

# Getting a safer LRT through a better design of its insertion in public space

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- Safety and LRT design
- Former hotspots European survey
- Conclusions
- Acknowledgements

# INTRODUCTION

- Paper based on part of the work done during the COST Action “Operation and safety of tramways in interaction with public space” (<http://www.tram-urban-safety.eu/>)
- Different approaches in Europe:
  - Close to heavy rail focusing on protection
  - More focused on integration (easier coexistence with pedestrians and cyclists)
- All the LRT systems deal with similar safety problems  
→ Same solutions and measures can be applied, taking into account the local context

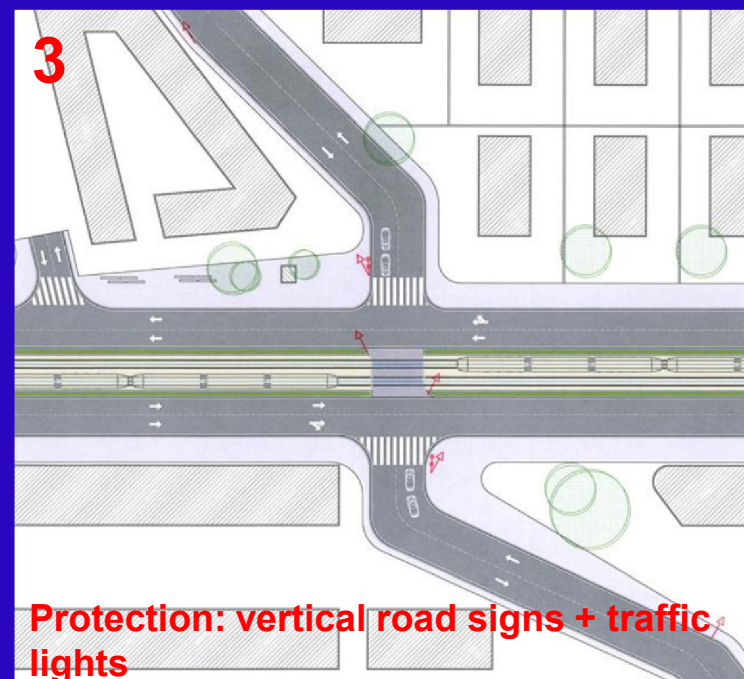
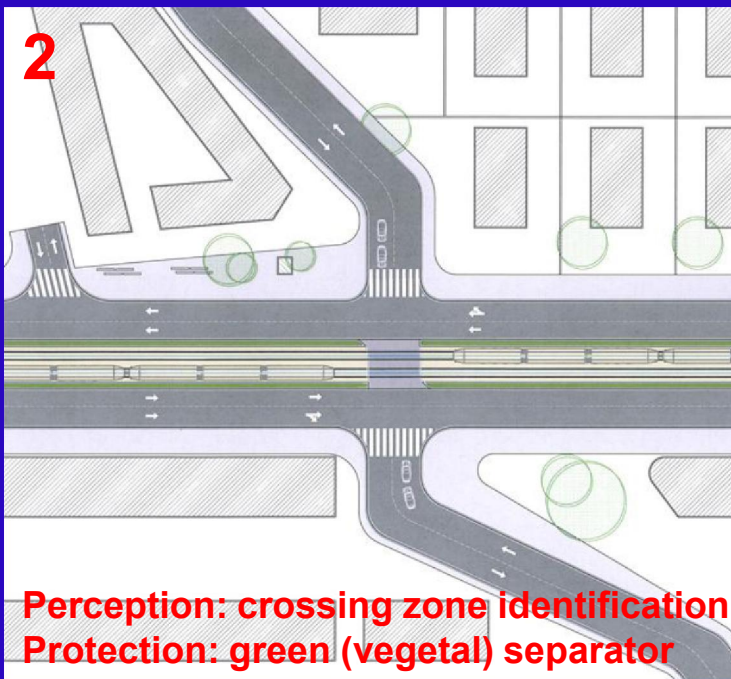
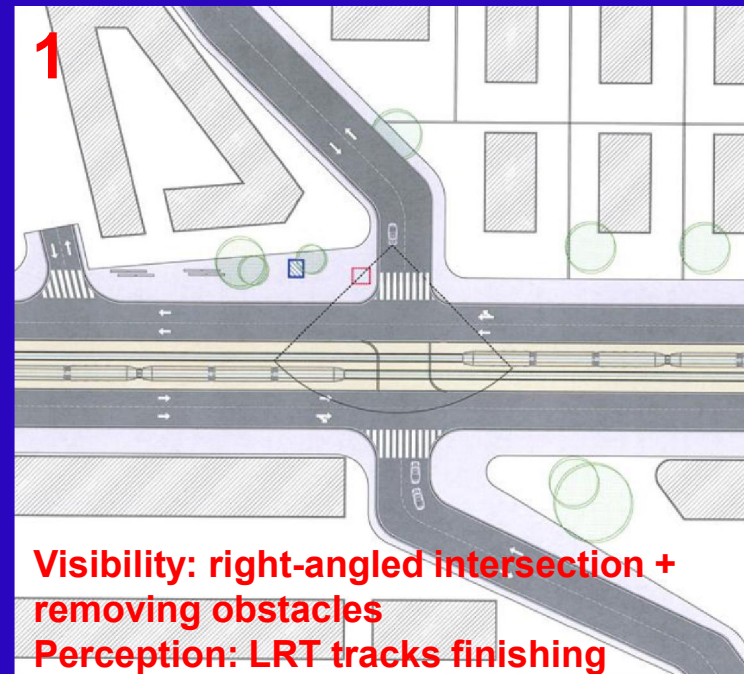
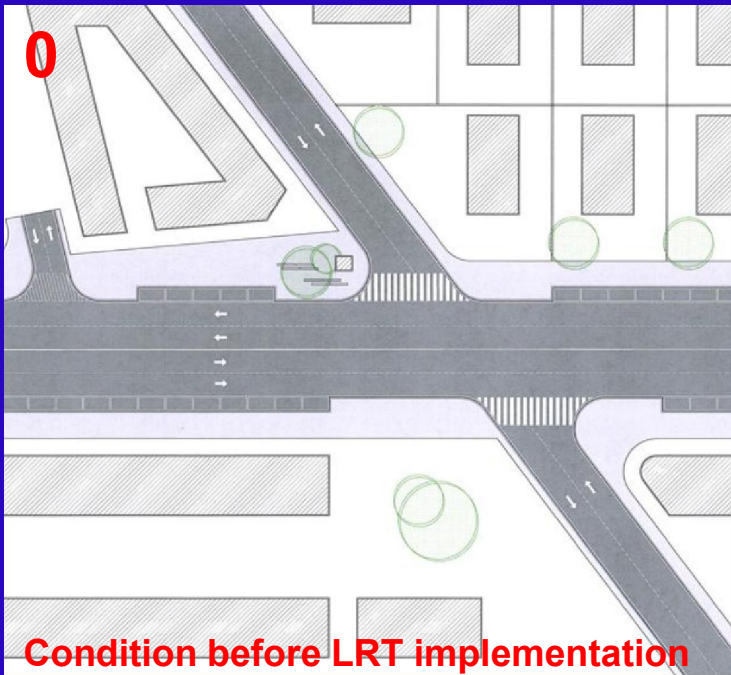


