EUROPEAN COMMISSION
DG RESEARCH

SIXTH FRAMEWORK PROGRAMME

THEMATIC PRIORITY 1.6

SUSTAINABLE DEVELOPMENT, GLOBAL CHANGE & ECOSYSTEMS

INTEGRATED PROJECT – CONTRACT N. TIP5-CT-2006-031315

CityMobil

Towards advanced transport for the urban environment

Deliverable no.	5.2.2
Deliverable title	First ex-post report (focus on Castellon)
Dissemination level	Public
Work Package	5.2
Author(s)	Daniele Stam
Co-author(s)	Adriano Alessandrini, Gianfranco Burzio, Irene Storri
Status (F: final, D: draft)	F
File Name	CityMobil_D.5.2.2_submit_v2.doc
Project Start Date and Duration	01 May 2006 - 30 April 2011

Executive Summary

The global objective of the CityMobil project is to achieve a more effective organisation of urban transport, resulting in a more rational use of motorised traffic with less congestion and pollution, safer driving, a higher quality of living and an enhanced integration with spatial development. For this aim, four different technologies will be tested and evaluated in the project: Personal Rapid Transit (PRT), CyberCars (CC), High Tech Buses (HTB), and Dual-mode Vehicles (DMV).

This deliverable is the third deliverable of the workpackage 5.2 (included in the Sub-project 5, named Evaluation) of the project, which concerns the evaluations of the demonstrations and the showcases of the project. This deliverable reports particularly the ex-post evaluations of the demonstration of Castellon (high-tech bus service between the university and the zone of Parc Ribalta) and of the showcase of Orta San Giulio (car-sharing service with dual-mode vehicles).

It is made of five sections, including the first introductive section.

The second section reports the evaluation plan of the Orta San Giulio showcase, which is subdivided in three parts:

- Site description
- Indicators to be measured and methods to collect them
- Measurement plan

23 indicators were planned to be measured through user interviews, vehicle and system logbooks, and calculations.

The third section reports the ex-post evaluations of the Castellon demonstration and the Orta showcase.

The Castellon ex-post evaluation has been made through 91 new system user interviews, 300 phone interviews to people travelling in Castellon, 3 interviews to the drivers of the new system, measurements on-field during the first ten months of the new system operations, and experts' opinions.

The users were generally satisfied with the new system, considering the service as useful, easy to use, reliable and well integrated with the other systems. Users also perceived a high quality of service, the information to use the system was available and comprehensible, the system was perceived as comfortable, safe, secure and with a high level of privacy, and the ticketing was quite good. The cleanliness of the system was also perceived as satisfactory. The system resulted to be safe for the drivers too and required the same workload required for a conventional system.

15% was the modal share, with more than 1500 daily trips and more than 2200 daily passenger·km travelled, and 10% average vehicle occupancy. There were no delays per trip, because the system works on dedicated lanes. The average waiting time was between 5 and 8 minutes during the weekdays, and the consequent system capacity was little less than 1000 passengers/hour. The daily consumption of the vehicles was little less than 1000 kWh, with an energy efficiency of 0.44 kWh/pax·km (due to the number of daily passenger·km travelled).

The start-up costs of the system were about 23 000 000€, the correspondent operating and maintenance costs were about 438 000€/year.

The consequent financial Cost-Benefit Analysis (CBA) of the system with 20 year time horizon provided a Net Present Value (NPV) of -21 000 000€.

A socio-economic CBA was also done, to take into account the safety effects and the environmental benefits due to the introduction of the new high-tech bus system and to include such benefits for the community in the analysis of the system. Such benefits were made of three terms and monetized as follows: 1 360 000€/year as safety benefits, 241 000€/year as noxious emission reduction benefits, and 45 000€/year as benefits due to a better use of resources. The consequent socio-economic CBA of the system with 20 year time horizon provided a NPV of 12 000 000€, meaning that the new system is socio-economically viable and that the installation of the system is convenient for the community.

Therefore such ATS appears to be socially convenient for the community and well accepted by people to cover their travels using it instead of the conventional systems.

The Orta ex-post evaluation was provided through questionnaires filled by 150 people who tested the new vehicles during the showcase.

Users were generally satisfied with the new system, considering it as useful, easy to use and well integrated with the other systems. The perception of safety, security, comfort, privacy and the satisfaction for the on demand systems were all fairly high. People would be willing to pay 2.20€ to use the service.

The evaluation of the system modal share provided the outstanding value of 82%. Even if the value obtained is quite larger than the real feeling of people (due to the fact that people were interviewed soon after they had "touched" the new concept of vehicles presented), it is however an index of the good feelings of Orta people for the use of dual-mode vehicles instead of the conventional ones.

The fourth section reports the cross-comparisons and findings done, considering the demonstrations and showcases evaluated in the previous deliverables 5.2.1a and 5.2.1b too.

Concerning the user acceptance, people were satisfied by the new transport systems proposed. They evaluated them as useful, easy to use and reliable. The safety, the comfort, and the cleanliness on the vehicles change on the basis of the system tested and the vehicles used. In all the tested sites people would pay to use the new services proposed.

The transport patterns were compared between Castellon (ex-post), Orta (ex-post) and Rome (ex-ante). Castellon and Rome demonstrations showed similar values of daily passenger·km travelled (2200 in Castellon ex-post, 3300 in Rome ex-ante), but the different kind of services provided (bus in Castellon, parkshuttle in Rome) is seen on the daily trips, 1500 in Castellon and 14000 in Rome, with different average passenger trips (1.4 km in Castellon, 0.4 km in Rome). The different values of system modal shares in Castellon (15%) and Orta (82%) is due to the outstanding Orta value, obtained by interviewing people after they tested the new system in the showcase, whereas in Castellon the value was calculated through interviews when the new system was yet operating.

The financial and socio-economic impacts were calculated for Castellon and Rome. Although the operation costs of the two demonstrations were similar (about 450 000 €/year), the differences between the investment costs (about 23 millions € for the construction of the Castellon system infrastructures, 1.5 millions € for the dedicated Cybercar lanes in Rome) provided two different financial NPVs of the CBAs with 10 year time horizon: -22 millions € in Castellon and -7 millions € in Rome. In Castellon the negative NPV became positive in the socio-economic CBA including the benefits for the community due to the new system introduction. The same CBA will be done in Rome once the ex-post data will be available.

The fifth section of the deliverable reports the fourth release of the Passenger Application Matrix, filled with the locally focused evaluations of the entire Sub-Project 5, made of demonstrations, showcases and case studies.

An annex with the general overview of the results of the evaluation process is reported at the end of the document.

TABLE OF CONTENTS

First ex-post report (focus on Castellon)

1 Introduction

The objective of the CityMobil project is to contribute to a more effective organisation of urban transport, resulting in a more rational use of motorised traffic with less congestion and pollution, safer driving, a higher quality of living and an enhanced integration with spatial development. In order to achieve this objectives advanced concepts for advanced road vehicles and passengers are developed. Furthermore new tools for managing the urban transport are introduced and barriers that are in the way of large-scale introduction of automated systems are removed.

The demonstration, the showcases and the case studies involved in the CityMobil project have to provide a data collection for the evaluation of their feasibility and performances. In such way it is possible to evaluate the results, linked to the introduction of the new technologies proposed in the project, in terms of advantages for the users and improvement of new transport scenarios. The evaluations have to be done according to the MAESTRO and CONVERGE methodologies, considering three different evaluation phases: initial evaluation, ex-ante evaluation, and ex-post evaluation.

This deliverable is the first ex-post report of the project, focused on the ex-post evaluations of the Castellon demonstration and of the Orta San Giulio showcase. It is made of five sections, including the present first introductive section.

The second section reports the evaluation plan of the Orta San Giulio showcase.

The third section reports the ex-post evaluations of the Castellon demonstration and the Orta showcase.

The fourth section reports the cross-comparisons and findings done, considering the demonstrations and showcases evaluated in the previous deliverables 5.2.1a and 5.2.1b too.

The fifth section of the deliverable reports the last release of the Passenger Application Matrix, the tool made to use the results of all the project system evaluations (demonstrations, showcases and city studies) according to their fields of application inside and/or outside the cities.

2 Evaluation Plans

2.1 Orta San Giulio

2.1.1 Site description

Lake Orta is one of the pre-Alpine lakes of the northern Italy, the most occidental one. It is about 13 km long and at full 2 kilometres in width, with a perimeter of nearly 35 km, 143 meters deep and it is situated at a height of 290 meters above sea level. The two sides are really different: the west shores are more steep and wild, with mountains dividing the Lake from Valsesia, while the east shores are more gentle, and behind them there is Lake Maggiore, over an exceptionally high mountain: Mount Mottarone (1491 meters above sea level), towards Borromeo Gulf and its islands. The sole emissary of the Lake is a stream, the Nigoglia; a curiosity about this torrent, the only one among those of pre-Alpine lakes of the northern Italy, is that it leaves the lake northward and lets its waters flow into the Toce and then in Lake Maggiore and Borromeo Gulf. Situated entirely in Piedmont, the area is divided in two different provinces, that's to say Novara and the "VCO" province of Verbano-Cusio-Ossola.

