THEMATIC WORKSHOP
INFORMATION SYSTEMS FOR SUSTAINABLE
ENERGY AND MOBILITY PLANNING
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PLANNING AND MANAGING MOBILITY IN MILAN. THE URBAN ROAD PRICING EXPERIENCE.

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Milan basic data

Area: 181.76 km²
Inhabitants: 1.324.000
Population density: 7.284 inhab./km²
GDP per capita: 43.000 €
Milan Municipality
1.324.000

Province of Milan (Metropolitan City)
3.176.180

Metropolitan Area
8.300.000

Lombardy Region
9.509.100
PM10 concentration in Europe (2011)

Source: European Environment Agency (EEA), 2013
PM2.5 concentration in Europe (2011)

Source: European Environment Agency (EEA), 2013
Daily Trips in Milan Area

- More than **850,000** people enter Milan every day;
- **400,000** cars enter Milan every day;
- **5,5 million** trips affect Milan every day;
- **12%** of daily total trips are related to commercial vehicles and produce **27%** of total CO2 road emissions;
- During working hours population reaches about **2,000,000**.

Source: AMAT, 2014
Distribution of car trips as a function of distance

Source: AMAT, 2013
Milan population density
(inhabitants per km²)

Source: AMAT, 2003
Modal Split

2005 Exchange movements
- Cars: 62%
- Moped: 4%
- LPT: 34%
- Bicycle: 3%

2013 Exchange movements
- Cars: 58%
- Moped: 4%
- LPT: 37%
- Bicycle: 1%

Source: AMAT, 2014
Modal Split

Foot trips, not included, amount to 10%

Source: AMAT, 2014
Milan Traffic Index (2002-2013)

**Railway:**
- 8 lines (“S” lines)  
  Length: 282 km

**Metro:**
- 4 lines (M1 – M2 – M3 – M5)  
  Length: 94.5 km

**Tramway:**
- 19 urban lines  
  Length: 187 km
- 2 suburban lines  
  Length: 24.4 km

**Trolley bus:**
- 4 urban lines  
  Length: 40.8 km

**Bus:**
- 58 urban lines  
  Length: 464 km
- 46 suburban lines  
  Length: 492 km

**Total:**
- 140 lines  
  1575 km

*not including call buses and car/bike sharing services*
### Metro and urban rail transport improvements in Milan

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>2009</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subway and urban rail networks extension (km)</td>
<td>~ 136 km</td>
<td>~ 180 km</td>
</tr>
<tr>
<td>N. of metro and rail stations</td>
<td>110</td>
<td>166 (+51%)</td>
</tr>
<tr>
<td>Coverage of urban area (%)</td>
<td>26.3%</td>
<td>36.5% (+39%)</td>
</tr>
<tr>
<td>Share of Milan population served by subway and urban rail networks</td>
<td>41.1%</td>
<td>58.3% (+42%)</td>
</tr>
<tr>
<td>Share of mobility demand served</td>
<td>49.7%</td>
<td>59.0% (+19%)</td>
</tr>
<tr>
<td>Modal share of public transport in morning peak hours</td>
<td>47.4%</td>
<td>53.7% (+13%)</td>
</tr>
<tr>
<td>Passengers/year</td>
<td>359 million</td>
<td>518 million (+44%)</td>
</tr>
</tbody>
</table>

**Source:** AMAT, 2009
Metro and urban rail lines in Milan (2009)
Metro and urban rail lines in Milan (2020)
Milan Sustainable Mobility Strategy
In 2007 Milan adopted a strategy for sustainable mobility, health and environment with the aim of improving environmental conditions, health and quality of life for people living and working in the Milan area.
Integrated strategy for sustainable mobility

**Strategic goals:**
1. Congestion reduction;
2. Air quality (and noise) improvement;
3. Road safety improvement.

**Means**
- Urban development orientation towards compactness;
- Promotion of sustainable mobility (walking, cycling, public transport, “clean” cars);
- Passenger cars, public transport and freight vehicles renovation;
- Disincentivation of use of most polluting vehicles;
- Adoption of innovative technologies;
- Public information and participation.
**Integrated strategy for sustainable mobility**

**Supply side actions**

- Rules for urban redevelopment;
- Extension of Public Transport underground and surface network;
- Improvement of Public Transport service (frequency, regularity, comfort, information, emissions, etc.);
- Introduction of new Public Transport flexible systems (on-demand buses, car sharing, bike sharing, etc.);
- Tariff simplification/integration and electronic ticketing;
- Extension of public transport dedicated lanes, bike lanes and pedestrian areas;
- New interchange parking lots;
- Electric car recharge infrastructure and experimentation;
- Road safety infrastructures.
Integrated strategy for sustainable mobility

Demand side actions

- Incentives for urban redevelopment;
- Regulation of goods distribution;
- Mobility management (incentives to use public transport for workers, families, etc.);
- Application of intelligent transport and traffic management systems;
- Extension of parking regulation;
- Road pricing.

