

CityMobil

SIXTH FRAMEWORK PROGRAMME

CityMobil Evaluation

Francesco Filippi
CTL – Sapienza

1

CityMobil

TOWARDS ADVANCED ROAD TRANSPORT FOR THE URBAN ENVIRONMENT

CTL evaluation team

Adriano Alessandrini, coordinator
Paolo Delle Site
Marco Valerio Salucci
Daniele Stam

SAPIENZA
UNIVERSITÀ DI ROMA

2

CityMobil

TOWARDS ADVANCED ROAD TRANSPORT FOR THE URBAN ENVIRONMENT

The European project CityMobil

Development and demonstrations of innovative transport technologies for Automated Transport Systems (ATS):

- Cybercars (CC)
- High-tech Buses (HTB)
- Dual-mode Vehicles (DMV)
- Personal Rapid Transit (PRT)

Tests, evaluations, and comparisons performed in several cities.


SAPIENZA
UNIVERSITÀ DI ROMA

3

CityMobil

TOWARDS ADVANCED ROAD TRANSPORT FOR THE URBAN ENVIRONMENT


ATS in CityMobil




Cybercars (CC)



High-Tech Buses (HTB)



Dual-mode Vehicles (DMV)



Personal Rapid Transit (PRT)

SAPIENZA
UNIVERSITÀ DI ROMA

4

CityMobil

TOWARDS ADVANCED ROAD TRANSPORT FOR THE URBAN ENVIRONMENT

The evaluation objectives

- What kind of transport services are ATS best suited to?
- What advantages do ATS offer over conventional systems?
- How would users react to ATS?
- What are the drawbacks?
- Will ATS be more sustainable than conventional systems?
- How much do they cost?

SAPIENZA
UNIVERSITÀ DI ROMA

5

CityMobil

TOWARDS ADVANCED ROAD TRANSPORT FOR THE URBAN ENVIRONMENT

SP5 deliverables

WP5.1 Definition of the evaluative framework

- D5.1.1: Evaluation plan
- D5.1.2: Weightings for use in Multi-Criteria Analysis

WP5.2 Demonstration evaluation

- D5.2.1: Field trial ex-ante evaluation report
- D5.2.2: First ex-post report
- D5.2.3: Second ex-post report
- **D5.2.4: Final ex-post report**

WP5.3 Ex-ante evaluation of other case studies

- D5.3.1: Evaluation report for the ex-ante studies
- D5.3.2: First update for the evaluation report for the ex-ante studies
- D5.3.3: Second update for the evaluation report for the ex-ante studies

WP5.4 Evaluation of advanced transport contribution to sustainability

- **D5.4.1: Assessment of automated road transport systems contribution to urban sustainability**

SAPIENZA
UNIVERSITÀ DI ROMA

6

CityMobil

The types of evaluations

- **Demonstrators** are real implementations of the ATS.
- **Showcases** are pilot projects aimed at disseminating ATS through dedicated events in different cities.
- **Case studies** use simulations to reproduce the behaviour and performance of ATS over different urban areas.

7

CityMobil

Evaluation techniques

- Implementation and measurements
- City simulation and scenario evaluation
- Technology testing
- Survey on acceptance and quality of service

8

CityMobil

The evaluation categories

- Acceptance
- Quality of service
- Transport patterns
- Social Impacts
- Environment
- Financial Impacts
- Economic
- Legal impacts
- Technological success

Showcases

Demonstrators

Case studies

9

CityMobil

Origins and destinations

- City Centre
- Inner suburbs
- Outer suburbs
- Suburban centre
- Major transport nodes
- Major parking lots
- Major educational or service facilities
- Major shopping facilities
- Major leisure facilities
- Corridors

10

CityMobil

Passenger Application Matrix (PAM)

The PAM rows and columns are the origin-destination (OD) considered in the cities.

All the evaluations are in the PAM cells.

The cells contain the ATS studied in the CityMobil cities according to the origin-destination of the trips they cover.