Orta (from Latin Hortus conclusus) is today counted among the most beautiful suburbs in Italy. Some people have defined it God`s watercolour (Markus Werner). The small town stands at the end of a promontory that stretches out into the lake, as if it wanted to reach its detached end, St. Julius Island, which is only a few hundred meters far (about 400). A little village with less than 1200 inhabitants, but a precious jewel to be protected. It will charm you easily: streets and quarters on a human scale, views over the Lake, shops, buildings and no traffic jams because cars are not allowed.
The core of the town is the square, consecrated to Mario Motta, Motta square is the starting point for other explorations of the town and of its wards, such as the one facing North, the Villa area, a succession of period buildings with wrought iron decorated balconies, or the other facing South and the Moccarolo area, a residential ward where you can find many charming villas with gardens overlooking the lake. High-class buildings take turns to more modest houses: simple dwellings with medieval foundations where fishermen and craftsmen used to live. Moreover, here is the starting point for a visit to the twin jewel of Orta, as precious as the town: the Island of St. Julius.

Cars are not allowed in the inner city centre and the connection with the external parking areas is based on a small bus, shaped as a small train, that will provide connections based on a not too much frequent schedule (every hour) or on demand (on the arrival of tourist coaches).

The CityMobil cars could integrate such service, offering a more appropriate service for tourist that will arrive on car/train, or they want to move inside the city or to reach the Sacro Monte leaving the car in the parking area.

2.1.2 Indicators to be measured and measurement methods

23 indicators have been planned to be measured: usefulness, ease of use, safety, user satisfaction for the on demand service, integration with other systems, user willingness to pay, perceived comfort, perceived level of privacy, perception of safety, fear of attack, induced mode changes in the other segments of the journey, system modal share, total passenger·km travelled, total number of trips, daily consumption, energy efficiency, failure rate, mean time between failures, mean time to repairs, number and type of accidents and incidents, log of obstacle avoidance procedures, log of emergency stops, and speed profiles.

User interview

Twelve indicators are measured by interviewing users using the questionnaire reported in Annex 1: system **usefulness**, system **ease of use**, system perceived **reliability**, **user**

satisfaction for the on demand service, **integration with other systems**, **user willingness to pay**, system **perceived comfort**, **perceived level of privacy on board of the vehicles**, system **perceived safety**, **Fear of attack; Induced mode changes in the other segments of the journey** and **System modal share**. 9 of such indicators are measured first by ranking their importance in their evaluation category and then having the new system scored in a scale from 1 to 5. The other three **user willingness to pay**, i**nduced mode changes in the other segments of the journey** and **system modal share** are measured differently. The willingness to pay is directly asked while the other two are derived from behavioural questions of present behaviour and future should the system be made available.

The sample of interviewees is expected to be statistically significant. The sample size should be calculated per each indicator according to the expected results and to the necessary tolerance and confidence interval; however since the showcase will run for a limited time and the number of people who will ride on the system might not be high any number of interviews above a threshold of 100 will be considered satisfactory.

Vehicle and system logbooks

The indicators to be collected through the vehicle and system logbook are: **Failure rate, Mean time between failures, Mean time to repairs, Number and type of accidents and incidents, Log of obstacle avoidance procedures, Log of emergency stops, Speed profiles**. From the speed profiles (if collected at any single trip) it will be possible to determine the total km travelled and in case a record is kept on whether there was a passenger or not on board (or else if the vehicle never moves without the passenger) it will be possible to measure also **Total passenger·km travelled** and **Total N° of trips**.

Calculations

Energy environmental indicators will be calculated upon the data collected through on-board vehicle measurements (speed profiles in particular): **Daily consumption (KWh)** and **Energy Efficiency (KWh/pkm)**.

2.1.3 Measurement plan

Measurements to be done in the two showcases weeks are only of indicators to be measured through: user interviews and vehicle and system logbooks.

User interviews should be done with the help of Orta City. A number of people should be asked to interview (using the questionnaire reported in the internal report of the Orta showcase duly translated from English to Italian) passengers after riding on the system.

3 Evaluations

3.1 Castellon - Ex-post

3.1.1 Data collection area

Eight different stretches are operating or going to be made in Castellòn.

At this moment the Castellón demonstration is operating in two of the stretches since mid 2008. Three hybrid buses are operating in the first stretch, from the University to the city centre (UJI-parc Ribalta), while one electric mini-bus is operating in the second stretch, called calle Colón stretch.

The ex-post data collection was done for the stretch 1, reported in Figure 1.

Figure 1 Stretch 1 (UJI-Parc Ribalta) of the Castellon demonstration

It is made of five stops: University Jaume I (UJI), Sos Baynat, Riu Sec, Paseo Morella, Parc Ribalta.

The total length of the stretch is 2 km per direction in two directions, meaning 4 km as total network length, and the distances between the stops are the following:

- UJI - Sos Baynat: 200 m;
- Sos Baynat - Riu Sec: 750 m;
- Riu Sec - Paseo Morella: 700 m;
- Paseo Morella - Parc Ribalta: 350 m.

The service along the stretch 1 is provided with 3 Civic Cristalis hybrid bus, operating from 7:30 a.m. to 10:30 p.m. during the weekdays, and from 7:30 a.m. to 10 p.m. on Saturadys, Sundays and holidays.

3.1.2 Data collection methods

As reported and requested in D1.4.5.1 "Impact assessment framework", the ex-post data of the Castellon demonstration have been collected through interviews to people who used the new high-tech bus system in the operating stretch 1 between the University Juame I and the Parc Ribalta (reported in Figure 1), interviews to the drivers of the high-tech buses, phone interviews to people travelling in Castellon, measurement on-field of the system parameters, and experts' opinions mainly about financial and economic impacts of the new system.

The users', drivers' and phone interviews have been collected in 2010 between February 16th and February 26th, including the weekend, while the measurements on-field were done in the period between June 26th, 2008 (date of start of the new system operations) and April 2009, and the experts' opinions were collected in the same period.

Concerning the users' interviews, 91 system users were interviewed after the used the system.

The indicators calculated through the results of such interviews were twelve of the Acceptance and Quality of service indicators (usefulness, ease of use, reliability, integration with other systems, information availability, information comprehensibility, user satisfaction, perceived cleanliness, perceived comfort, perceived level of privacy, perception of safety, fear of attack) and three of the Transport Patterns indicators (average journey time per OD pair, journey time variability, interchange time). For two of them (average journey time per OD pair, journey time variability) both the ex-ante and the ex-post values were calculated on the basis of the users' answers to the interviews.

3 drivers' interviews were collected, due to the fact that there were only 4 drivers working at the demonstration and only 6 drivers were been trained to drive the high-tech buses.

The indicators obtained through driver interviews are two Transport patterns indicators (incidents and driver workload) and all the Technological success ones (docking accuracy, failure rate, mean time between failures, mean time to repairs).

300 phone interviews were made, providing one Transport patterns indicator, the system modal share (the ex-ante value was collected in analyses reported in D1.4.5.2 "Ex-ante impact assessment of the Castellon demonstration" and regarded the whole Castellon area).

Through the measurements on-field seven Transport patterns indicators (total passenger·km travelled, total number of trips, vehicle occupancy, total delay per trip, average waiting time, waiting time variability, effective system capacity), and seven Environment indicators (daily consumption, energy efficiency, NO_x, PM_{10} and/or $PM_{2.5}$, CO, CO_2, L_{den} and L_{night}) were calculated. Total passenger·km travelled were calculated using both the data of the measurements on-field and of the users' interviews. The ex-ante values of total passenger·km travelled and total number of trips were also calculated from the users' interviews results in accordance with the measurements on-field.

Eight financial impacts indicators (track construction and civil works, vehicle acquisition/construction, control system and apparatus start-up costs, personnel, vehicle maintenance, track and civil infrastructures maintenance, control system maintenance operating costs, operating revenues) and two economic indicators (net present value and internal rate of return) were obtained through measurements on-field and experts' opinion.

3.1.3 Indicator measurements and results

The indicators collected in the ex-post phase of the Castellon demonstration and their values are reported in the following Table 1.

For five transport patterns indicators (system modal share, total passenger·km travelled, total number of trips, average journey time per OD pair, journey time variability) the ex-ante values were also calculated and are reported in Table 1.

The ex-ante value of system modal share is the one reported in the deliverable 1.4.5.2 "Ex-ante impact assessment of the Castellon demonstration", coming from the analyses of the “Transport Plan for Castellon and its surroundings” made by the Generalitat Valenciana in 2002. It is therefore referred to the whole Castellon area analysed in that transport plan.

The other four ex-ante values were obtained through the 91 users' interviews in accordance with the measurements on-field, thus they refers to the area interested by the system.

The ex-post values of the acceptance and quality of service indicators were obtained as the average values of the user satisfaction performances, in a ranking from 1 (worst performance) to 5 (best performance), as reported in the questionnaire used for the user interviews reported in the Annex A of the D1.4.5.1 "Impact assessment framework".

Concerning the four user acceptance indicators collected, **usefulness** and **ease of use** are the best rated indicators, with 3.7 as performance rating. The service was also perceived as reliable and good integrated with the other systems, with both of the corresponding indicators (**reliability** and **integration with other systems**) rated 3.6.

