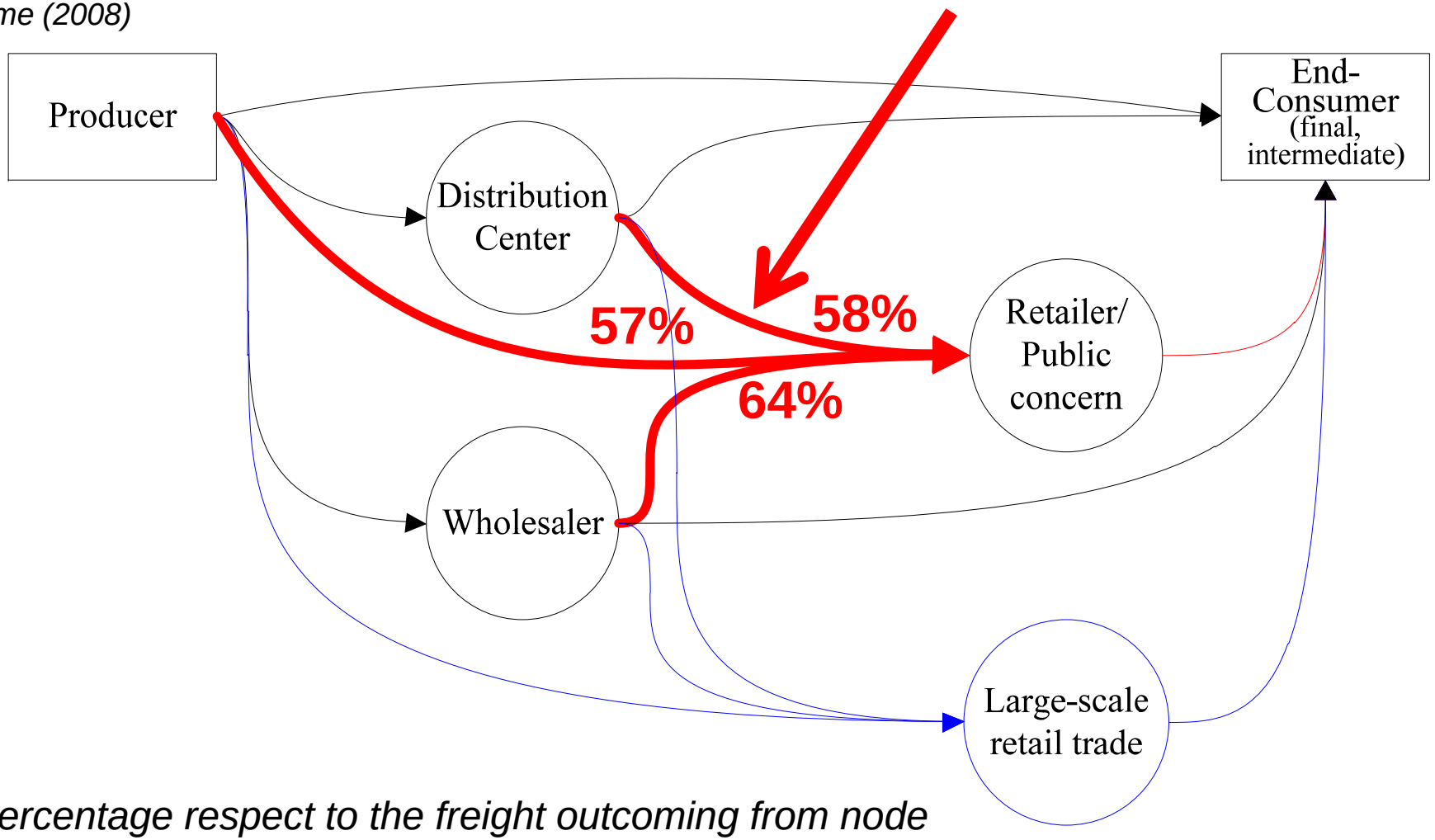
	Emitted *[tons/day]*	**Attracted** *[tons/day]*
Building Materials	-	467.7
Clothing	38.2	1,075.0
Foodstuff s	34.4	5,234.2
Home accessories	88.3	2,863.8
Household and personal hygiene	0.1	207.4
Stationery	31.0	2,475.9
Other goods	3.2	2,175.2
Total	**195.2**	**14,499.2**

- ✓ **82% of freight quantity is destined to satisfy end-consumer demand**

Truck driver

Distribution process (distributive logistics)

Rome (2008)



Percentage respect to the freight outcoming from node

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Choice dimensions, decision-makers and measures/policies

	Demand			Supply			
Choice dimension	*Distribution centre location?*	*Shop location and dimension?*	*Acquisition zone?*	*Service type?*	*What time?*	*Which vehicle?*	*Which restocking tour?*
Decision-maker							
Retailer	x	x	x	x	x	x	x
Wholesaler				x	x	x	x
Carrier					x	x	x
Measures/Policies							
Urban Distribution Centre/transit point			x	x	x	x	x
Time windows				x	x		x
Weight constraints				x		x	x
Road/parking pricing				x		x	x
Incentives				x		x	x
Specific permits				x		x	
ITS							x

Modeling framework to assess city logistics scenarios

Main requirements

- ✓ To point out the decision-makers' choices
- ✓ To take into account the effects on choices due to measures/policies implementations