The PAM provides a brief account of all evaluations and the first step for the selection of the most appropriate ATS in an OD.

11

CityMobil

The PAM

O \ D	1	2	3	4	5	6	7	8	9	10
1. City centre	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.
2. Inner suburbs	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.
3. Outer suburbs	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.
4. Suburban centre	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.
5. Transport nodes	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.
6. Parking lots	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.
7. Service facilities	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.
8. Shopping facilities	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.
9. Leisure facilities	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.
10. Corridors	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.	with eval.

Legend:
 with eval.
 without eval.

CityMobil Evaluation

12

CityMobil

Demonstrator sites

- Castellon (ES) - HTB
- Heathrow (UK) - PRT
- Rome (IT) - CC
- La Rochelle (FR) - CC

TOWARDS ADVANCED ROAD TRANSPORT FOR THE URBAN ENVIRONMENT

SAPIENZA UNIVERSITÀ DI ROMA

CityMobil

Showcase sites

- Daventry (UK) - PRT
- La Rochelle (FR) - DMV
- Orta San Giulio (IT) - DMV
- Trondheim (NO) - CC
- Vantaa (FI) - CC

TOWARDS ADVANCED ROAD TRANSPORT FOR THE URBAN ENVIRONMENT

SAPIENZA UNIVERSITÀ DI ROMA

CityMobil

Case studies

- Gateshead (UK) – CC, PRT, HTB, DMV
- Madrid (ES) – CC, PRT, HTB, DMV
- Sophie-Antipolis (FR) – DMV
- Trondheim (NO) – CC, PRT, HTB, DMV
- Uppsala (SE) – PRT
- Wien (AT) – CC, PRT, HTB, DMV

TOWARDS ADVANCED ROAD TRANSPORT FOR THE URBAN ENVIRONMENT

SAPIENZA UNIVERSITÀ DI ROMA

CityMobil

Example of PAM cells

	D	City centre	Inner suburbs
O			
City centre		CC (Gateshead, Madrid, Trondheim, Wien) PRT (Gateshead, Madrid, Trondheim, Wien, Uppsala) DMV (La Rochelle, Orta San Giulio)	-
Inner suburbs		CC (Gateshead, Trondheim) PRT (Gateshead, Trondheim, Uppsala) HTB (Gateshead, Madrid, Trondheim, Wien)	CC (Gateshead, Madrid, Trondheim, Wien) PRT (Gateshead, Trondheim, Uppsala) HTB (Gateshead, Madrid, Trondheim, Wien)

TOWARDS ADVANCED ROAD TRANSPORT FOR THE URBAN ENVIRONMENT

SAPIENZA UNIVERSITÀ DI ROMA

16

CityMobil

Three cell examples

- City centre → City centre
- Inner suburbs → Inner suburbs
- Outer suburbs → City centre

TOWARDS ADVANCED ROAD TRANSPORT FOR THE URBAN ENVIRONMENT

SAPIENZA UNIVERSITÀ DI ROMA

CityMobil Presentation

17

CityMobil

City centre → City centre

Case studies:

- CC Gateshead, Madrid, Trondheim, Wien;
- PRT Gateshead, Madrid, Trondheim, Wien, Uppsala;
- DMV Gateshead, Madrid, Trondheim, Wien.

Showcases:

- DMV La Rochelle, Orta San Giulio.