Table 1 Ex-ante and ex-post Castellon collected indicators

Evaluation category	**Impact**	**Indicator**	**Ex-ante**	**Ex-post**
Acceptance	User acceptance	Usefulness		3.7
		Ease of use		3.7
		Reliability		3.6
		Integration with other systems		3.6
	Willingness to pay	User Willingness		
		Authority Willingness		
Quality of service	Information	Information availability		3.8
		Information comprehensibility		3.8
	Ticketing	User satisfaction		3.7
	Cleanliness	Perceived cleanliness		3.6
	Comfort	Perceived comfort		3.7
	Privacy	Perceived level of privacy		3.7
	Perception of safety and security	Perception of safety		3.7
		Fear of attack		3.7
Transport patterns	Modal change	Induced mode changes in the other segments of the journey		
		System modal share	15% (daily trips in the whole Castellon area)	15%
	System use	Total passenger·km travelled	2370/day	2210/day
		Total number of trips	1310/day	1530/day
		Vehicle occupancy		10%
	System performances	Average Journey time per OD pair	Node 1→2:	Node 1→2: 2'

Evaluation category	Impact	Indicator	Ex-ante	Ex-post
			5' Node 1→4: 16' 45'' Node 1→5: 24' 30'' Node 4→5: 11' 30''	Node 1→4: 8' Node 1→5: 12' Node 4→5: 4'
		Journey time variability	Node 1→2: N.A. Node 1→4: 4' 30'' Node 1→5: 9' Node 4→5: 5' 30''	Node 1→2: N.A. Node 1→4: 2' 25'' Node 1→5: 5' Node 4→5: 2' 30''
		Total delay per trip		0
		Average Waiting time		5' → school days (7:30 - 9:30 am) 8' → school days (9:30 am - 10:30 pm) and no school days 15' → Saturdays 30' → Sundays and holidays
		Waiting time variability		0
		Interchange time		2' 40''
		Effective system capacity		960 p/h → school days (7:30 - 9:30 am) 600 p/h →

Evaluation category	Impact	Indicator	Ex-ante	Ex-post
				school days (9:30 am - 10:30 pm) and no school days 320 p/h → Saturdays 160 p/h → Sundays and holidays
	Spatial Accessibility	Change in range of key activities accessible within time thresholds		
	Service Accessibility	Access times for mobility impaired users		
	Safety	Incidents		The vehicles seldom had incidents from the start of the system
		Accident levels		
		Driver workload		The same required for a conventional system
Environment	Energy	Daily consumption (KWh)		986 kWh
		Energy Efficiency (KWh/p·km)		0.44 kWh/p·km
	Toxic emissions	NO_x		1.84 g/km
		PM_{10} and/or $PM_{2.5}$		0.25 g/km
		CO		0.15 g/km
	Climate Change	CO_2		960 g/km
	Noise	L_{DEN} and L_{night}		74 dB (<80 dB, 96/20 EC limit)
	Land take	Loss of green space from construction		
		Total land use change		
Financial impacts	Start up costs	Track construction		19 000 000€

Evaluation category	Impact	Indicator	Ex-ante	Ex-post
		and civil works		
		Vehicle acquisition/constructi on		2 600 000€
		Control systems and apparatus		1 250 000€
	Operating costs	Personnel		175 000 €/year
		Vehicle maintenance		158 000 €/year
		Track and civil infrastructures maintenance		30 000 €/year
		Control system maintenance		75 000 €/year
	Revenues	Operating revenues		520 000 €/year
	Subsidies	Perceived public subsidies		
Economic	Temporary job provided by installation and demonstration	Jobs provided at the demonstration site		
		Jobs increase induced at the manufacturers		
	Long terms effects on jobs	Local effects on employment		
	Vitality	Vitality index		
	Efficiency	Net Present Value		Financial CBA (20 years): -21 000 000€ Socio-economic CBA (20 years): 12 000 000€
		Internal Rate of Return		Financial CBA (20 years): -16% Socio-economic CBA (20 years):

Evaluation category	Impact	Indicator	Ex-ante	Ex-post
				6.5%
Legal impacts	Impacts on legal and regulatory framework	Induced regulation procedure changes		
Technological success	Performance	Docking Accuracy		3
	Reliability	Failure rate		1 correction of automatic driving each 2-3 travels
		Mean time between failures		1h 30' (considering about 30' per travel)
		Mean time to repairs		Repairs not needed

With regards to the eight quality of service indicators measured, the information to use the system is available and comprehensible, with the corresponding indicators (**information availability** and **information comprehensibility**) both rated 3.8. The system was perceived as comfortable, safe, secure and with a high level of privacy, and the ticketing was quite good (the corresponding indicators **perceived comfort**, **perception of safety**, **fear of attack**, **perceived level of privacy**, **ticketing user satisfaction** being all rated 3.7), and the **perceived cleanliness** of the system was also satisfactory (3.6).

Concerning the transport patterns modal change indicators, **system modal share** ex-ante value is referred to the whole Castellon area, whereas the ex-post value, obtained through phone interviews, refers to the stretch 1 of the Castellon demonstration reported in Figure 1. Both ex-ante and ex-post values are 15%, meaning that the new system designed is able to attract the same amount of people within its potential users as the old public transport system was able on the whole Castellon area.

The system use indicators were calculated directly from the data collected on the field. Starting from the end of June 2008, when the stretch 1 of the Castellon demonstration was operating, until April 2009 the monthly passengers, vehicle trips and kilometres travelled were collected. About 467 000 passengers travelled in the period between the end of June 2008 and April 2009, meaning that the ex-post **total number of trips** were 1530 passengers/day. On the basis of the users' interviews, the ex-ante value was calculated by considering people using the old bus system in the same area, replaced by the new Castellon system. Such value is 1310 daily passengers, meaning that 220 new passengers have been attracted by the new system. 100 of them used the car before the system introduction, whereas the remaining 120 made their travels on foot.

The **total passenger·km travelled** were calculated on the basis of the modal split obtained through the users' interviews. In the survey of 91 users, 57% of them went from UJI to Parc Ribalta, 24% from UJI to Paseo Morella, 18% from Paseo Morella to Parc Ribalta, and only 1% from UJI to Sos Baynat. Considering the distances between the stops, the total number of daily passenger·km travelled obtained is 2210. The new system was built on a dedicated lane, specifically made for it. The bridge on the Riu Sec was built to allow the system to have a straight lane. It reduced the length of the old system route, which was 2.6 km long from Parc Ribalta to the University and vice-versa (the new system is 2 km per direction long). The ex-ante passenger·km value was calculated starting from the ex-ante value of the total number of trips, and considering the bus stops on the old route. The calculated value is 2370, meaning that further 160 passenger·km were travelled before the new system installation. It is due only to the fact that the distance covered by the old bus system was larger than the new system, and although the old system produced more passenger·km travelled, it attracted 220 daily passengers less than the new one.

The high-tech buses used to provide the service are three Civis Cristalis hybrid buses, each one with 80-place capacity. The 467 000 passengers were served with about 58 000 vehicle trips, meaning an average **vehicle occupancy** of 467 000/58 000 = 8 passengers/vehicle, 10% of the vehicle capacity.

Concerning the system performances, the **average journey time per OD pair** and the **journey time variability** were calculated directly from the users' interviews. The survey answers allowed to calculate such two indicators for four arcs of the network: UJI - Sos Baynat, where the time required for the journey was 2 minutes and no variability was available, UJI - Paseo Morella, with 8 minutes journey time and 2 minutes and 25 seconds variability, UJI - Parc Ribalta, with 12 minutes journey time and 5 minutes variability, and Paseo Morella - Parc Ribalta, with 4 minutes journey time and 3 minutes variability. All such values are valid for both the directions. They showed an improvement to the ex-ante values (calculated on the basis of the interviews too), where the average journey times per OD pair were twice the ex-post values and the journey time variability was always higher than the ex-post ones.

Interchange time was also calculated from the users' interviews and was 2 minutes and 40 seconds.

Total delay per trip is 0 because the system works on dedicated lanes, thus travel time is always near the minimum time required to cover the single OD pairs.

The **average waiting time** was provided in the same period of the measurements on-field (June 2008 - April 2009), and taken directly from the scheduled service hours. It changed according to the different days. In the school days the waiting time was 5 minutes from 7:30 a.m. to 9:30 a.m. and 8 minutes from 9:30 a.m. to 10:30 p.m.. In the no-school days the waiting time was 8 minutes for the whole service, from 7:30 a.m. to 10:30 p.m.. On Saturday the waiting time was 15 minutes for the whole service (from 7:30 a.m. to 10 p.m.), and on Sunday and holidays 30 minutes for the whole service (from 7:30 a.m. to 10 p.m.).

The **waiting time variability** was 0 as for the total delay per trip.

The **effective system capacity** was calculated directly from the average waiting time: 960 passengers/hour on school days from 7:30 a.m. to 9:30 a.m., 600 passengers/hour on school days from 9:30 a.m. to 10:30 p.m. and on no-school days, 320 passengers/hour on Saturday and 160 passengers/hour on Sunday and holidays.

The two safety transport patterns indicators measured, **incidents** and **driver workload**, were obtained through the drivers' interviews. Concerning the incidents, the interviewed drivers reported that the vehicles seldom had incidents from the start of the operations of the system. The driver workload required was the same required for a conventional system.