Currently the Municipality of Milan is developing a new Sustainable Urban Mobility Plan in line with the previous approach.
Road pricing: from Ecopass to Area C
Pollution Charge: Ecopass

Ecopass is a daily entrance charge (7.30 am – 7.30 pm working days) to access the city center by passenger and freight vehicles.

The charge is proportional to PM10 tail emissions of vehicles.

The charge is coherent with the “polluter pays principle” and with Italian traffic laws.

The system entered in force on 1 January 2008.
Pollution Charge: Ecopass

The ECOPASS area was defined on the basis of:

- High congestion;
- Easy access control;
- Strong public transport service.

- 8.2 km² (4.5% of city surface)
- Residents: 77,000 (6%)
## Pollution charge scheme

<table>
<thead>
<tr>
<th>Class</th>
<th>Category of vehicle</th>
<th>Daily charge (€)</th>
<th>PM 10 Emission factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1</td>
<td>Low emission vehicles (LPG, methane, hybrid, electric)</td>
<td>free</td>
<td></td>
</tr>
</tbody>
</table>
| Class 2 | Petrol Euro 3+  
Diesel Euro 3+ with particulate filter installed before sale  
Diesel Euro 5 with particulate filter installed after sale | free             | ≤ 10 mg/km             |
| Class 3 | Petrol Euro 2 and Euro 1                                                           | € 2              | ≤ 10 mg/km             |
| Class 4 | Petrol Euro 0  
Diesel cars Euro 1, 2, 3 (and 4 without particulate filter)  
Diesel commercial vehicles Euro 4 without particulate filter  
Diesel commercial vehicles Euro 3 | € 5              | > 10 mg/km  
≤ 100 mg/km 5 |
| Class 5 | Diesel cars Euro 0  
Diesel commercial vehicles Euro 0, 1, 2                                           | € 10             | > 100 mg/km 10         |
43 electronic gateways control the access to the area through cameras reading license plates. Plates are identified through an OCR (Optical Character Recognition) system. Vehicles not paying the charge (if not exempt) are fined (70 euros).
Payment system

Payment is simple and can be made through different channels:
• authorized ticket sellers (shops, tobacconists, newsagents, public transport information points)
• telephone (by credit card)
• web (by credit card)
• bank ATM (automatic cash dispensers)
• bank RID (permanent debt authorization)

Various passes are available:
• daily passes
• multiple day passes
• discounted yearly passes for residents inside the area (equivalent to 10% of full charge)

The charge can be paid the same day of transit or the following one.
In a municipal **Referendum**, 79% of voters express their favour for further reducing urban congestion and pollution through the application of the charge to all 4 wheels vehicles;

The pollution charge called Ecopass is replaced by a congestion charge called «**Area C**»;
Congestion Charge: Area C

• In operation Monday to Friday 7.30 to 19.30 (with the exception of Thursday 7.30 to 18);
• **Flat charge** for all vehicles (5€);
• **Commercial and service vehicles** pay 3€ (in alternative 5€ with 2 hours free parking);
• **Residents** have 40 free accesses per month (after 2€ each);
• Motorcycles and scooters, electric vehicles, hybrid vehicles, as well as natural gas, LPG and bi-fuel vehicles are **exempt**.
## Comparison of congestion charges in 3 European cities