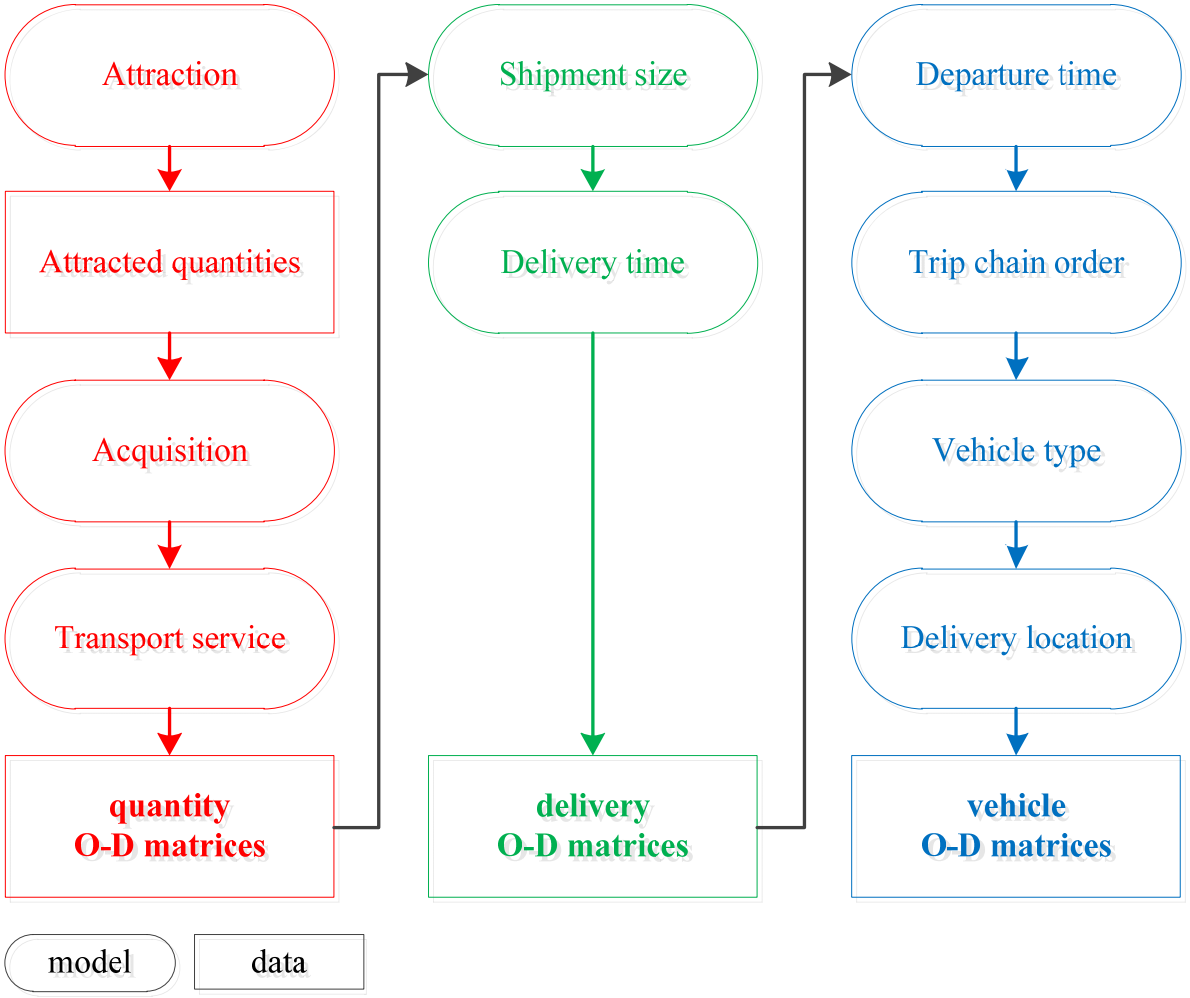
Modeling framework to assess city logistics scenarios

Structure

Quantity
allows to capture the mechanisms underlying the freight demand generation

Delivery
allows to follow the decisional and logistic process of restocking

Vehicle
Input for assignment and performance models



Quantity model sub-system

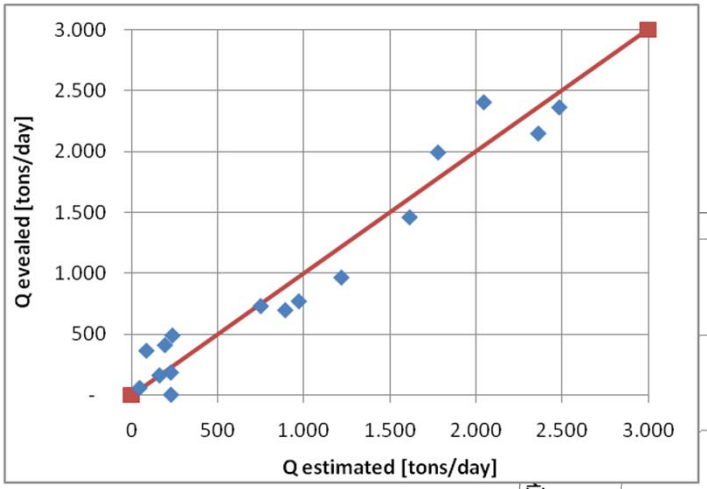
$$Q_{od}[r] = Q_{.d} \cdot p[o/d] \cdot p[r/od]$$

- ✓ $Q_{od}[r]$ is the average quantity flow of freight attracted by zone *d* and coming from zone *o* with transport service type *r*;
- ✓ $Q_{.d}$ is the average quantity of freight attracted by zone *d* (**attraction model**);
- ✓ $p[o/d]$ is the probability that freight attracted by zone *d* comes from zone *o* (e.g. production place/firm, distribution centre, warehouse, etc. - **acquisition model**);
- ✓ $p[r/od]$ is the probability to be restocked by transport service type *r* (**transport service type model**).