The seven environment indicators measured were calculated through measurements on-field. The Civis Cristalis hybrid bus energy consumption is 2.65 kWh/km; in the measurement period the buses travelled about 123 000 km, meaning 372 km/day. Therefore the **daily consumption** was 2.65·372 = 986 kWh.

The **energy efficiency** was obtained directly as the ratio between daily consumption and total passenger·km travelled, and was about 0.44 kWh/p·km. Such value is half the value of the U.S. conventional buses, 0.88 kWh/p·km (according to *Transportation Energy Data Book: Edition 29*), but however higher than the value of the U.K. conventional buses, 0.33

kWh/p·km (according to *Lowson, 2003, Energy use and sustainability of transport systems*). It is mainly due to the low occupancy of the vehicles in Castellon, 10% in average. For example, if the average occupancy was three times larger than the actual one (meaning 30%), the energy efficiency of the high-tech buses would become about 0.15 kWh/p·km. To improve the system energy efficiency is another goal of the system, and it can be obtained by attracting more people to the system use.

The Civis Cristalis did not produce noxious emissions in loco, thus **NO_x**, **PM_{10} and/or $PM_{2.5}$**, **CO**, **CO_2** were calculated according to MEET project, *Methodology for calculating transport emissions and energy consumption*. The emissions from the production of electricity in Spain in 2010 are: NO_x =0.75 g/kWh, PM_{10} and/or $PM_{2.5}$=0.1 g/kWh, CO=0.06 g/kWh, CO_2=390 g/kWh (according also to http://epi.yale.edu/). Starting from these values, the daily production of noxious emissions of the system are NO_x =740 g, PM_{10} and/or $PM_{2.5}$=99 g, CO=59 g, CO_2=385 kg. According to the data collected during the first ten months of the system operations from the end of June 2008 to April 2009, about 400 daily km were travelled by the buses, meaning that the daily noxious emissions per km were: NO_x =1.84 g/km, PM_{10} and/or $PM_{2.5}$=0.25 g/km, CO=0.15 g/km, CO_2=960 g/km. Comparing such values with those reported in *Alessandrini and Persia, 2001, Evaluation of hybrid buses in urban public transport service*, the best improvement due to the high tech buses is that concerning NO_x, which are about ten times lower than the value of 11.55 g/km measured for such hybrid buses. CO is half the value of 0.30 g/km of those hybrid buses, whereas for the CO_2 the decrease is about 10% (960 g/km against 1082 g/km).

With regards to the noise, **L_{den} and L_{night}** were referred to the 96/20 EC limit for acoustic emissions. The maximum allowed value is 80 dB, and the Civis Cristalis noise emissions were 74 dB.

Concerning the financial impacts, obtained through the measurements on-field and the experts' opinions, **the track construction and civil works** start-up cost was about 19 000 000€. Such cost includes about 185 000€ for the design realization, about 740 000€ for the construction management and 4 000 000€ for the construction of the bridge on the Riu Sec river. The **vehicle acquisition/construction** start-up cost for the 3 Civis Cristalis buses used was about 2 600 000€ (7-9 further buses are foreseen to be used in the future development of the system, with a cost of about 7 000 000€), and the **control systems and apparatus** start-up cost for the optical guide was about 1 250 000€.

The operating costs were estimated on the basis of the correspondent start-up costs. Both **vehicle maintenance** and **control system maintenance** costs were calculated as 6% of the correspondent start-up costs, 158 000 €/year and 75 000 €/year respectively. Considering the scheduled service of the new system, 4 bus drivers were required, together with an operator for the system control, meaning a personnel of 5 employees. Considering a cost of 35 000 €/year per employee, a total **personnel cost** of 175 000 €/year was calculated. For the **track and civil infrastructures maintenance**, a cost of 30 000 €/year was included to consider the network management (bus stops, road signals, etc.).

The **operating revenues** of the system were calculated considering two terms, the first made of the user ticket revenues, and the second due to the mileage cost of the old bus system, which can considered as a benefit due to the correspondent money saved.

Different kinds of ticket are available for the Castellon public transport, including the new high-tech bus system: one-trip ticket (0.9€), 10-trip young ticket (5€), 10-trip ticket (6€), 30-day ticket (22€). Retired people and social workers do not pay to use the public transport. According to the data on the different tickets used to travel with the new system (18% of users with one-trip ticket, 53% with 10-trip young, 9% with 10-trip, 9% with 30-day, 7% retired people, 4% social workers), provided by the measurements on-field, about 290 000 €/year have been estimated as user ticket revenues.

The second term of the operating revenues was calculated by assuming 2.64 €/veh·km as mileage cost for a conventional bus. This cost has been obtained considering: 450 000 € bus investment cost, 0.5 €/km depreciation with 10 years as time horizon, 5 km/l bus consumption, 0.4 €/km fuel cost, 1 €/km driver cost, and 20% as overheads. The mileage of the old bus system was 237 veh·km/day (obtained by the ex-ante value of 2370 daily passenger·km travelled, with an average of 10 passenger per vehicle, as reported in the "Transport Plan for Castellon and its surroundings" for the old line replaced by the new system). With such figures, the annual revenues due to the money saved by using the new system instead of the old one are about 230 000 €.

The total annual operating revenues were therefore 520 000 €.

With such financial figures, the financial Cost-Benefit Analysis (CBA) of the new system was done. The cash-flows are:

- Start-up costs, spent one year before the service starting , 22 850 000 €;
- Operating costs, spent each year to run the system, 438 000 € growing each year according to an inflation rate set to 2.3% a year;
- Revenues, deriving from the user tickets and the deleted costs of running a conventional bus service, 520 000 € growing with the inflation rate each year as the operating costs.

The time horizon has been set to 20 years and the discount factor set to 2.0%.

The calculated **financial Net Present Value** (NPV) is about -21 000 000 € meaning that the municipality has to pay nearly 21 000 000 € to operate the new system during the 20-year time horizon. The correspondent **financial Internal Rate of Return** (IRR) calculated is -16%.

Together with the financial CBA, the socio-economic CBA of the new system has been done, in order to give a monetary value to the safety effects and to the environmental benefits due to the introduction of the new high-tech bus system, and to include such benefits for the community in the analysis of the system.

Concerning the safety monetization, considering the high-tech buses accident free (because they work on dedicated lanes) the benefits to account for in the socio-economic CBA are those due to the reduction of mileage of cars and conventional buses. According to the *Handbook on estimation of external costs in the transport sector*, the accident costs on the urban roads in Spain are 5.24 €/veh·km for passengers cars and 13.35 €/veh·km for heavy duty vehicles, in which the buses are included. The car mileage reduction was 113 veh·km/day, and the bus mileage reduction was 237 veh·km/day. With such figures a benefit of about 1 360 000 €/year has been calculated.

Two kinds of environmental benefits have been considered here: the reduction of noxious emissions due to the reduction of circulating polluting vehicles and the benefits due to a better use of the resources.

The pollutant emissions are produced by cars and conventional buses. According to the *Handbook on estimation of external costs in the transport sector*, the costs associated to passenger cars with displacement between 1.4 and 2 litres on urban roads are 0.1 €/veh·km for petrol cars and 0.4 €/veh·km for diesel cars in EURO5 class, whereas the cost associated to heavy duty vehicles with mass between 16 and 32 tons in EURO5 class is 2.7 €/veh·km. Considering the mileage reductions used in safety monetization and the car mileage reduction equally divided among petrol and diesel cars, a noxious emission reduction benefit of 241 000 €/year has been calculated.

The external costs associated to resource consumption are, according once again to the *Handbook on estimation of external costs in the transport sector*, 0.7 €/veh·km for a car, 0.2 €/veh·km for a bus and 0.01 €/veh·km for an high-tech bus. Applying these values to the mileage reduction for cars and buses and to the mileage of the new high-tech buses (276 veh·km/day), a 45 000 €/year energy assessment benefit has been obtained.

No direct benefits on the users were considered, because to calculate the time and costs saved by the users by shifting from the conventional bus to the high-tech bus was not possible.

The socio-economic CBA was therefore made following the same procedure of the financial one adding the safety, energy and environmental benefits to the calculation as if they were a real cash-flow. Considering these benefits in the NPV calculation as any other benefit, increasing them each year with the inflation rate, the **socio-economic Net Present Value** obtained is about 12 000 000 € with 20 year time horizon. Such value means that the new system is socio-economically viable and that that the community would benefit in its installation. The break-even point of the system is before the end of the fourteenth year of operations, when the socio-economic NPV become positive. The correspondent **socio-economic Internal Rate of Return** calculated is 6.5%.

The technological success indicators were all calculated through the driver interviews. The **docking accuracy** was measured by using a ranking from 1 to 5 as for the acceptance and quality of service indicators, and the value obtained is 3, meaning that it was considered as sufficient by the drivers.

The **failure rate** was calculated considering each correction of the automatic driving as a failure. It means that the system had not real failures, only needs sometimes a manual correction of the automatic driving. One correction was needed each 2-3 travels, meaning a **mean time between failures** (corrections) of one hour and half. Repairs were not needed, thus no **mean time to repairs** was required.

3.2 Orta San Giulio - Ex-post

3.2.1 Data collection methods

In the Orta San Giulio showcase five of the Acceptance indicators (usefulness, ease of use, user satisfaction for the on demand service, integration with other systems, user willingness to pay) and four of the Quality of Service indicators (perceived comfort, perceived level of privacy, perception of safety, fear of attack) were measured in the ex-post survey through specific questions. One indicator belonging to the Transport Patterns, system modal share, was also measured through the survey.