# INTRODUCTION

- Two main parts of LRT influencing safety:
  - Infrastructure: expensive and hard to change once it has been built
  - Operation management: can solve some infrastructure problems but this ability is limited
- Main LRT safety issue: interaction with other street-users
  - Intersections: roundabouts and other at-grade intersections
  - Pedestrian crossings or other places where pedestrians cross the tracks.

# SAFETY AND LRT DESIGN

- Three main aspects for guaranteeing LRT safety:
  - Visibility between LRT and other street-users
    - Right-angled intersections
    - Removing obstacles
    - Adequate lightning conditions
  - Perception of the LRT (and information to other street-users)
    - Raising awareness
      - Finishing of the tracks with different material, color or texture than the surrounding areas
      - Marking the swept path of the vehicle
      - On the vehicle: use of bright colors, running with lights on, use of horns at some specific locations
      - Information: vertical and horizontal informative signs
  - Protection of the LRT in its interaction with other street-users
    - Physical barriers
    - Prescriptive signs and traffic lights



# FORMER HOTSPOTS EUROPEAN SURVEY

- Questionnaire about hotspots answered by 24 LRT agencies from 13 different countries
- Hotspots: “Places in the urban area where the most accidents (collisions) occurred in a fixed period”
- Review of former hotspots with the measures applied to avoid hazards

# FORMER HOTSPOTS EUROPEAN SURVEY

## Road at-grade intersections

Blackhall Place - Benburb Street intersection, Dublin (Ireland)