<table>
<thead>
<tr>
<th></th>
<th>London</th>
<th>Stockholm</th>
<th>Milan</th>
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</thead>
<tbody>
<tr>
<td><strong>Start year</strong></td>
<td>February 2003</td>
<td>January 2006 (7 months trial)</td>
<td>Pollution charge from January 2008</td>
</tr>
<tr>
<td></td>
<td>Permanently since August 2007</td>
<td>Permanent from August 2007</td>
<td>Congestion charge from January 2012</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(formally a trial until April 2013)</td>
</tr>
<tr>
<td><strong>Area</strong></td>
<td>21 km² (1.3% of the city surface)</td>
<td>30 km² (16% of the city surface)</td>
<td>8 km² (4.5% of the city surface)</td>
</tr>
<tr>
<td></td>
<td>Western extension from February 2007 to January 2011 Metropolitan area 14 m inhab.</td>
<td>Stockholm County 1.9 m inhab.</td>
<td>Metropolitan area 3 m inhab.</td>
</tr>
<tr>
<td><strong>Amount of charge</strong></td>
<td>£ 5</td>
<td>SEK 20 (about € 2) during peak periods (7:30-8:30, 16:00-17:30), SEK 15 30 minutes before and after the peak periods and SEK 10 during the rest of the period 6.30-18.30. The total charge per day is capped at SEK 60.</td>
<td>Pollution charge: proportional to vehicles' emission class, of € 0, 2, 5 or 10 per day. Congestion charge: flat charge of € 5 per day.</td>
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<tr>
<td></td>
<td>£ 8 from July 2005</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>£ 10 from January 2011</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>£ 11.50 (about € 14,50) from June 2014</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Applicance of charge</strong></td>
<td>Cordon pricing</td>
<td>Cordon pricing</td>
<td>Cordon pricing</td>
</tr>
<tr>
<td></td>
<td>Daily fee</td>
<td>Single passage fee (with daily limit)</td>
<td>Daily fee</td>
</tr>
<tr>
<td></td>
<td>Pay for entrance, exit, intra-area trips</td>
<td>Pay for entrance and exit of the area</td>
<td>Pay for entrance in the area</td>
</tr>
<tr>
<td><strong>Time of application</strong></td>
<td>Weekdays, 7.00-18.00</td>
<td>Weekdays, 6.30-18.30</td>
<td>Weekdays, 7.30-19.30</td>
</tr>
</tbody>
</table>

*Source: Croci and Ravazzi, 2014*
# Effects on traffic of congestion charging

<table>
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<th>Milan</th>
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</thead>
<tbody>
<tr>
<td><strong>Reduction of whole traffic with respect to reference</strong>&lt;br&gt;year</td>
<td>-14% (2003)</td>
<td>-21% (2006)</td>
<td>Ecopass:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-18% (2009)</td>
<td>-19,3% (2010) euro IV diesel charged</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-19% (2010)</td>
<td>-10,8% (2011)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-20% (2011)</td>
<td>Area C:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-38,8% (2012)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-37,6% (2013)</td>
</tr>
<tr>
<td><strong>Congestion reduction</strong></td>
<td>-30% (2003)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-22% (2005)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-8% (2006)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0% (2007)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-36% (2006)</td>
<td></td>
<td>reduced chargeable passenger traffic on</td>
</tr>
<tr>
<td></td>
<td>£8 charge drove to a 53% reduction of fully chargeable traffic in 2007.</td>
<td></td>
<td>average by 60,5% and in the last year (2011) by 79,8% and 63,2%, respectively for a € 2 and € 5 charge</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(A possible interpretation is that class 3 vehicles owners are wealthier and change cars more often than class 4)</td>
</tr>
</tbody>
</table>
### Costs and Revenues (excluding fines)

<table>
<thead>
<tr>
<th></th>
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<th>Milan</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Set up investment</strong></td>
<td>160 m £ (203,5 m €)</td>
<td>1.900 m SEK (207,2 m €)</td>
<td>7 m € (excluding sunk costs)</td>
</tr>
<tr>
<td><strong>Annual operating cost</strong></td>
<td>90 m £ (114,4 m €)</td>
<td>220 m SEK (23,9 m €)</td>
<td>14 m €</td>
</tr>
<tr>
<td><strong>Gross revenues per year (excluding fines)</strong></td>
<td>from 138 m £ to 227 m £ in 2012 (from 175,5 m € to 288,6 m € in 2012)</td>
<td>763 m SEK (83,2 m €)</td>
<td>from 12 m € in 2008 to 5,9 m € in 2011 (Ecopass); 30 m € in 2012 (Area C)</td>
</tr>
<tr>
<td><strong>Ratio operating costs / revenues</strong></td>
<td>37% (in 2008; falling from initially 42%)</td>
<td>25% (in 2010 falling from initially 40%)</td>
<td>22% (falling from initially 40%)</td>
</tr>
</tbody>
</table>

**Source:** Croci and Ravazzi, 2014
Elasticity of car use to charge

<table>
<thead>
<tr>
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<th>Stockholm</th>
<th>Milan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elasticity</td>
<td>0.47 (Transport for London, 2008)</td>
<td>0.70 in 2006 to 0.85 in 2009 onwards (Börjesson et a.i, 2012)</td>
<td>0.46 - 0.66 (for different classes of emissions of vehicles). (own estimation)</td>
</tr>
<tr>
<td>values</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Croci and Ravazzi, 2014
Ecopass/Area C main results: social benefits

Benefits in terms of the reduction of social costs are still under calculation, but it is already evident that they largely overweight costs. They include:

- **Value of time gained**;
- **Reduction of costs of accidents (insurance costs)**;
- **Reduction of health costs (due to pollutant emission reduction)**;
- **Reduction of CO2 emissions**;
- **Increase of value of real estate**;
- **Other benefits**.