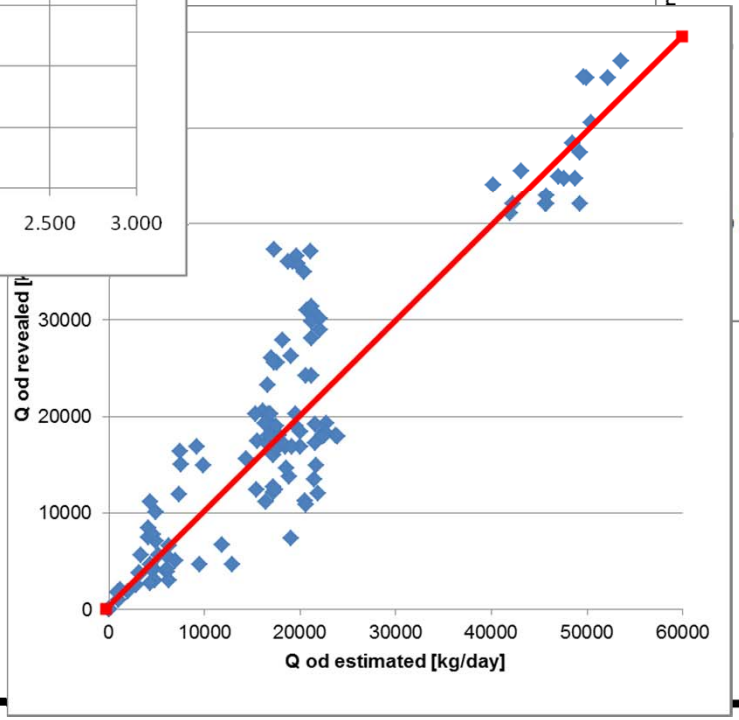
For simplicity of notation, the class index *s* (freight type) and *h* (time period) have been taken as understood unless otherwise stated

Revealed *vs* estimated quantities

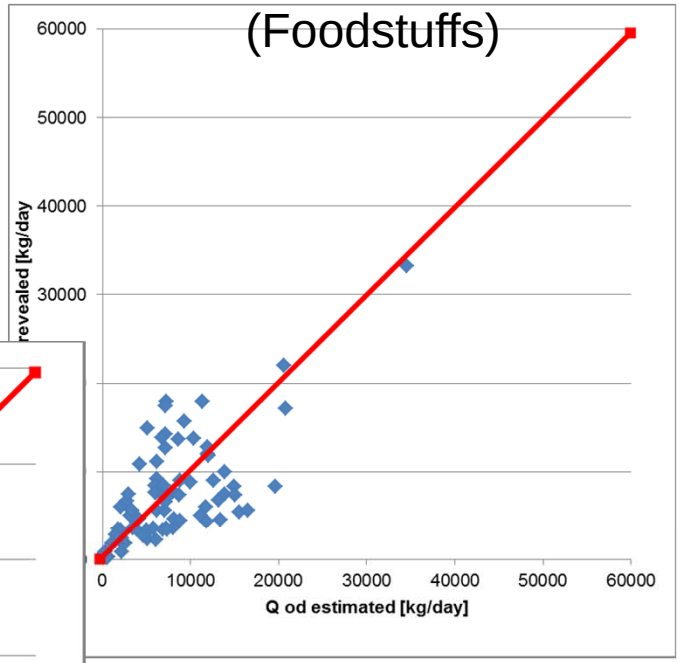
Attracted Quantity



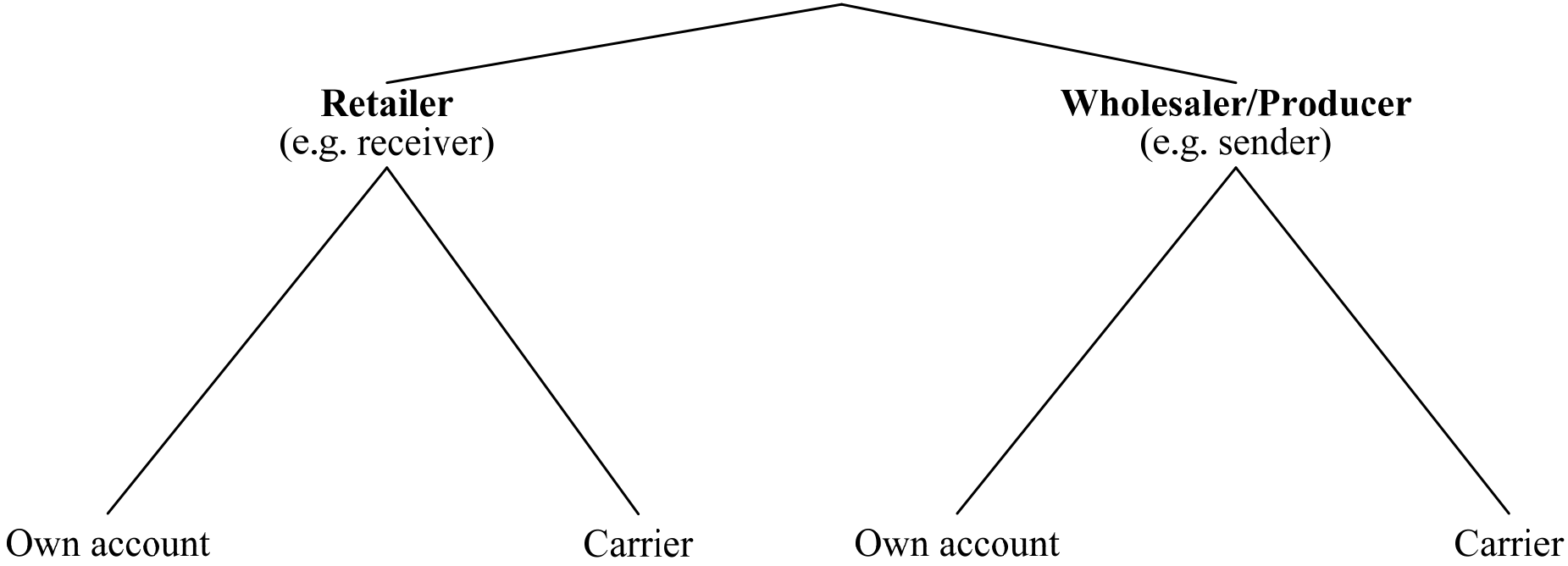
Quantity O-D flows
(Other goods)