Oversized advanced LRT signs

Flashing red road studs embedded in the pavement



Color contrasting anti-skid road pavement

Number of crashes by year:

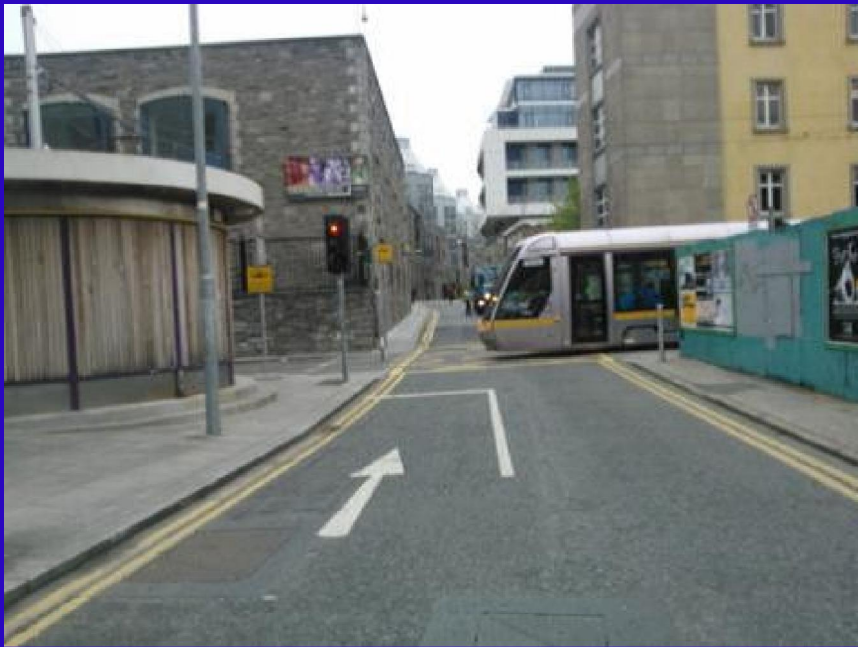
2004: 3	2005: 3	2006: 2	2007: 0	2008: 2	
2009: 1	2010: 4	2011: 1	2012: 1	2013: 0	2014: 2



# FORMER HOTSPOTS EUROPEAN SURVEY

## Road at-grade intersections

Bow Street intersection, Dublin (Ireland)



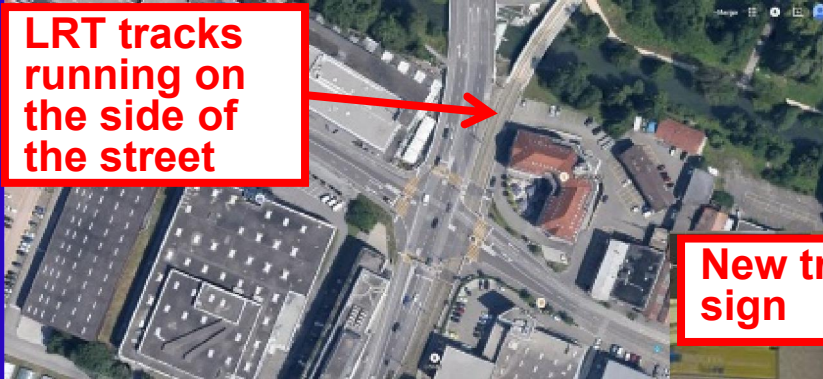
Number of crashes by year:	2004: 0	2005: 1	2006: 0	2007: 1	2008: 1	
	2009: 1	2010: 0	2011: 3	2012: 1	2013: 1	2014: 0

# FORMER HOTSPOTS EUROPEAN SURVEY

## Road at-grade intersections

Ringstrasse in Dübendorf, Zürich (Switzerland)