Analysis of social costs shows that business (especially retail) has not been affected by Ecopass/Area C.
Bike Sharing
Bike Sharing in Milan: BikeMi

BikeMi was introduced in 2008. It now has over 200 stations and more than 3,000 bikes.
BikeMi stations distribution and usage rates

**Annual subscription**
- Rate: **36€**;
- first 30 minutes: **free**;
- then **€ 0,50** every 30 minutes up to 2 hours;
- then **€ 2** per hour.

**Weekly subscription**
Rate: **6€**

**Daily subscription**
Rate: **2,50€**
BikeMi. Development of number of bikes

Source: IEFE- Bocconi University elaboration.
BikeMi. Development of number of users with annual subscription

Daily record: **13.129** catches (September 16, 2014)

Source: Elaboration IEFE-Bocconi University.
Important success factors are **proximity** of stations to attractors and **visibility** of stations from attractors.

Data show the relevance of the **role of urban planning** for the best positioning of bike sharing stations and the need to carefully consider the features of surrounding environment to optimise the distribution of bike sharing stations in a territory.

**Source:** Croci and Rossi, 2014
Car Sharing
Car Sharing in Milan

Until 2013 two public owned operators: Guidami (Municipality of Milan) and E-Vai (Lombardy Region); they operate with fixed stations;

June 2013⇒ The Municipality of Milan launches a public call for a “free floating” car sharing service;

August 2013⇒ Car2Go (Mercedes) is the first private company operating in Milan; during 2014⇒ 2 more private operators join the market: Enjoy (joint venture among ENI, Trenitalia and FIAT) and Twist (Volkswagen); they operate with free floating systems.

Moreover in 2013 the Municipality promotes Eqsharing (fully electric quadricycles); it operates with fixed stations.
Car Sharing in Milan

Car2Go

Enjoy

Twist

GuidaMI

EqSharing
Car Sharing in Milan

Guidami → 158 cars (small and medium cars, vans and electric vehicles). 7,000 declared members.

E-vai → about 100 cars in the metropolitan area in correspondence to rail stations (mainly electric vehicles). 23,000 declared members.

Car2Go → 800 Mercedes Smart. 70,000 declared members.

Enjoy → 600 Fiat500 + 44 Fiat500L. 112,000 declared members.

Twist → 500 Volkswagen Up. 12,000 declared members.

EQ sharing → 120 electric quadricycles.

Today in Milan there are more than 2,000 cars and about 200,000 subscriptions to the services.
Note: Many people have more than one subscription.
Car Sharing system features

An annual subscription is required. For the new systems the cost varies between 0 and 20 €). A credit card is required.
A cost between 0,19 and 0,29 €/Km is applied (rate can be reduced during stops and can increase for trips longer than 50 Km).

An App shows the position of available cars. A car can be booked through the App (normally not later than 30 minutes).
A smart card allows to open and close the card. Last systems don’t require it and allow to unblock the car through the App or an SMS.
In case of need to refuel, the user gets a bonus.

Cars are exempt from congestion charge and parking fees on public spaces.
Milan has been able to **significantly reduce congestion and traffic emissions** in the last 6 years.

An **integrated sustainable mobility strategy**, including measures on both the demand and the supply sides has been developed.

**Urban road pricing is a key element** of this strategy.

The **system evolved** from a pollution charge to a congestion charge.

**Political and public debate** were relevant factors in setting up and decide permanency of the systems. A **referendum** was a key factor at that purpose.

A robust **increase of public transportation** was announced and implemented in coincidence with the introduction of the charge and a substantial part of **revenues are invested for sustainable mobility**.

**Innovative bike sharing and car sharing systems** have been introduced and are also rapidly increasing.

**ICT** applied to mobility and rapid diffusion of smart phones and Apps are key factors of **innovation**.
Conclusions

It shows a **high deterrent effect of the charge**, as measured on travel behavior changes referred to all traffic and in particular to chargeable traffic. The **demand elasticities** of car travel in response to a congestion charge are considerably **higher** than the values in response to fuel costs in literature and even to traditional tolls for roads and bridges. Urban congestion charging, though limited to pioneer experiences, confirms its ability to reduce congestion in an **effective** way.
Thank for the attention.

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