Quantity O-D flows
(Foodstuffs)



Transport service type model



$$p[r / od]$$

p[r/od] is the probability to be restocked by transport service *r*

Delivery model sub-system

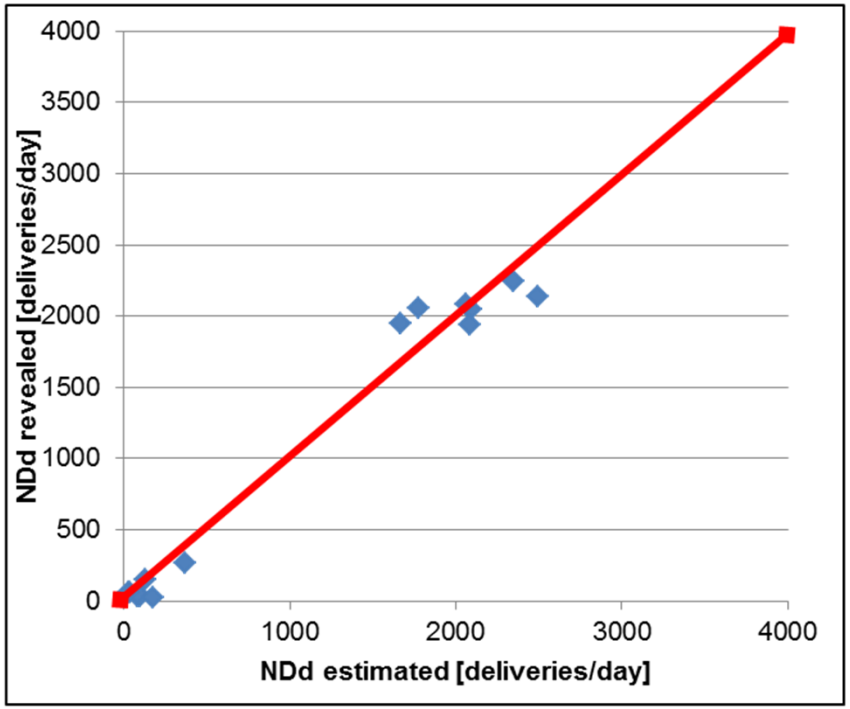
$$ND_{od}[\tau\, r] = \frac{Q_{od}[r]}{q[r]} \cdot p[\tau \,/\, d]$$

- ✓ $ND_{od}[\tau\, r]$ is the number of deliveries carried out by service type *r* on *od* pair in time slice τ;
- ✓ $Q_{od}[r]$ is the average freight quantity flow on *od* pair by service type *r*;
- ✓ $q[r]$ is the average freight quantity delivered with service type *r* (**shipment size model**).
- ✓ $p[\tau / d]$ is the probability of having deliveries in time slice τ (**delivery time model**)

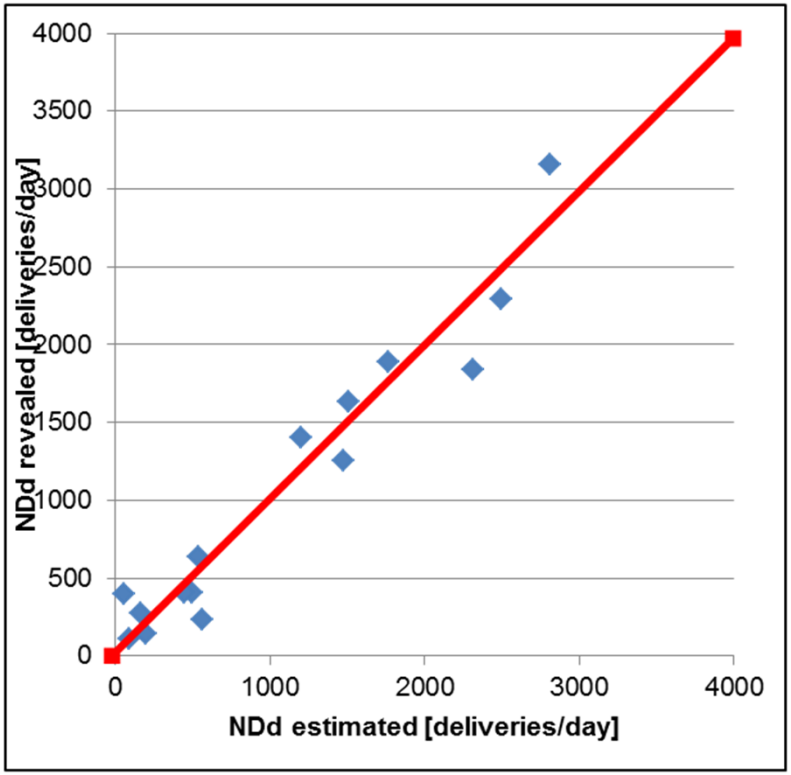
For simplicity of notation, the class index *s* (freight type) and *h* (time period) have been taken as understood unless otherwise stated