LRT tracks  
running on  
the side of  
the street

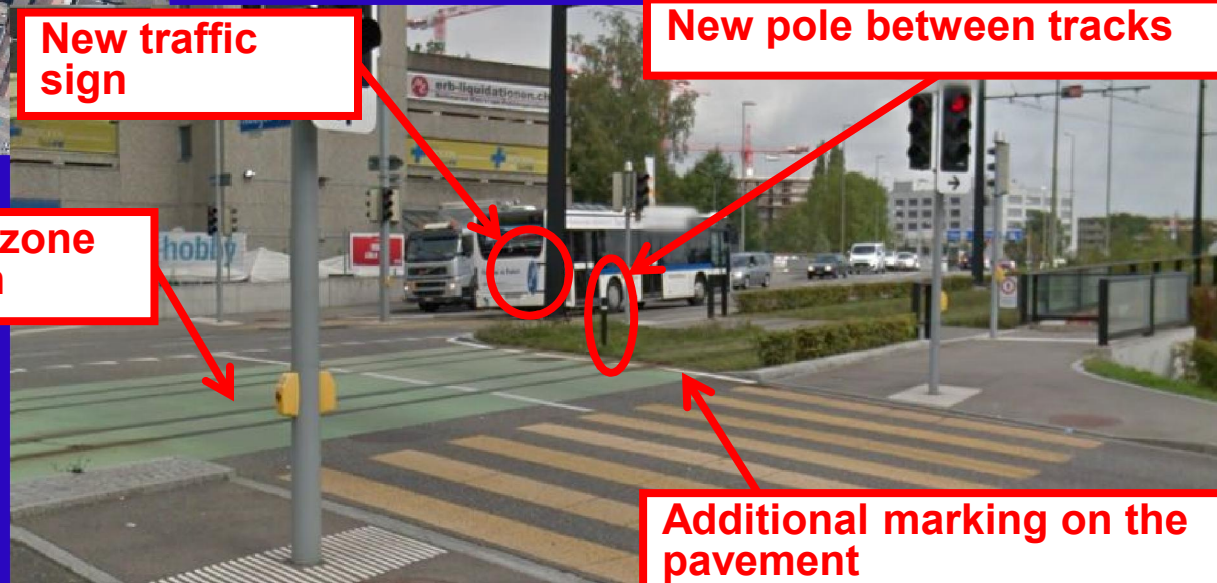


6 events of track intrusion during the first three months of operation.  
No new event after the implementation of these measures

New traffic  
sign

New pole between tracks

Painting of tracks zone  
pavement in green



Additional marking on the  
pavement

# FORMER HOTSPOTS EUROPEAN SURVEY

## Roundabouts

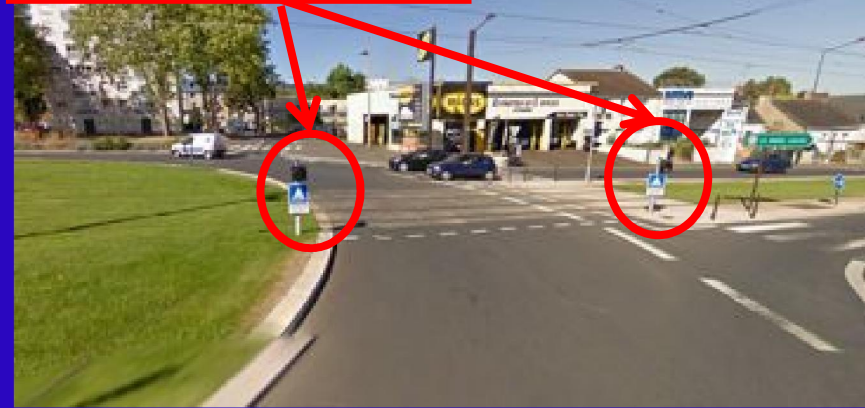
Paul Cézanne roundabout, Le Mans (France)



**“Shark teeth” marks (Sept. 2010)**

**Single traffic lights**

**Before**



**Double traffic lights (May 2012)**

**After**



Number of crashes and passenger falls due to emergency brake by year:

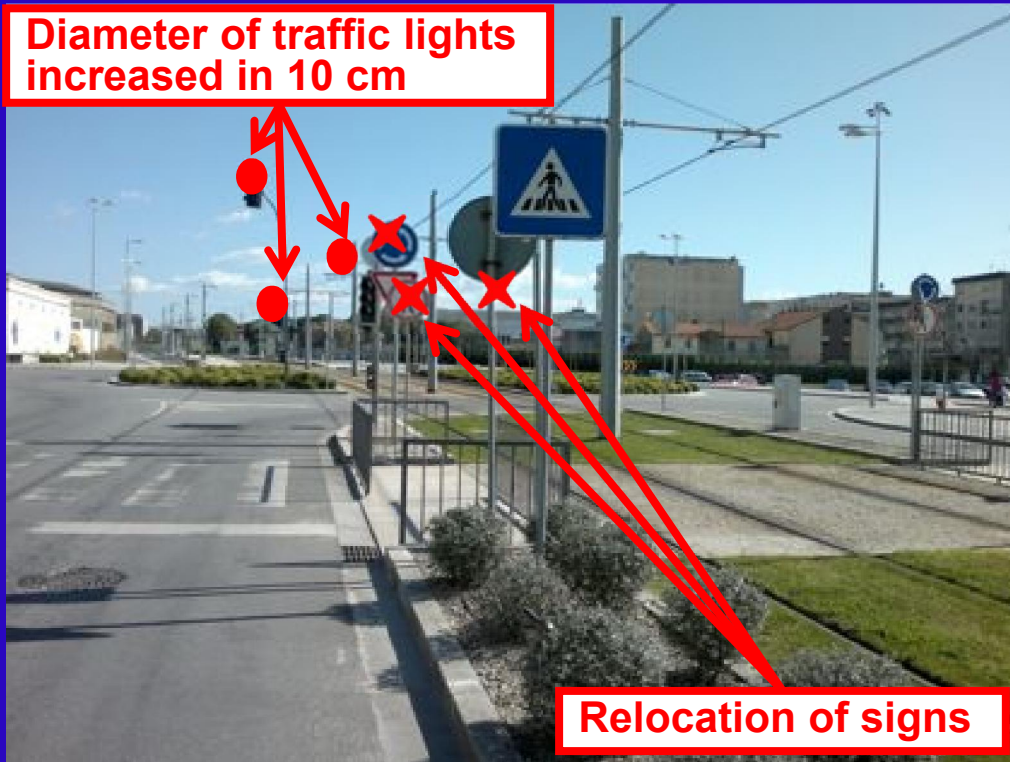
Nov. 2007 (inauguration) – 2008: 7				2009: 2
2010: 0	2011: 1	2012: 2	2013: 0	

# FORMER HOTSPOTS EUROPEAN SURVEY

## Roundabouts

São Brás roundabout, Porto  
(Portugal)

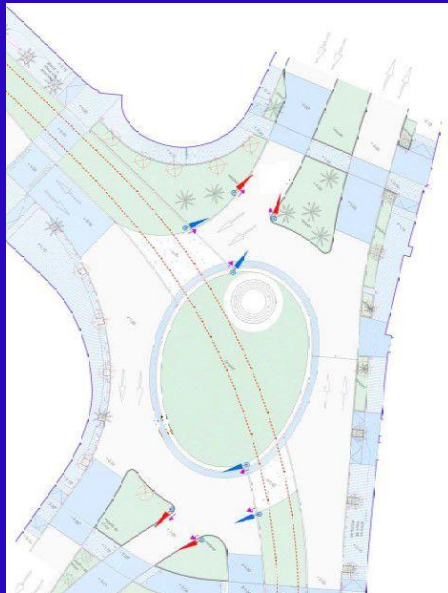
Diameter of traffic lights  
increased in 10 cm






# FORMER HOTSPOTS EUROPEAN SURVEY

## Roundabouts

Cruz de Piedra roundabout,  
Tenerife (Spain)



### SYMBOLS

-  Existing traffic light
- Measures implemented*
-  Additional traffic light
-  Double small red light

**New double small traffic light in the lower part of existing traffic lights**



**New traffic lights at the entrance to the roundabout that are close to the LRT tracks crossing**

Number of crashes (and  
emergency brakes) by year:

2007: 9 (64)	2008: 7 (24)	2009: 4 (29)	
2010: 2 (14)	2011: 1 (9)	2012: 0 (11)	2013: 3 (12)

