New metro line in Turin: an analysis of the impacts on road traffic accidents and local mobility

6th July 2015
Session: Thinking Mobility - Well Being, Awareness & Technology

Selene Bianco¹, G. Melis², E. Eynard², C. Marietta², M. Tabasso², C. Mamo¹, E. Gelormino¹, G. Costa¹

1. Epidemiology Unit, Local Health Unit TO3
2. SiTI - Higher Institute on territorial systems for innovation
Turin is the fourth city of Italy in terms of population.

Surface area: 130.01km².
Citizens: 896,773 (31-12-2014).

Until 2006 Turin did not have a subway line.
In Turin, the first Italian automatic underground has been built and now it moves about 130,000 passengers per day.

The full path starts from the neighbouring town of Collegno to the south of Turin.

Segments of the subway line:

2006: Fermi (Collegno) – Porta Susa station (Turin)

2007: Porta Susa station (Turin) – Porta Nuova station (Turin)

2011: Porta Nuova station (Turin) – Lingotto (Turin)
Effects of the first segment of the metro line

• The opening of the first segment of Turin subway (2006) had effects on the modal behavior of city users:
  • modal diversion from car to subway, mostly evident among richer people with higher educational qualification (23% in comparison to 15.5% average). (Pronello, Rappazzo, & Camusso, 2012).

We expect that the new metro segment could
• increase quality of sustainable urban mobility,
• reduce traffic and air pollution,
• reduce traffic accidents.
Measurable data

Which effects could be investigated?

- Traffic flows
- Air pollution
- Road traffic accidents

But…

Data about traffic flows are available only for few roads and short periods.

Particle detectors are not located close enough to the metro line.

Road traffic accidents occurred in Turin during 2002-2013 - National Institute of Statistics (ISTAT):

- All road collisions resulting in deaths (within the 30th day) or injuries and involving at least one vehicle (or animal) circulating on a road.

- Main aspects of road accidents (date and location of the accident, road type and name, weather, circumstances and consequences on persons involved).

- Each observation is referred to a single collision, which can involve more injured people.
How could it be possible to assess the short term impacts of the new segment of metro line on road accidents in Turin?
Aim of the study

The aim of the study is to investigate if there is a causal connection between the opening of the metro and the trend change in traffic accidents through a pre-post intervention analysis.

An analysis of the distribution of different typologies of road injured has also been performed.
Subway catchment area

- A pre-post analysis requires a sufficient number of observations.
- Thus, we focused on the last segment: from the Porta Nuova Station to Lingotto.

- Catchment area:
  - radius of 500m around each subway stations,
  - only the census cells covered at least by the 50% of this area (GIS technology) have been considered.
  - 4.21 km²

(Murrey et al., 1998), (Pagliara et al., 2006), (Pagliara et al., 2006 - 2007 PS - PN, 2007 - 2011 PN - Lingotto)
Traffic accidents in the subway catchment area

- In order to locate each accident from text addresses, a geocoding process (Google geocoding) was required.

- Since the process is long and expensive, only accidents within the catchment area were geocoded.
Check if the series can be modelled by an ARIMA (Autoregressive integrated moving average) process.

- The trend of road traffic accidents is highly autocorrelated, all p values for the test of the first 6, 12, 18 and 24 months autocorrelations are <0.0001.

- If we use the 2002-2011 data to fit the model and then forecast for 2012-2013, we obtain a good approximation of observed data.

- An ARIMA autocorrelation model can successfully be used for the ITS analysis.
The following model has been used to perform ITS:

\[ Y_t = \beta_0 + \beta_1 \cdot t + \beta_2 \cdot \delta_{\text{int}} + \beta_3 \cdot t_1 + \varepsilon_t \]

where

- \( t \) is the counter of the time of the series,
- \( \delta_{\text{int}} \) is 0 before intervention and 1 after
- \( t_1 \) is the time after intervention,
- the error \( \varepsilon_t \) represents the random variability at time \( t \),
- \( \beta_0 \) estimates the baseline level
- \( \beta_1 \) estimates the baseline trend
- \( \beta_2 \) estimates the level change immediately after the intervention
- \( \beta_3 \) estimates the change in the trend after intervention compared with the trend prior to it.
- \( \beta_1 + \beta_3 \) is the post-intervention slope.