Revealed *vs* estimated deliveries

Attracted delivery flows (Foodstuffs)



Attracted delivery flows (Other goods)



Vehicle model sub-system

Average freight vehicle flow, *VC*, transporting freight type *s* between the zone *o* and the zone *d* in time period *h* characterized by:

- service type (*r*)
- time slice (τ)
- departure time (*t*)
- number of stops (*n*)
- vehicle type (*v*)

$$VC_{od}^{sh}[vnt\tau r]$$

For simplicity of notation, the class index *s* (freight type) and *h* (time period) will be taken as understood unless otherwise stated $\Rightarrow$ $VC_{od}[vnt\tau r]$

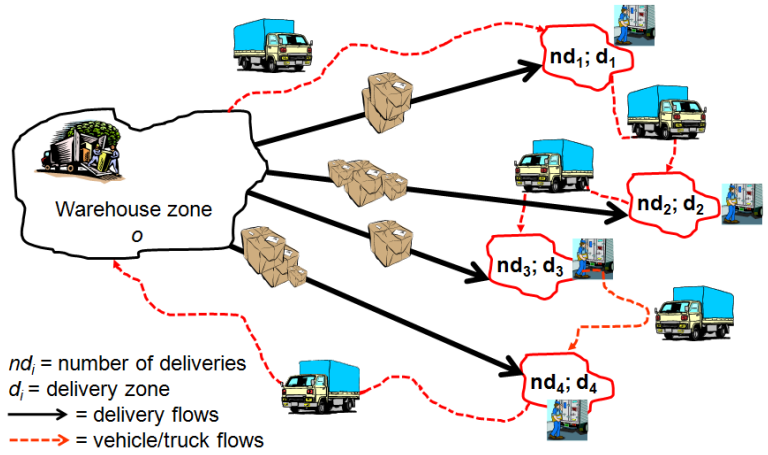
Vehicle O-D Problem definition

DELIVERIES

O-D	o	d_1	d_2	d_3	d_4
o		nd_1	nd_2	nd_3	nd_4
d_1					
d_2					
d_3					
d_4					

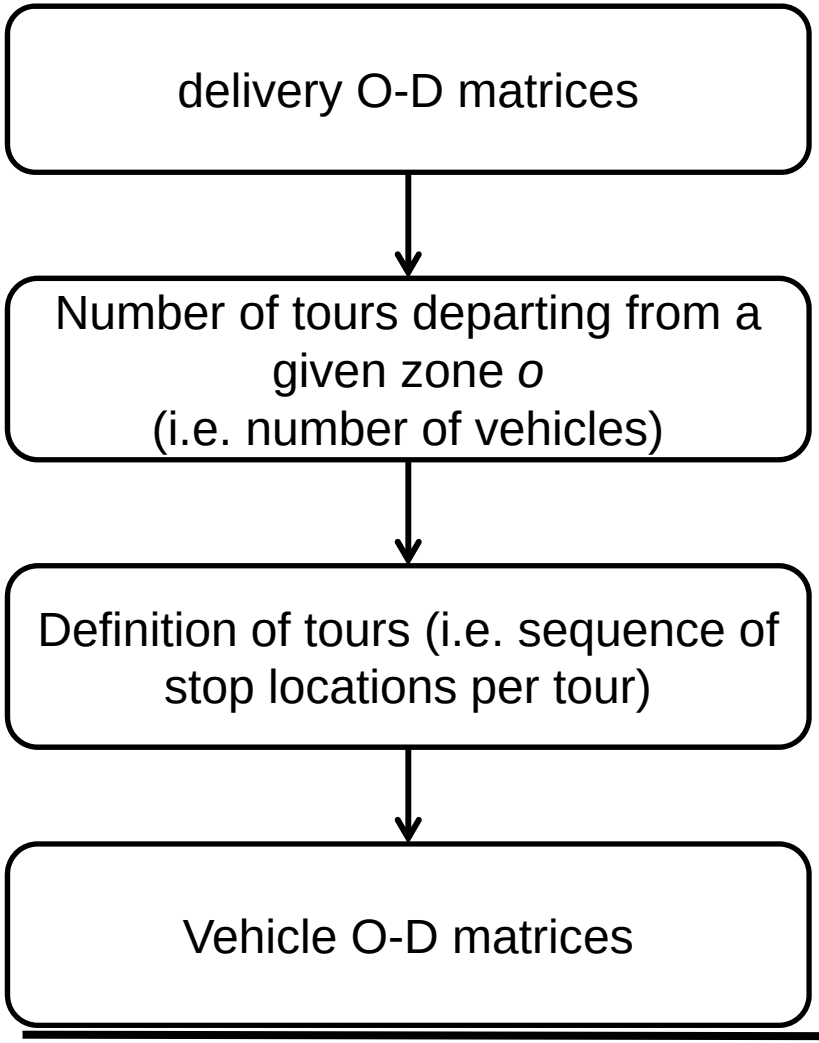
FREIGHT VEHICLES

O-D	o	d_1	d_2	d_3	d_4
o		*1*			
d_1			*1*		
d_2				*1*	
d_3					*1*
d_4	*1*				



- Restocker jointly chooses the **number** and the **location** of deliveries for each restocking tour
- Each restocker defines his tours trying to **reduce his costs** (e.g. using routing algorithm)
- The O-D matrices are the **sum** of **single** restocker **behaviours**