TOWARDS ADVANCED ROAD TRANSPORT FOR THE URBAN ENVIRONMENT

SAPIENZA UNIVERSITÀ DI ROMA

CityMobil Presentation

18

CityMobil

Indicators

Case studies

- Transport patterns
- Social, environmental and financial impacts

Showcases

- Acceptance
- Quality of service

CityMobil Presentation 19

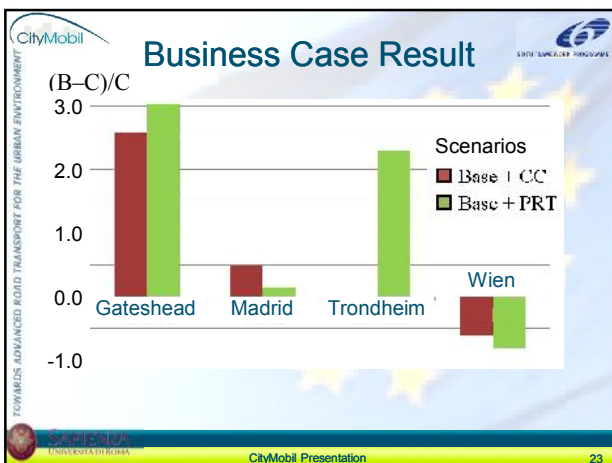
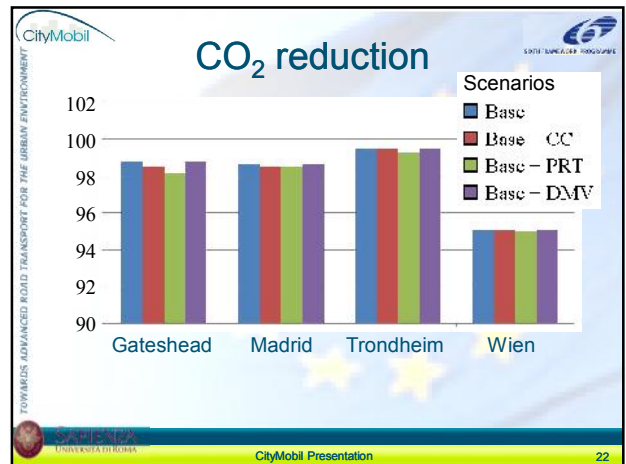
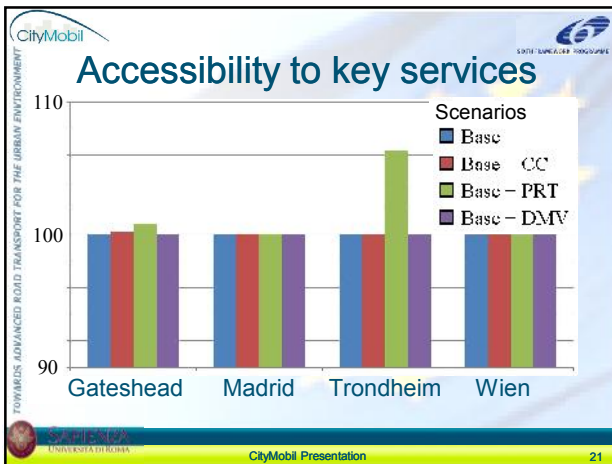
CityMobil

The techniques

MARS simulation for Gateshead, Madrid, Trondheim, and Wien ATS

PRTsim micro-simulation for Uppsala

CityMobil Presentation 20



CityMobil

PRT comparison

Trondheim (Mars) and Uppsala (PRTsim)

Similar features of the PRT schemes

- 4-place vehicles
- 35-40 km/h as average speed
- PRT segregated from other traffic

CityMobil Presentation 24

CityMobil **Modal share simulations**

Modes	UPPSALA		TRONDHEIM	
	with PRT %	Δ %	with PRT %	Δ %
PRT	20	+20	27	+27
Car	55	-10	30	-10
Slow Modes	25	-5	38	-15
Bus	0	-5	5	-2

CityMobil Presentation 25

CityMobil **DMV at La Rochelle and Orta**

Acceptance and quality-of-service indicators

- Each indicator scored in questionnaire from 5 (completely satisfied) to 1 (completely dissatisfied).
- Indicator performance is average value of all scores provided by the interviewees.

CityMobil Presentation 26

CityMobil **La Rochelle and Orta**

DMV

Usefulness Ease of use Comfort Safety Security

CityMobil Presentation 27

CityMobil **City centre → City centre**

Main results:

- ATS perform best in small/medium cities (e.g. Gateshead and Trondheim), with better benefits and advantageous BCR
- PRT is more convenient than the other technological solutions for the centres of small/medium cities.