- We defined as intervention period the time interval from the beginning of works to the opening of the subway.
- This model controls for both baseline level and trend.
- All analysis have been performed by means of SAS PROC ARIMA.
Interrupted time series analysis: results

Regression parameters of Turin time series: the trend level change is significant but the pre and post intervention slopes are not.

| Parameter | Meaning                              | Estimate | Standard error | t value | Approx Pr > |t| |
|-----------|--------------------------------------|----------|----------------|---------|-------------|---|
| $\beta_0$ | baseline value                       | 374.826  | 18.585         | 20.170  | <.0001      |   |
| $\beta_1$ | baseline trend                       | -0.371   | 1.160          | -0.320  | 0.750       |   |
| $\beta_2$ | level change after the intervention  | -56.537  | 24.086         | -2.350  | 0.022       |   |
| $\beta_3$ | trend change after intervention with respect to $\beta_1$ | -1.091   | 1.421          | -0.770  | 0.446       |   |

Regression analysis of subway area time series: no significant trend changes have been detected.

| Parameter | Meaning                              | Estimate | Standard error | t value | Approx Pr > |t| |
|-----------|--------------------------------------|----------|----------------|---------|-------------|---|
| $\beta_0$ | baseline value                       | 15.162   | 1.681          | 9.020   | <.0001      |   |
| $\beta_1$ | baseline trend                       | -0.059   | 0.105          | -0.560  | 0.575       |   |
| $\beta_2$ | level change after the intervention  | 0.661    | 2.178          | 0.300   | 0.763       |   |
| $\beta_3$ | trend change after intervention with respect to $\beta_1$ | -0.090   | 0.129          | -0.700  | 0.488       |   |
### Injured distribution, 2004-2013

<table>
<thead>
<tr>
<th>Injured</th>
<th>Turin</th>
<th>Subway area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>Pedestrians</td>
<td>6552</td>
<td>10.95</td>
</tr>
<tr>
<td>Car</td>
<td>39207</td>
<td>65.54</td>
</tr>
<tr>
<td>Public transport</td>
<td>1693</td>
<td>2.83</td>
</tr>
<tr>
<td>Truck/Lorries</td>
<td>1130</td>
<td>1.89</td>
</tr>
<tr>
<td>Other heavy duty vehicles</td>
<td>136</td>
<td>0.23</td>
</tr>
<tr>
<td>Bikes</td>
<td>1833</td>
<td>3.06</td>
</tr>
<tr>
<td>Motorcycles</td>
<td>9084</td>
<td>15.19</td>
</tr>
<tr>
<td>Hit-and-run driver</td>
<td>127</td>
<td>0.21</td>
</tr>
<tr>
<td>Minicar</td>
<td>59</td>
<td>0.1</td>
</tr>
<tr>
<td>All</td>
<td>59821</td>
<td>100</td>
</tr>
</tbody>
</table>

For both Turin and the catchment area:
- the trend of injured pedestrians and motorcyclists is slowly decreasing,
- the trend of injured cyclists is increasing.
- However, no significant trend changes can be detected by ITS nor by a Chi-square test.

- Injured can be considered as a proxy of modal behavior of road users.
- People seems to be more likely to walk, take public transport or use two wheel means of transport in the subway catchment area than in the rest of the city.
Hypothesis for the discussion

• No interchange parking facility.
• The metro segment extends parallel along the main railway.
• Most of the private car traffic that goes through this area flows outside the city.
• Traffic accidents density (2002-2013):
  • Turin: 303.6 accidents/km2
  • subway catchment area: 412.4 accidents/km2
• Average population:
  • Turin: 892,700 (6,867 people/km²)
  • subway catchment area: 60,630 (14,401 people/km²)
Shall we suppose that the opening of this segment of the metro had no impact on road users modal behaviour?

Which factors contributed to a different road accidents trend between the catchment area and the entire city?
Limits of this study

- Lack of data about traffic.
- Lack of environmental/pollution data.
- Only road accidents involving injured people have been analysed.
- No knowledge of socio-economic characteristics of injured people.
- No knowledge about changes in the choice of transport modes.
• The building of a transport infrastructure like a metro line can probably impact on traffic and road accidents, but...

… other measures should be achieved in parallel.

Sustainable mobility should be integrated in an urban renewal program needing policies taking into account other aspects of a neighbourhood:

• physical,
• socio-economic,
• environmental,
• cultural
• …
Thank you for your attention