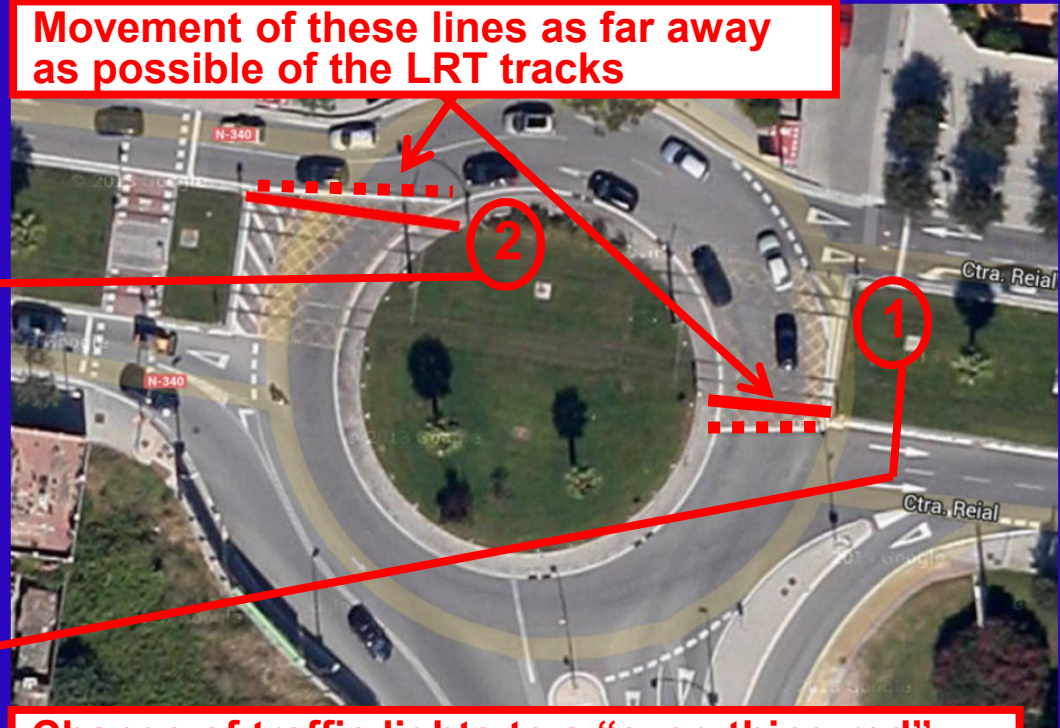
# FORMER HOTSPOTS EUROPEAN SURVEY

## Roundabouts

Reial Road - Baix Lobregat  
Av., Barcelona (Spain)



**Movement of these lines as far away as possible of the LRT tracks**



**Change of traffic lights to a “everything red” situation when the LRV is approaching**

Number of crashes by year:

2006: 10	2007: 8		
2010: 1	2011: 2	2012: 3	2013: 1

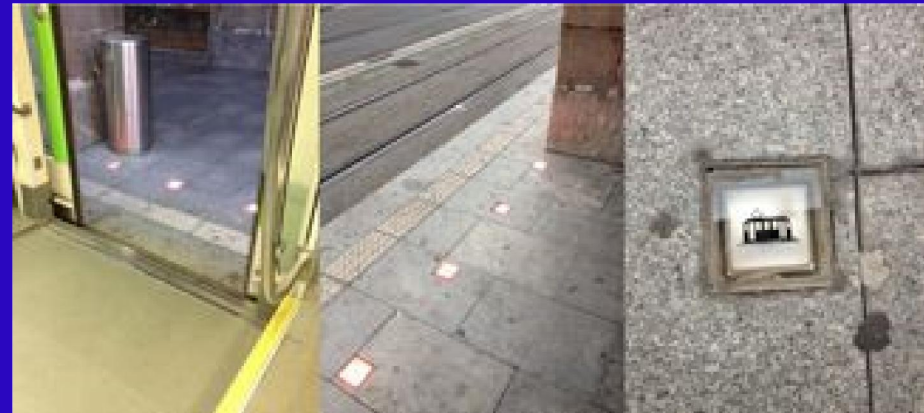
# FORMER HOTSPOTS EUROPEAN SURVEY

## Interaction with pedestrians Ribera Street, Bilbao (Spain)



Number of crashes by year:

2008: 14	2009: 13	2010: 12
2011: 10	2012: 6	2013: 5



# FORMER HOTSPOTS EUROPEAN SURVEY

Interaction with pedestrians  
Zara and Testi Avenues, Milan (Italy)





# CONCLUSIONS

- Former hotspots: locations in the network that used to have the higher crash figures, but that are now safer places
- Measures implemented in one network can be applicable to other ones facing similar problems or to the design of new lines
- Local context has to be considered in each case
- Figures about number of crashes before and after the implementation of measures are used to try to endorse their effectiveness
  - In general, improvements in these figures are slight (because the number of LRT crashes is commonly low)
  - Many factors can influence the situation (road traffic flow changes, new speed limitations, ...) → it is difficult to infer if the measures have been effective by themselves or not

**VISIT OUR WEBSITE**  
<http://www.tram-urban-safety.eu/>

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- Authors thank the persons from the LRT agencies who filled in the questionnaires about hotspots.