CityMobil Presentation 28

CityMobil **Inner suburbs → Inner suburbs**

Case studies:

- CC Gateshead and Trondheim;
- Feeder CC Gateshead, Madrid, Trondheim, Wien;
- PRT Gateshead and Trondheim;
- HTB Gateshead, Madrid, Trondheim, Wien;
- DMV Gateshead, Madrid, Trondheim, Wien.

Showcase:

- PRT Daventry

CityMobil Presentation 29

CityMobil **Indicators**

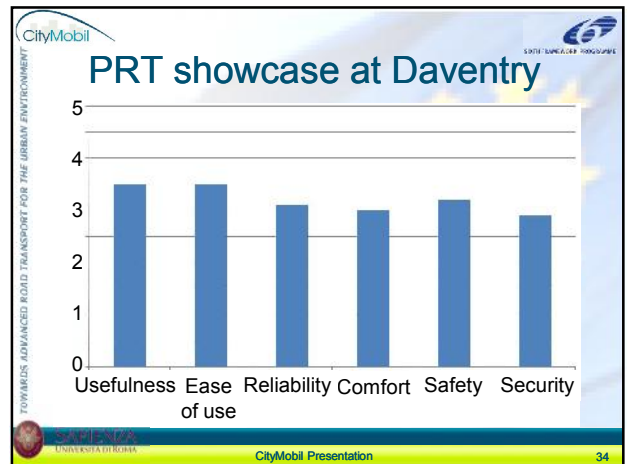
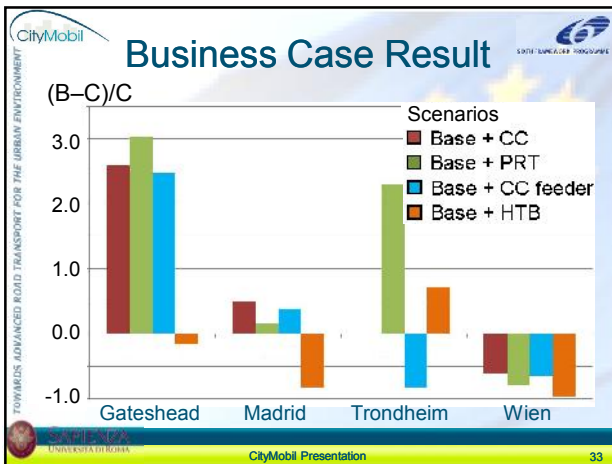
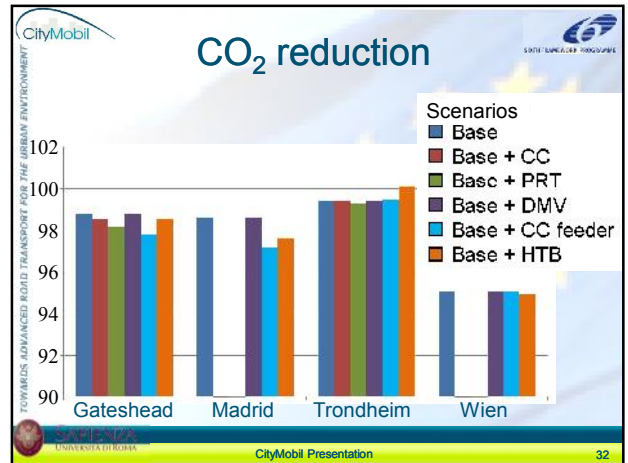
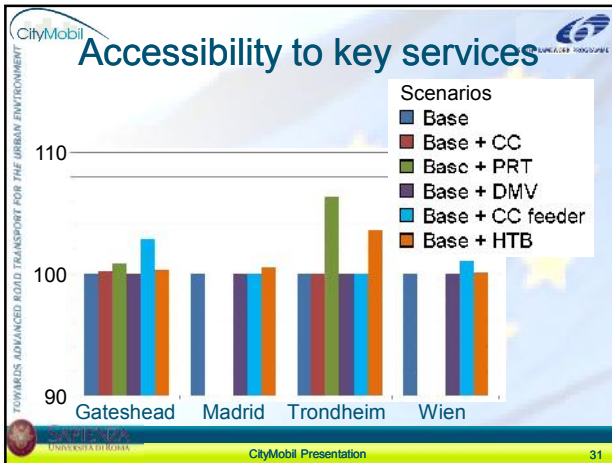
Case studies