For all of them the ex-post evaluation was obtained through the questionnaire answers.

155 people answered the questionnaire after that they used the new system during the showcase.

The interviewed people were submitted to a set of 12 questions, subdivided in the following categories:

- The first 2 questions were related to the evaluation of the system in terms of acceptance and quality of service, and allowed to calculate the 9 acceptance and quality of service indicators. For each indicator the performance was measured by assigning a value from 1 to 5, in order to quantify the level of user satisfaction (where 1 means completely dissatisfied, 2 somewhat dissatisfied, 3 fairly satisfied, 4 very satisfied, and 5 completely satisfied), with the exception of the user willingness to pay, which is quantified through money rankings.
- The next 4 questions were about the transport habits and the reaction to the introduction of a system based on the Dual-Mode Vehicles, and allowed to calculate the system modal share indicator, by calculating the percentage of people willing to use the Dual-Mode Vehicles if they were available;
- One further question was free and concerning suggestions to facilitate the use of the Dual-Mode Vehicles;
- The last 5 questions were related to the users' main characteristics (age, gender, education, occupation, income).

10 indicators were therefore totally quantified in terms of ex-post evaluation, all belonging to the reference set provided in the evaluation framework of the CityMobil project.

3.2.2 Indicator measurements and results

The ex-post evaluations of the 10 indicators measured through the Orta questionnaire are reported in Table 2.

For eight of the indicators (usefulness, ease of use, user satisfaction for the on demand system, integration with other systems, perceived comfort, perceived level of privacy, perception of safety, fear of attack) the evaluation was obtained as the average value of the user satisfaction performances, in a ranking from 1 to 5, as explained in the previous section 3.2.1.

As reported in Table 2, both the four acceptance and the four quality of service indicators showed similar values.

For all of them the values were reported including the second decimal place, thus allowing to show the best performing ones.

Concerning the acceptance indicators, three of them (usefulness, ease of use and integration with other systems) were evaluated about 3.7, whereas integration with other systems value was about 3.6.

Figure 2 shows their values. Usefulness and integration with other systems are the best indicators, with 3.73 as performance rate. Ease of use is little less performing, with a rate of 3.70.

Table 2 Indicator evaluations in user acceptance survey of the Orta showcase

Evaluation Category	Impact	Indicator	Ex-post evaluation
Acceptance	User acceptance	Usefulness	3.73
		Ease of use	3.70
		User satisfaction for the on demand service	3.57
		Integration with other systems	3.73
	Willingness to pay	User willingness	2.20€
Quality of service	Comfort	Perceived comfort	3.60
	Privacy	Perceived level of privacy	3.55
	Perception of safety and security	Perception of safety	3.62
		Fear of attack	3.57
Transport patterns	Modal change	System modal share	82%*

* result obtained soon after people of the interviewed survey tested the dual-mode vehicles

User satisfaction for the on demand service is the less rated indicator, with 3.57 as performance rate. It has however a 0.16 gap from the two best rated indicators, meaning that the users were well-disposed to accept the new system in all of its characteristics, considering it as useful, easy to use and well integrated with the other systems and being at the same time satisfied by the on demand service.

With regards to the quality of service indicators, all of them were rated about 3.6, as reported in Figure 3.

Perception of safety was the best performing, with 3.62. The system was also perceived as comfortable, with the rate of 3.60. The last two rated indicators, fear of attack and perceived level of privacy, was rated 3.57 and 3.55 respectively.

The quality of service was therefore evaluated as homogeneously satisfactory, with the average rate of 3.6 for the four indicators, and 0.07 as the difference between the evaluations of the best rated indicator and of the less rated one.

The fifth acceptance indicator, user willingness to pay, was evaluated by quantifying the money users would be willing to pay to use the service.

Seven different answers were proposed in the questionnaire to quantify such money: 1) Nothing, 2) Less than 0.5€, 3) Between 0.5€ and 1€, 4) Between 1€ and 2€, 5) Between 2€ and 3€, 6) Between 3€ and 4€, 7) More than 4€.

Figure 4 reports the distribution of the answers within the survey of interviewed people. More than 80% of the interviewed people were willing to pay more than 1€ to use the service: 32% would pay between 1€ and 2€, 24% between 2€ and 3€, 14% between 3€ and 4€, and 12% more than 4€.

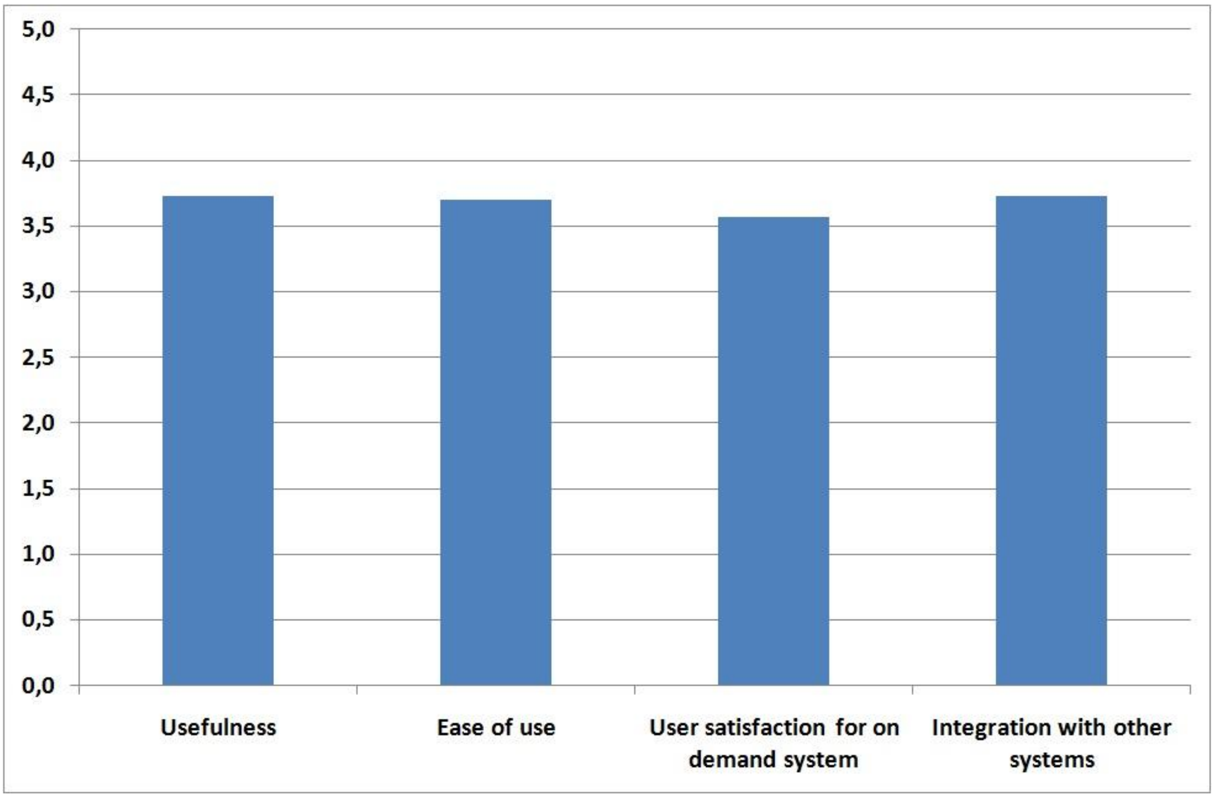

Figure 2 Orta ex-post user acceptance indicators

People willing to pay less than 1€ was subdivided in: 10% between 0.5€ and 1€, 4% less than 0.5€ and 4% not willing to pay to use the system.