Vehicle sub-system structure



$$ND_{od}\left[\tau r\right]$$

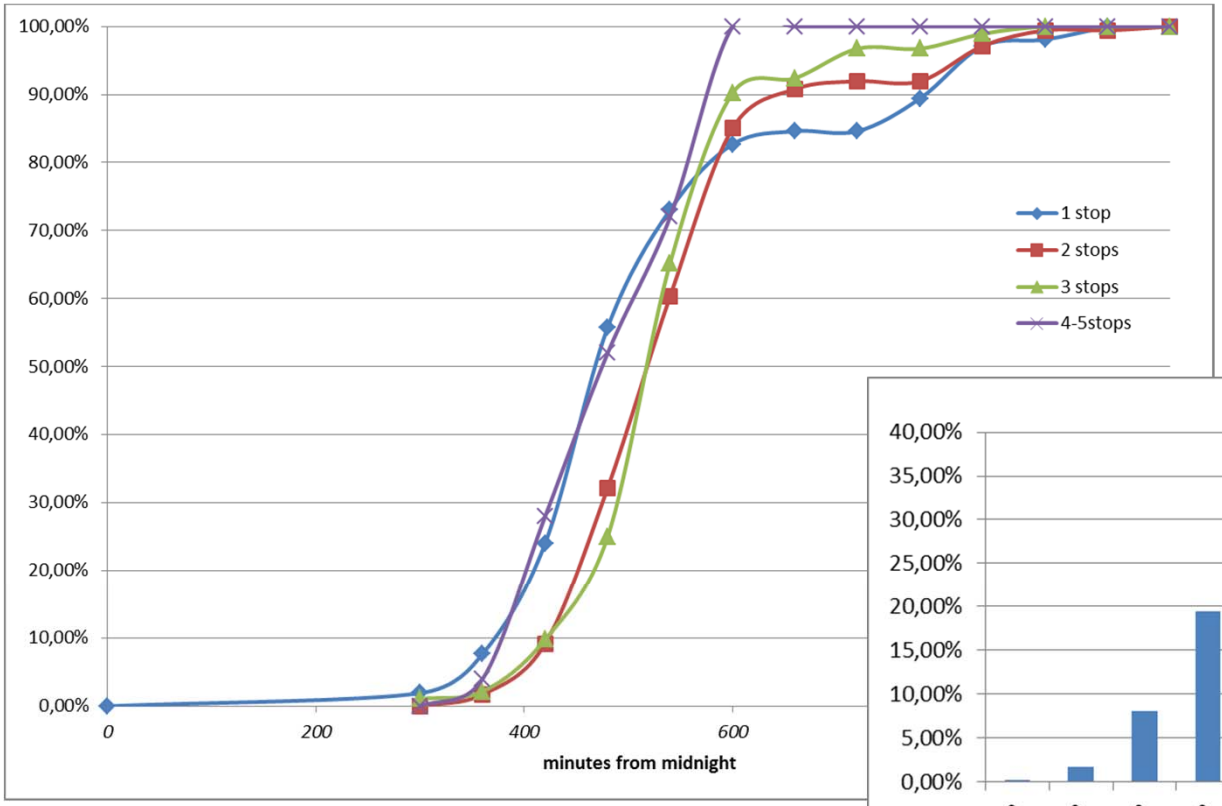
$$T_o\left[vnt\tau r\right] = T_o\left[\tau r\right] \cdot p\left[t \,/\, \tau ro\right] \cdot p\left[n \,/\, t\tau ro\right] \cdot p\left[v \,/\, nt\tau ro\right]$$

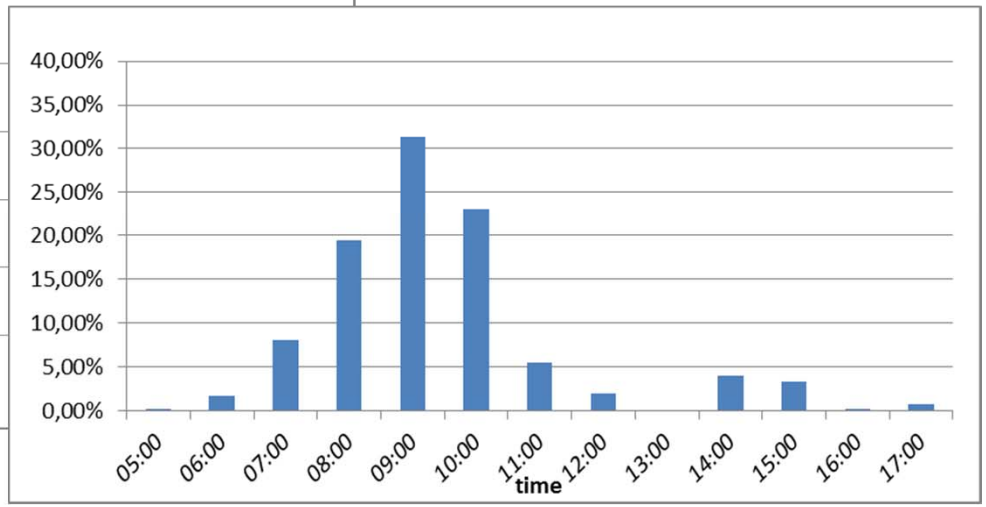
$$p\left[d_j^{k+1} \,/\, d_i^k vnt\tau ro\right]$$