- Transport patterns
- Social, environmental and financial impacts

Showcase

- Acceptance
- Quality of service

CityMobil Presentation 30



Inner suburbs → Inner suburbs

Main results:

- In general the implementation of complementary measures appears to have the most significant impacts.
- Implementations in small/medium cities show better impacts than in large cities.
- PRT is the best solution in Trondheim, while in a polycentric city like Gateshead the best solution is PT feeder CC.
- Beneficial effects also in Wien, but the BCR is disadvantageous.

Outer suburbs → City centre

Case studies:

- CC Trondheim
- PRT Trondheim
- HTB Madrid and Trondheim
- DMV Madrid and Trondheim

Demonstrator:

- HTB Castellon

CityMobil

Indicators

Case studies and demonstrator:

- Transport patterns
- Social, environmental, and financial impacts

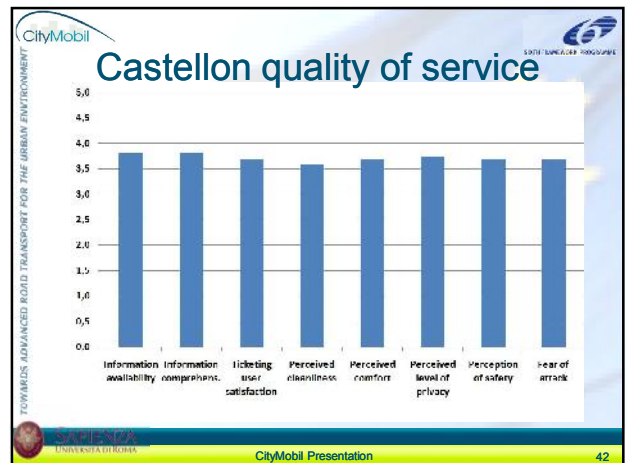
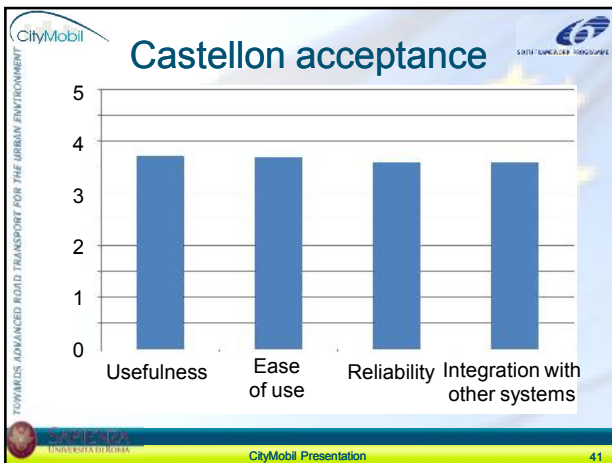
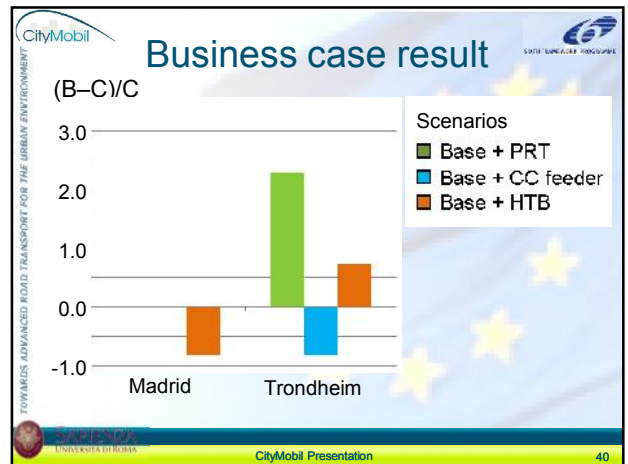
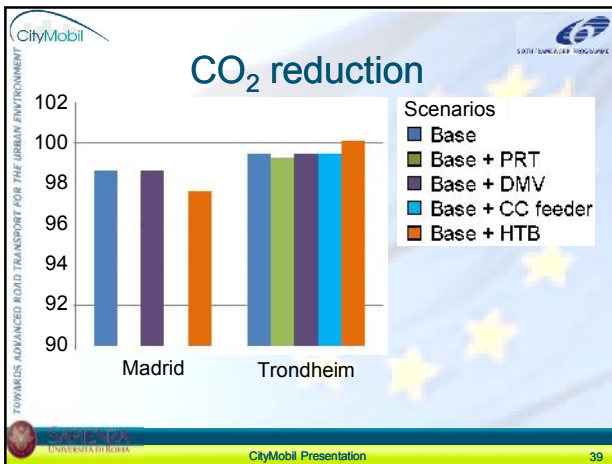
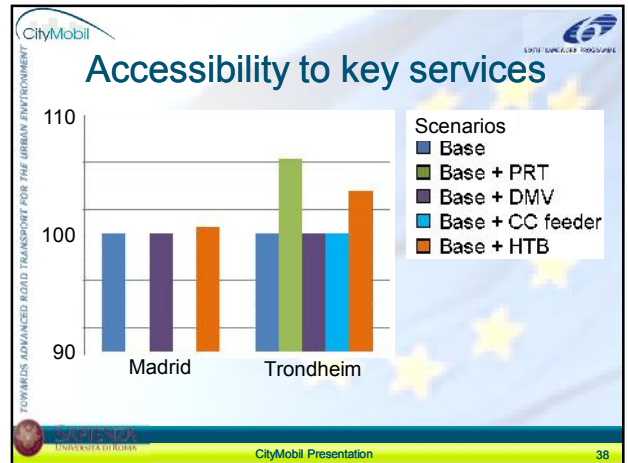
Demonstrator:

- Acceptance
- Quality of service

TOWARDS ADVANCED ROAD TRANSPORT FOR THE URBAN ENVIRONMENT

SAPIENZA UNIVERSITÀ DI ROMA

CityMobil Presentation 37



CityMobil

TOWARDS ADVANCED ROAD TRANSPORT FOR THE URBAN ENVIRONMENT

SAPIENZA UNIVERSITÀ DI ROMA

Castellon transport patterns

- 15% system modal share (PT modal share of Valencia region is 14%)
- About 1500 daily passengers travelled on 2 km network)
- More than 200 passengers attracted from other transport modes
- Average waiting time: 5–8 minutes on weekdays

CityMobil Evaluation 43

CityMobil

TOWARDS ADVANCED ROAD TRANSPORT FOR THE URBAN ENVIRONMENT

SAPIENZA UNIVERSITÀ DI ROMA

Castellon environmental indicators

- Daily consumption: 985 kWh
- Energy efficiency: less than 0.5 kWh/pax·km
- Noise: 74 dB (under 96/20 EC limit)

CityMobil Evaluation 44

CityMobil

TOWARDS ADVANCED ROAD TRANSPORT FOR THE URBAN ENVIRONMENT

SAPIENZA UNIVERSITÀ DI ROMA

Castellon financial impacts

Start-up costs

- Track construction and civil works 19 M€
- Vehicles: 2.6 M€ for 3 Cibus Cristalis hybrid buses
- Control systems and apparatus: 1.2 M€