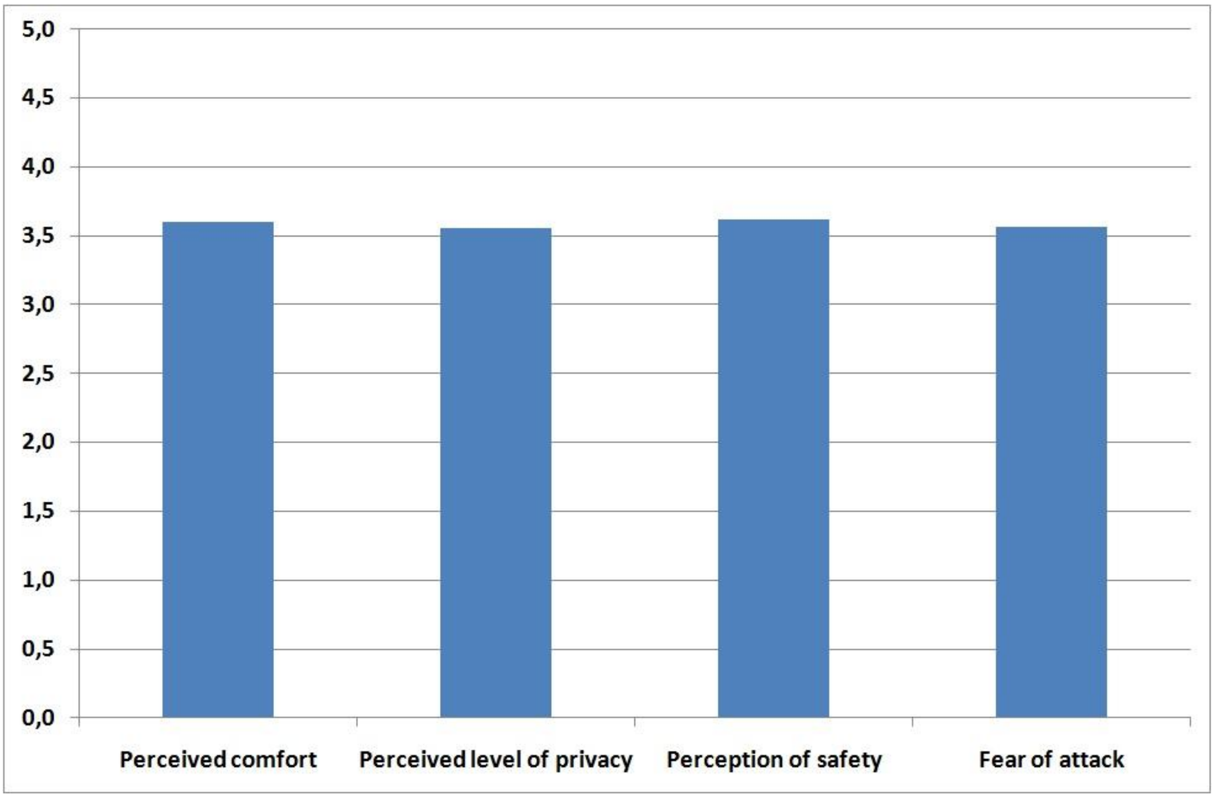

Figure 3 Orta ex-post quality of service indicators

Therefore interviewed people were generally willing to pay to use the service.

To quantify the average value they would pay, the weighted average of the answers were done. For each one of the possible answers, the intermediate value of the range considered was assumed as the value to be paid (for example 1.5€ for the answer "Between 1€ and 2€", 3.5€ for the answer "Between 3€ and 4€"), with exceptions of the answers "Nothing", where the value 0 was considered, and more than 4€, where the value considered was 4.5€.

With such assumptions, the average value people would pay to use the service is 2.20€, as reported in Table 2.

The transport patterns indicator evaluated, system modal share, was calculated directly from the fourth and the fifth question of the questionnaire, regarding the mode of transport used at the moment by the interviewed people and the possibility to use the Dual-Mode Vehicle if they were available respectively.

The value obtained through the survey analysis was 82%, meaning that eight out of ten people would use a Dual-Mode Vehicle to his/her travels if they were available in Orta.

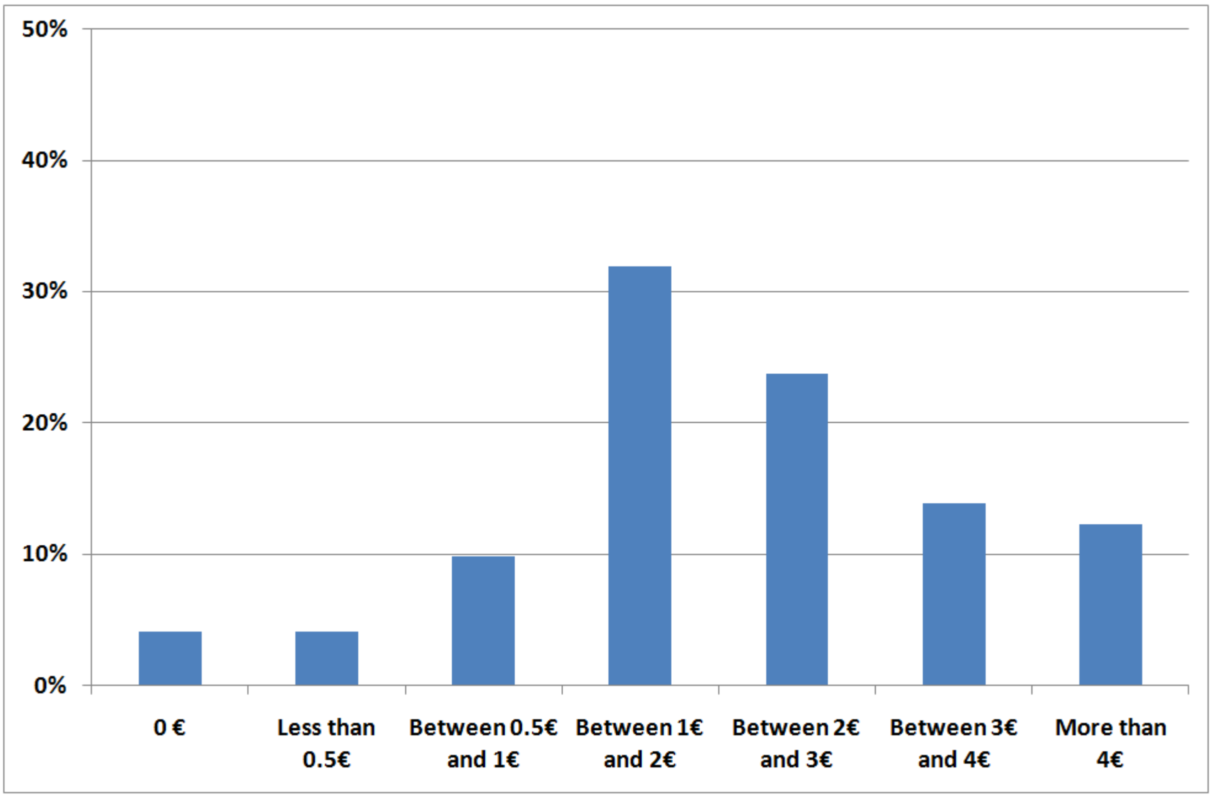

Figure 4 Orta user willingness to pay

This outstanding value is due to the fact that people were interviewed soon after they had "touched" and "tasted" the new concept of vehicles presented in the showcase. They showed therefore to be completely well-disposed to accept the use of such new vehicles; even if the value obtained is larger than the real feeling of people, it is however a valid index of the good feelings of Orta people for the use of dual-mode vehicles instead of the conventional vehicles, thus providing a very good result for the future developments.

4 Cross-comparisons and findings

4.1 User acceptance

The user acceptance of the new systems proposed and tested through the CityMobil project can be showed by comparing the results of the sites in which the ex-post evaluation has been done.

Six surveys have been provided, of which five showcases (Trondheim, Vantaa, La Rochelle, Daventry, Orta San Giulio) and one demonstration (Castellon). Four of them (Trondheim, Vantaa, La Rochelle, Daventry) have been yet analysed and compared in the previous deliverables 5.2.1a and 5.2.1b. However a global comparison with the two further ex-post evaluations reported in this document has been done, including a demonstration together with the showcases.

In Table 3 all the indicators measured are reported, together with the performance ratings obtained by the surveys.

Four indicators have been collected for all the sites surveyed: usefulness, ease of use, perceived level of privacy, and perception of safety.

Three indicators have been collected in five of the six sites: user willingness to pay (not measured in Castellon), reliability and perceived cleanliness (these two not measured in Orta).

Integration with other systems and perceived comfort have not been measured in La Rochelle and Daventry, whereas user satisfaction for the on demand service has not been measured in La Rochelle, Daventry and Castellon (where the services are not on demand).

Fear of attack has been measured in Orta and Castellon, whereas information availability, information comprehensibility and ticketing user satisfaction have been measured only in Castellon.

Considering the average values of those indicators measured at least in four of the six sites, ease of use is the best perceived with an average value little less than 3.7. Good satisfaction value was obtained by usefulness, with more than 3.5 as average performance rating. Reliability, integration with other systems, perception of safety, perceived level of privacy obtained quite sufficient average values (little more than 3.4), even if in Daventry and Vantaa the systems were not considered as safe and with a good level of privacy. Perceived cleanliness and comfort close the ranking, with average values respectively 3.35 and 3.3.

The interviewed people were also well-disposed to pay to use the new systems in the five sites in which user willingness to pay has been measured. Considering a user willingness value in the middle of the ranges provided as answers (1.5€ for Trondheim, Vantaa and Daventry, where people answered between 1€ and 2€, and 2.5€ for La Rochelle where people answered between 2€ and 3€), the average value people would pay to use the services is little less than 2€.

As general conclusions, people were satisfied by the new ATS proposed. They evaluated them as useful, easy to use and reliable. The safety, the cleanliness and the level of comfort on the vehicles change on the basis of the system tested, and may be influenced not only by the kind of service (with or without a driver), but also by the kind of vehicles used to provide the service. In all the sites people would pay to use the new services proposed.