$$VC_{d_i d_j}\left[\, vnt\tau ro\right]$$

Delivery tour departure time

$$p\left[t \,/\, \tau ro\right]$$

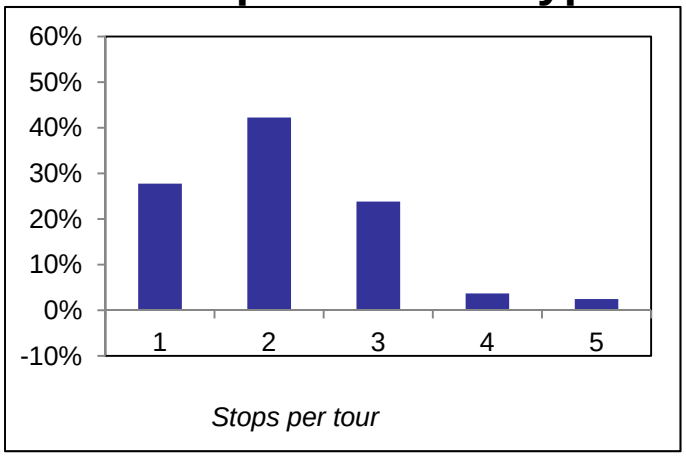




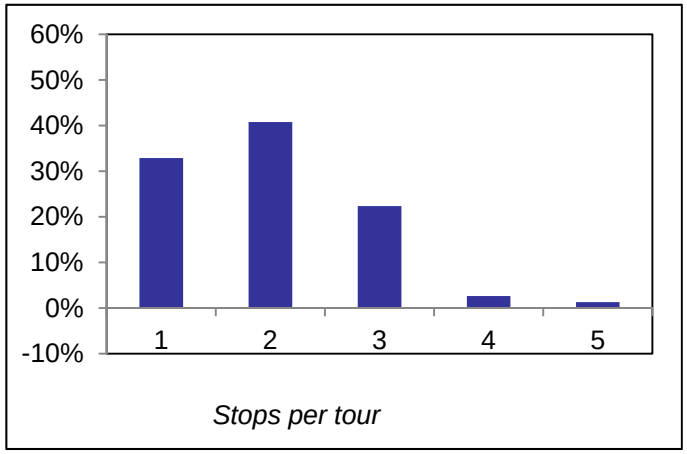
Trip chain order distribution

$$p\left[n / t\tau ro\right]$$

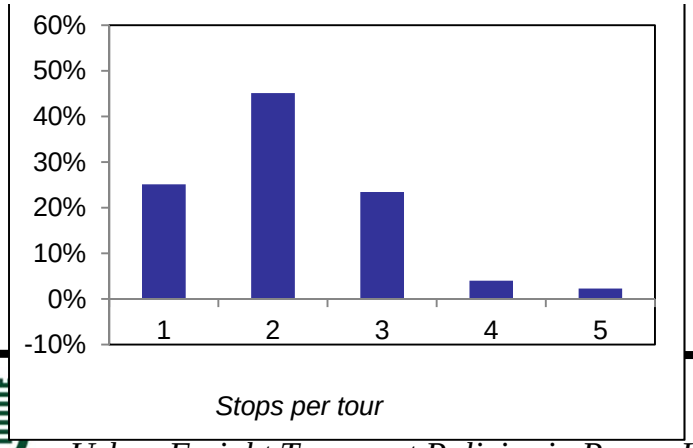
All transport service types



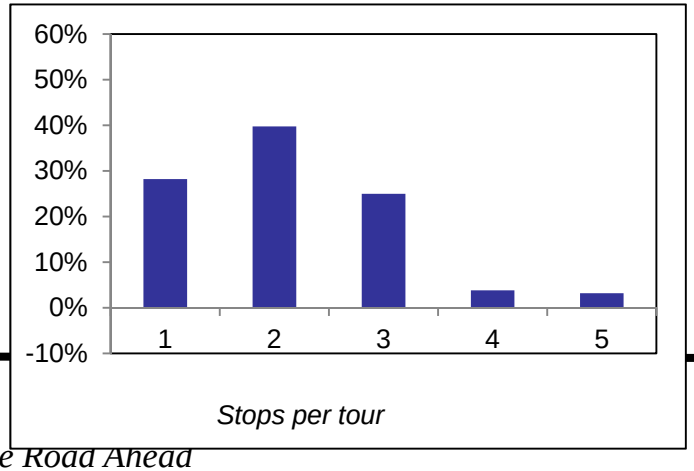
Retailer in own account



Wholesaler in own account

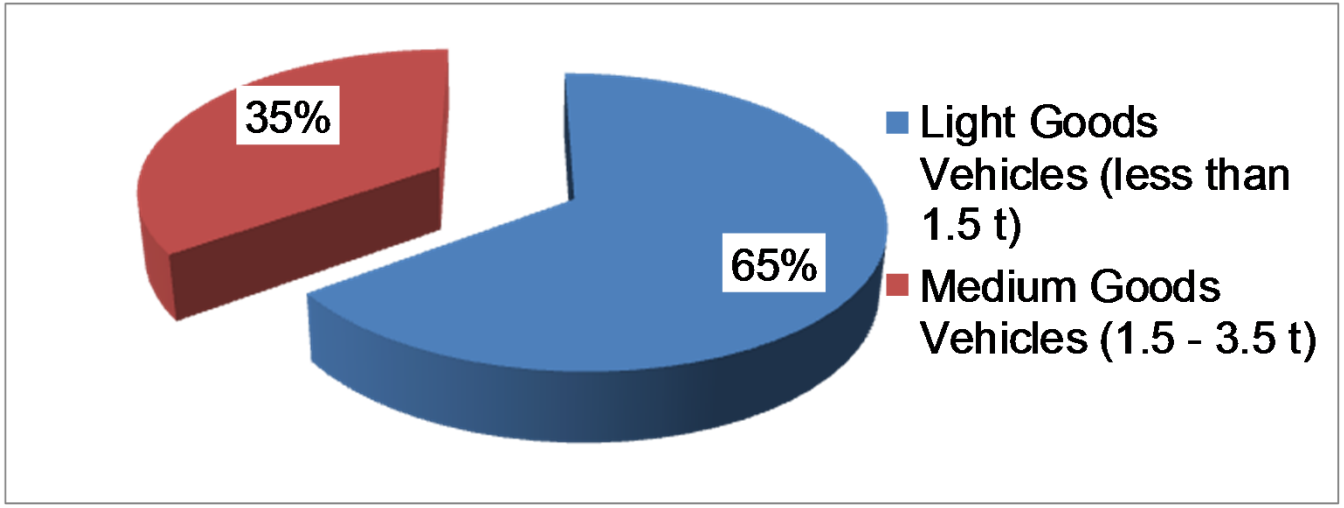


Carrier



Vehicle type

$$p[v / nt\tau ro]$$



- ✓ Average transported quantity:
  - ➢ LGV (< 1.5 t): 800 kg
  - ➢ MGV (1.5 – 3.5 t): 1.716 kg

- ✓ Average shipment size
  - ➢ LGV (< 1.5 t): 185 kg
    - ▪ Retailer in own account: 183 kg
    - ▪ Wholesaler in own account: 214 kg
    - ▪ Carrier: 154 kg
  - ➢ MGV (1.5 – 3.5 t): 382 kg
    - ▪ Retailer in own account: 414 kg
    - ▪ Wholesaler in own account: 406 kg
    - ▪ Carrier: 336 kg

Next delivery location

$$p\left[d_j^{k+1} \,/\, d_i^k vnt\tau ro\right]$$

- ✓ The next stops within a tour is averagely close: 2.5 km (less than 6 minutes)
- ✓ The average ratio between the distance to be covered to reach the next delivery location and the current covered distance is **0.77**
- ✓ 10% of next stops is within the same zone
- ✓ more stops/deliveries for **foodstuffs**
- ✓ The probability of a zone increases with its **attraction** capacity and **closeness**

Modeling framework to assess city logistics scenarios

Features 1/2

✓ It allows to take in to account the influence of, e.g.:

- socio-economic characteristics of a traffic zone on attracted freight traffic;
- localization of freight centers (e.g. distribution centers, warehouses) on generated freight traffic for each zone;
- characteristics of shops with related depots and shipment size on the choice of service type (retailer in own account, wholesaler in own account, carrier) and vehicle type;
- type of freight, accessibility of origin and destination zones, type of vehicle, shipment size and capacity of attraction zone on the pattern of restocking tours.

Modeling framework to assess city logistics scenarios

Features **2/2**

- ✓ It is able to evaluate the impacts of city logistics measures/policies that aim to, e.g.:

  - ➢ increase the shipment size, with a variation of number of deliveries, pattern of restocking tour and vehicle type;
  - ➢ reduce the passive accessibility (i.e. time windows and/or area-pricing, that push to restocking tour with more deliveries);
  - ➢ try to concentrate retail activities (i.e. less vehicle-km and short tours);
  - ➢ limit the dimensions of vehicles (with increasing of number of deliveries).

Overview

- ✓ Introduction
- ✓ City Logistics Policies Framework
- ✓ Policy Assessment Methodology
- ✓ City Logistics Policies in Rome
- ✓ The surveys
- ✓ Modeling Framework to Assess City Logistics Scenarios
- ✓ Conclusions

Conclusions

- ✓ The 2001 implemented measures (mainly access restrictions and charging scheme with electronic access control) have caused some important changes in freight transport patterns within the inner area of Rome, e.g.:
  - ➢ reduction of own account
  - ➢ increasing of light and less pollutant vehicles

Conclusions

- ✓ The 2008 survey shows that some critical aspects of urban freight transport still persist:
  - ➢ the frequency of restocking with a higher number of retailers receiving goods one or more times a day is increased
  - ➢ the absolute number of freight vehicles accessing the inner area is increased
  - ➢ the goods movements are still concentrated in the morning hours
  - ➢ the lack of loading and unloading zones

Conclusions

- ✓ Even though other measures have been implemented after 2011, further measures to improve the efficiency of goods distribution process are in progress:
  - ➢ Two-tier distribution system
  - ➢ Nearby Delivery Area within the inner area
  - ➢ Four Peripheral Public Distribution Centers

Conclusions

- ✓ Further analysis in order to improve the calibrated models for the ex-ante assessment

- ✓ Extension of data analysis and modeling in order to consider land-use/transport interaction:
  - ➢ Shopping mobility (e.g. user's behavior)
  - ➢ Retailing, public concern and large-scale retail trade locations

Workshop: Innovation in Urban Freight

February 6-7, 2012

Seattle, Washington, USA

Session: 03:00 PM – 04:00 PM - Monday, February 6, 2012

Urban Freight Transport Policies in Rome:

Lessons Learned and the Road Ahead

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