Operating revenues 0.5 M€ per year

Social NPV of 12 M€ in 20 years, due to:

- Accident reduction
- Noxious emission reduction
- Better use of resources

CityMobil Evaluation 45

CityMobil

TOWARDS ADVANCED ROAD TRANSPORT FOR THE URBAN ENVIRONMENT

SAPIENZA UNIVERSITÀ DI ROMA

Technological success indicators

- Docking accuracy evaluated 3 (quite sufficient) by the HTB drivers in a scale from 5 (best) to 1 (worst)
- One manual correction of the automatic driving every 3 trips
- Zero vehicle repairs needed in 10-month period
- Infrastructure (optical guidance) low maintenance cost

CityMobil Evaluation 46

CityMobil

TOWARDS ADVANCED ROAD TRANSPORT FOR THE URBAN ENVIRONMENT

SAPIENZA UNIVERSITÀ DI ROMA

Outer suburb to City Centre

Main results:

- The HTB proved the most convenient ATS, better than DMV.
- The PRT proved positive in Trondheim (small city).

06/12/2011 CityMobil Presentation 47

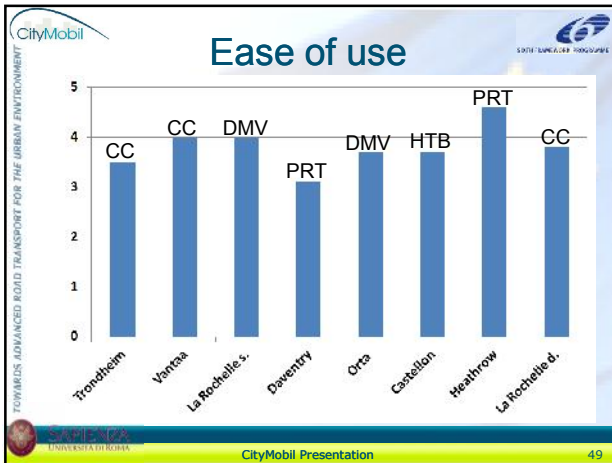
CityMobil

TOWARDS ADVANCED ROAD TRANSPORT FOR THE URBAN ENVIRONMENT

SAPIENZA UNIVERSITÀ DI ROMA

Evaluation general results

- ATS generally perceived as easy to use and useful for solving mobility problems
- ATS evaluated as reliable, especially in partly automated applications with driver
- Comfort, privacy, safety and security performances are positive



CityMobil

6 SIXTH FRAMEWORK PROGRAMME

Ease of use evaluation

- Average evaluation: 3.8 (results of 3 demonstrators and 5 showcases)
- Heathrow PRT demonstrator evaluation: 4.6 → Highest value
- Daventry PRT showcase: 3.1 → Lowest value, due to the vehicles used in the showcase

SAPIENZA UNIVERSITÀ DI ROMA

CityMobil

6 SIXTH FRAMEWORK PROGRAMME

Evaluation of PRT and CC

PRT and CC are best-performing ATS:

- in small/medium cities as autonomous public transport in the city centre
- as feeders for public transport where demand is spread around urban periphery

If segregated, high installation costs but high mobility benefits

If not segregated, low installation costs, but legal aspects of vehicle certification to be considered

SAPIENZA UNIVERSITÀ DI ROMA

CityMobil

6 SIXTH FRAMEWORK PROGRAMME

Evaluation of HTB and DMV

HTB:

- best-performing ATS in medium/large cities on high demand corridors
- require high investment costs
- provide high social benefits and are socially viable

DMV:

- show same CC benefit as public transport feeder
- allow advanced car-sharing through innovative capabilities as automatic parking and platooning

SAPIENZA UNIVERSITÀ DI ROMA

CityMobil

6 SIXTH FRAMEWORK PROGRAMME

Thank you

For information:
CITYMOBIL Website:
www.citymobil-project.eu

SAPIENZA UNIVERSITÀ DI ROMA