Table 3 Cross-comparison for the user acceptance indicators for the six ex-post evaluations (five showcases and one demonstration)

Evaluation Category	Impact	Indicator	Ex-post performance rating					
			Trondheim	Vantaa	La Rochelle	Daventry	Orta San Giulio	Castellon
Acceptance	User acceptance	Usefulness	3.1/5	3.3/5	3.8/5	3.5/5	3.7/5	3.7/5
		Ease of use	3.5/5	4.0/5	4.0/5	3.1/5	3.7/5	3.7/5
		Reliability	3.2/5	3.3/5	3.6/5	3.5/5		3.6/5
		User satisfaction for the on demand service	3.5/5	3.3/5			3.7/5	
		Integration with other systems	3.1/5	3.3/5			3.7/5	3.6/5
	Willingness to pay	User willingness	1 to 2€	1 to 2€	2 to 3€	1 to 2 €	2.20€	
Quality of service	Information	Information availability						3.8/5
		Information comprehensibility						3.8/5
	Ticketing	User satisfaction						3.7/5
	Cleanliness	Perceived cleanliness	3.7/5	2.9/5	3.6/5	3.0/5		3.6/5
	Comfort	Perceived comfort	3.1/5	2.8/5			3.6/5	3.7/5
	Privacy	Perceived level of privacy	3.5/5	2.7/5	3.8/5	3.2/5	3.6/5	3.7/5
	Perception of safety and security	Perception of safety	3.7/5	3.0/5	3.7/5	2.9/5	3.6/5	3.7/5
		Fear of attack					3.6/5	3.7/5

4.2 Transport patterns

The site of Castellon is the only one in which a lot of transport patterns indicators have been measured after the ex-post survey. As reported in section 3.1 of the present document, also five ex-ante indicators were available: system modal share, total passenger·km travelled, total number of trips, average journey time per OD pair, and journey time variability.

According to the indicators provided in the previous deliverables (5.2.1a and 5.2.1b), comparisons were possible between Rome and Castellon for two indicators (total passenger·km travelled and total number of trips), and between Castellon and Orta San Giulio for one indicator (system modal share).

The total number of daily trips in the Rome demonstration is little more than 14000, whereas in Castellon it was more than 1300 with the conventional bus (ex-ante phase) and more than 1500 with the new high-tech bus system (ex-post phase). The large difference between Rome and Castellon values is due to the different services provided. In Rome the 20-place cybercars serve the P1 car-park (containing about 3000 cars) during the exhibition days, taking people from the slots in which they parked their cars and from the train station and keeping them to the exhibition building entrance (and vice-versa). It is a parkshuttle service. In Castellon both the 80-place old buses previously used and the actual 80-place new high-tech buses make a public transport service between the University campus Juame I and the zone of Parc Ribalta.

Even if the network lengths are similar at the moment (2.2 km per direction in Rome, 2 km per direction in Castellon), the different kinds of service generate such large difference in the total number of trips.

However, the difference between the total number of daily passenger·km travelled is less evident: about 3300 passenger·km have been calculated ex-ante for the Rome demonstration, whereas for the Castellon demonstration they were little less than 2400 before the new system and more than 2200 with the new system. Such difference is due to the fact that the average passenger journey in Rome demonstration is 0.2 km for people coming to the exhibition building by car and 0.4 km for people coming by train, whereas in Castellon it was about 1.8 km before the new system introduction and it is about 1.4 km with the new system.

Concerning the system modal share, the value obtained in the Orta showcase (82%) was very different from the value obtained for the Castellon demonstration (15%). As reported in section 3.2, the high percentage of people willing to use the new system in Orta indicates the good feeling of people for the innovative concept, but it is also due to the fact that they were interviewed soon after testing and "touching" the system. The value obtained in Castellon indicates that the new system produces good results, because the 15% percentage measured is about the same value measured in the ex-ante analysis (reported in the deliverables 5.2.1b and 1.4.5.2) for the whole Castellon area with the conventional bus systems, meaning that the new system is well accepted by people and the new concept of bus does not keep users away from the public transport.

4.3 Financial and socio-economic impacts

The financial and socio-economic impacts cross-comparison can be done for the demonstration of Rome and Castellon, on the basis of the costs and revenues estimated and collected, and the consequent cost-benefit analyses.

The main cost differences were those concerning the start-up costs: the works to install the new cybercar system in the P1 car-park in Rome requires about 3 300 000€, whereas the works to build the new high-tech bus system in Castellon required an investment of about 23 000 000€. The difference in such costs is mainly due to the track construction costs, about 19 000 000€ in Castellon, where all the system infrastructures were built ex-novo (including the construction of the new bridge on the Riu Sec river), and 1 500 000€ in Rome, required to change the car-park structure in order to include the dedicated cybercar lanes.

The operating and maintenance costs were similar: 455 000€/year for the Rome demonstration and 438 000€/year for the Castellon demonstration. More personnel is required in Castellon, because the vehicles have the driver whereas in Rome cybercars are fully automated, and more annual system costs are required, while in Rome the track and civil infrastructure costs are higher than in Castellon.

The revenues calculated in Castellon (520 000€/year), due to tickets to use the buses, are more than twenty times larger than those considered in Rome (25 000€/year) and due to the car-park hourly fees.

The Net Present Value of the financial cost-benefit analysis with 10 year time horizon of the Rome demonstration, about -7 000 000€, is significantly different from that calculated for Castellon with the same time horizon, about -22 000 000€. However, the Castellon demonstration has been proved to be socially viable through the socio-economic cost-benefit analysis, which provided 12 000 000€ as net present value with 20 year time horizon, meaning that the new system produces a benefit for the community. Once the data about social benefits will be available for Rome, the same socio-economic cost-benefit analysis will be done.

5 Passenger application matrix on the basis of demonstration and showcase evaluation

The final step of the evaluation process, which will be addressed in the next WP5.4, will be to formalize the generalization of the results coming from the different inputs to the CityMobil technologies appraisal and finally provide a global assessment of the technologies.

In order to set the stage to this process, a dedicated table was built by the evaluation team, named Passenger Application Matrix. The purpose of this tool is to move the focus from the researcher perspective to the decision maker’s one, typically more practical, trying to think in terms of what system is best to be implemented in order to improve the mobility in a certain specific situation.

In this matrix the case studies, the demonstrations and the showcases are grouped according to the type of areas linked by the single scheme. Being the possible OD pairs the same (rows and columns), the matrix results to be a two-dimension symmetrical one. The information for each OD pair, expressed in terms of the available indicator values, can be considered as the third dimension.

The use of this general view should be ideally focused on each cell of the matrix, and help evaluate pro and cons of the implementation of the different technologies in each particular environment. Nevertheless a strict “single cell based” analysis will not be always feasible, in particular when the city-study modeling are involved; in fact in the modeled scenarios, due to the different dimensions of the cities, the area types may not be consistent with the categorization of the matrix, or the same area type of cities that are very different in dimension may lead to non proper comparisons; on the other hand, the indicator values resulting from the models may refer to single zones of the modeled area and not to the entire city, and this may avoid the cross comparisons as well. Such cases do not however represent a problem to the matrix filling, because in these cases it will be possible to provide valid results to the decision makers by changing the level of the geographical scale and evaluating the information on a more aggregate geographical level, i.e. grouping more cells.

In Figure 5 the fourth release of the passenger application matrix is represented.

It represents the fourth step of the matrix evolution: after the first release presented in D5.3.1a, it has been filled with case studies results, reported in D5.3.1b, and with the results of demonstrations and showcases obtained in this deliverable, in D5.2.1a and in D5.2.1b.

Destination⟶ **Origin** ↓	City centre	Inner suburbs	Outer suburbs	Suburban centres	Major transport node	Major parking lot	Major service facility	Major shopping facility	Major leisure facility
City centre	ICCC (Gateshead. Madrid. Trondheim. Vienna) **PRT** (**Gateshead. Madrid. Trondheim. Vienna**) DMV (La Rochelle, Orta)								
Inner suburbs	ICCC (Gateshead. Trondheim) **PRT** (**Gateshead. Trondheim**) HT-bus (Gateshead. **Madrid**. Trondheim. **Vienna**) DMV	ICCC (Gateshead. Trondheim) PTFCC (**Gateshead**. Madrid. Trondheim. Vienna 1) **PRT** (Gateshead. **Trondheim**) HT-Bus (Gateshead. **Madrid**. Trondheim. **Vienna**) DMV PRT (Daventry)							
Outer suburbs	PTFCC (Trondheim) PRT (Trondheim) **HT-bus** (**Madrid**. Trondheim, Castellon) DMV (Madrid. **Trondheim**)	PTFCC (Trondheim) PRT (Trondheim) **HT-bus** (**Madrid**. Trondheim, Castellon) DMV (Madrid. **Trondheim**)	PTFCC (Trondheim) **PRT** (Trondheim) HT-bus (Trondheim) DMV						
Suburban centre (within an intermediate distance range)	HT-bus (Gateshead)	HT-bus (Gateshead)							
Major transport node (e.g. airport, central station)	HT-bus (Gateshead) CC (Vantaa)	HT-bus (Gateshead)			PRT (Heathrow)				
Major parking lot				CC (Rome)	CC (Rome)				
Major educational or service facility (e.g. University campus, hospital)	PRT (Trondheim) HT-bus (Castellon)	PRT (Trondheim)	PRT (Trondheim)				CC (Trondheim showcase)		
Major shopping facility	ICCC (Gateshead) **PRT** (Gateshead) HT-bus (Gateshead)	ICCC (Gateshead) **PRT** (Gateshead) HT-bus (Gateshead)		HT-bus (Gateshead)					
Major leisure facility (e.g. amusement parks)	HT-bus (Castellon)								
Corridor	**HT-bus** (**Gateshead. Madrid. Trondheim. Vienna**) DMV	**HT-bus** (**Gateshead. Madrid. Trondheim. Vienna**) DMV	HT-bus (Trondheim) DMV	HT-bus (Gateshead) DMV					

Figure 5 Fourth release of the Passenger Application Matrix

6 Sources

Reference list

Alessandrini, A. and Persia, L.. Evaluation of hybrid buses in urban public transport service. Presented at PROSPER congress – Hybrid technology in public transport service Karlsruhe 19-20 September 2001 included in the pre-printed CD-rom conference proceedings.

