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.

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?

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
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.

Evaluation techniques

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

The evaluation categories

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

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

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.
### Demonstrator sites
- Castellon (ES) - HTB
- Heathrow (UK) - PRT
- Rome (IT) - CC
- La Rochelle (FR) - CC

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

### 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

### Example of PAM cells

<table>
<thead>
<tr>
<th>DO</th>
<th>City centre</th>
<th>Inner suburbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>CC (Gateshead, Madrid, Trondheim, Wien)</td>
<td>PRT (Gateshead, Madrid, Trondheim, Wien)</td>
<td>DMV (La Rochelle, Orta San Giulio)</td>
</tr>
<tr>
<td>CC (Gateshead, Madrid, Trondheim, Wien)</td>
<td>PRT (Gateshead, Trondheim, Uppsala)</td>
<td>DMV (La Rochelle, Orta San Giulio)</td>
</tr>
</tbody>
</table>

### Three cell examples
- City centre → City centre
- Inner suburbs → Inner suburbs
- Outer suburbs → City centre

### City centre → City centre
- Showcases: DMV La Rochelle, Orta San Giulio.
Indicators
- Case studies
  - Transport patterns
  - Social, environmental and financial impacts
- Showcases
  - Acceptance
  - Quality of service

The techniques
- MARS simulation for Gateshead, Madrid, Trondheim, and Wien ATS
- PRTsim micro-simulation for Uppsala

Accessibility to key services
- Gateshead
- Madrid
- Trondheim
- Wien

CO\(_2\) reduction
- Gateshead
- Madrid
- Trondheim
- Wien

Business Case Result
- 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
Modal share simulations

<table>
<thead>
<tr>
<th>Modes</th>
<th>UPPSALA with PRT %</th>
<th>TRONDHEIM with PRT %</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRT</td>
<td>20</td>
<td>+20</td>
</tr>
<tr>
<td>Car</td>
<td>55</td>
<td>-10</td>
</tr>
<tr>
<td>Slow Modes</td>
<td>25</td>
<td>-5</td>
</tr>
<tr>
<td>Bus</td>
<td>0</td>
<td>-5</td>
</tr>
</tbody>
</table>

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.

La Rochelle and Orta

Usefulness Ease of use Comfort Safety Security

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.

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

Indicators

Case studies
- Transport patterns
- Social, environmental and financial impacts
Showcase
- Acceptance
- Quality of service
Accessibility to key services

CO₂ reduction

Business Case Result

PRT showcase at Daventry

Inner suburbs → Inner suburbs

Outer suburbs → City centre

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.

Case studies:
CC  Trondheim
PRT  Trondheim
HTB  Madrid and Trondheim
DMV  Madrid and Trondheim
Demonstrator:
HTB  Castellon
Indicators

Case studies and demonstrator:
- Transport patterns
- Social, environmental, and financial impacts

Demonstrator:
- Acceptance
- Quality of service

Accessibility to key services

CO₂ reduction

Scenarios:
- Base
- Base + PRT
- Base + DMV
- Base + CC feeder
- Base + HTB

Business case result

(B – C)/C

Scenarios:
- Base + PRT
- Base + CC feeder
- Base + HTB

Castellon acceptance

Ease of use
Usefulness
Reliability
Integration with other systems

Castellon quality of service
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

Castellon environmental indicators

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

Castellon financial impacts

Start-up costs
- Track construction and civil works 19 M€
- Vehicles: 2.6 M€ for 3 Civis 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

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

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).

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
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

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

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

Thank you

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