Boundy, R., G., Davis, S., C., Diegel, S., W., 2010, *Transportation Energy Data Book: Edition 29*, Prepared for the Vehicle Technologies Program Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy, contract no. DE-AC05-00OR22725

CITYMOBIL CONSORTIUM, 2007, *Evaluation Framework*, D5.1.1 of CityMobil project

CITYMOBIL CONSORTIUM, 2009, *Field trial A ex-ante evaluation report*, D5.2.1a of CityMobil project

CITYMOBIL CONSORTIUM, 2010, *Field trial B ex-ante evaluation report*, D5.2.1b of CityMobil project

CITYMOBIL CONSORTIUM, 2010, *Castellon impact assessment framework*, D1.4.5.1 of CityMobil project

CITYMOBIL CONSORTIUM, 2010, *Ex-ante impact assessment of the Castellon demonstration*, D1.4.5.2 of CityMobil project

CITYMOBIL CONSORTIUM, 2011, *Ex-post impact assessment of the Castellon demonstration*, D1.4.5.3 of CityMobil project

Coffey, R., Lowson, M., V., 1996, *A comparative analysis of energy consumption and emission of urban transport systems*, in "Urban Transport and the Environment II", Eds. Baldasano, Recio and Sucharov, Computational Mechanics Publications

GENERALITAT VALENCIANA (2002)– *Plan de Transporte de Castellò y su Entorno* – MECSA, Madrid

GENERALITAT VALENCIANA (2010)– *Tram Castellon: informe de seguimento de la red de plataforma reservada al transporte publico en Castellon de la Plana* – TRAM, Transporte/Metropolitano/dela/Plana

Litman, T., 2010, *Guide to Calculating Mobility Management Benefits*, Victoria Transport Policy Institute

Lowson, M., V., 2003, *Energy use and sustainability of transport systems*, Prepared under the Cybercar Contract Task 3.4 Energy Management

Maibach, M., Schreyer, C., Sutter, D., van Hessen, H.P., Boon, B.H., Smokers, R., Schroten, A., Doll, C., Pawlowska, B., Bak, M., 2008, *Handbook on estimation of external costs in the transport sector*, Produced within the study Internalisation Measures and Policies for All external Cost of Transport (IMPACT), Publication Number: 07.4288.52

MEET project, 1999, *Methodology for calculating transport emissions and energy consumption*, Deliverable 22 of the MEET project

http://epi.yale.edu/

Annex - Main results of the SP5 evaluation process

The global objective of the CityMobil project is to achieve a more effective organisation of urban transport, resulting in a more rational use of motorised traffic with less congestion and pollution, safer driving, a higher quality of living and an enhanced integration with spatial development.

For this aim, four different technologies will be tested and evaluated in the project: Personal Rapid Transit (PRT), CyberCars (CC), High Tech Buses (HTB), and Dual-mode Vehicles (DMV).

The demonstration, the showcases and the case studies involved in the CityMobil project have to provide a data collection for the evaluation of their feasibility and performances. In such way it is possible to evaluate the results, linked to the introduction of the new technologies proposed in the project, in terms of advantages for the users and improvement of new transport scenarios. Three different evaluation phases are required for each site: initial evaluation, ex-ante evaluation, and ex-post evaluation.

An evaluation framework has been made in the first phases of the project, capable of capturing the social, environmental, economic, legal and technological impacts of Advanced Transportation Systems (ATS). The framework was required to operate at spatial scales ranging from laboratory and test-track interventions, through computer modelling to real-world implementations on a large scale. For the evaluation of passenger transport systems a list of 64 indicators was generated, subdivided in 9 evaluation categories: Acceptance, Quality of service, Transport patterns, Social impacts, Environment, Financial impacts, Economic, Legal impacts, Technological success. This can be viewed as the complete envelope of overarching indicators which could form part of the evaluation of each of the different elements of Citymobil.

This is the executive summary of the whole evaluation process of the workpackage 5.2, and reports all the data collected and evaluated at the moment. The topics of the present deliverable are specifically reported in the different sections, whereas they are considered and compared with all the demonstrations and showcases evaluated in such executive summary.

The data of the locally focused evaluations of the entire Sub-project 5, made of demonstrations, showcases and case studies, are used to fill the cells of a bi-dimensional matrix, taken directly from the Sub-project 2, called “Passenger Application Matrix”.

In this matrix the case studies, the demonstrations and the showcases are grouped according to their origins and destinations (respectively rows and columns of the matrix).

Ten possible origins and ten possible destinations are in the matrix. They are:

- City centre,
- Inner suburbs,
- Outer suburbs,
- Suburban centre,
- Major transport nodes (e.g. airport, central station),
- Major parking lots,
- Major educational or service facilities (e.g. university campus, hospital),
- Major shopping facilities,
- Major leisure facilities (e.g. amusement parks),
- Corridor.

The cells of the matrix represent all the possible OD pairs.

They are filled with the ATSs studied in the project, in terms of results of the local evaluation processes.

In the project different technologies, with different studies, in different contexts and with different methods have been studied. For example the travels from outer suburbs to city centre are studied for the following ATSs: Public Transport Feeder Cybercars in Trondheim, High-Tech Buses in Castellon, Madrid and Trondheim, Personal Rapid Transit in Trondheim, Dual-Mode Vehicles in Gateshead, Madrid, Trondheim and Vienna. The matrix output for this cell is made of Transport Patterns, Social, Environmental, Financial, Economic Impacts of each of those ATS for such kind of trip; it allows to select the most appropriate ATS to be designed for different and specific situations covering such trip.

The filled matrix is therefore the final result of the evaluation, and at the same time the tool to move the focus from the researcher perspective to the decision maker's one, typically more practical, trying to think in terms of what system is best to be implemented in order to improve the mobility in a certain specific situation. Each cell of the matrix contains the results of the local evaluation processes for each ATS evaluated for the combination origin/destination represented in the considered cell, and on the basis of the available indicators it will be possible to define the impacts to be expected by each ATS for the given OD pair and consequently to choose the most appropriate ATS.

The cells of the matrix covered at the moment by demonstrations and showcases are the following, reported with the corresponding demonstration and/or showcase:

- City centre to city centre: La Rochelle and Orta San Giulio showcases with Dual-Mode Vehicles;
- Inner suburbs to inner suburbs: Daventry showcase with PRT;
- Outer suburbs to city centre: Castellon demonstration with High Tech Bus;
- Outer suburbs to inner suburbs: Castellon demonstration with High Tech Bus;
- Major transport nodes to city centre: Vantaa showcase with Cybercars;
- Major transport nodes to major transport nodes: Heathrow demonstration with PRT;
- Major parking lot to suburban centre: Rome demonstration with Cybercars;
- Major parking lot to major transport nodes: Rome demonstration with Cybercars;
- Major educational or service facility to city centre: Castellon demonstration with High Tech Bus;
- Major educational or service facility to major educational or service facility: Trondheim showcase with Cybercars;
- Major leisure facility to city centre: Castellon demonstration with High Tech Bus.

For what concerns the case studies, the results of their evaluation divided according to the cells of the matrix covered are widely reported in the deliverable 5.3.1b, named "Evaluation report for the ex-ante study".

For all the demonstration and showcases (with the only exception of Rome), indicators belonging to the acceptance and quality of service evaluation categories have been measured through interviews, and the average performances of such interviews have been reported in a ranking from 1 (worst performance) to 5 (best performance). With such available performances, comparisons between different cells of the matrix about the users' reactions to the ATS are possible for the common indicators.

Furthermore for the demonstrations of Rome and Castellon and for the showcases of Daventry and Orta San Giulio some of the transport patterns and economic indicators have been measured.

City centre to city centre

In the city centre to city centre scenario the technology evaluated is the Dual-Mode Vehicles, tested in two showcases: La Rochelle and Orta San Giulio.

Concerning the La Rochelle showcase, it is based on a car sharing service with automatic relocation and platooning of the vehicles, whose description is reported in the deliverable 5.2.1a and the evaluation is widely reported in the deliverable 5.2.1b.

Figure 6 shows the six acceptance and quality of service indicators measured, which provided the following results:

- Users were generally satisfied with the Dual-Mode Vehicles system, with an average performance rate of 3.8;
- The ease of use is the best rated indicator, with 4.0 as performance rating;
- The service was perceived as useful and safe, with both of the corresponding indicators rated 3.8;
- Reliability, perceived comfort and fear of attack, are less rated than the previous three indicators (3.6 for the first two and 3.7 for the last one).

Different vehicles were used in the La Rochelle showcase: Yamaha, Fiat, Cycab and a larger cybercar.

With regards to the Orta San Giulio showcase, the vehicles used were considered to integrate the bus service that connects the inner city centre, where cars are not allowed, with the external parking areas, where the cars are parked. Its description is reported in the section 2 of this deliverable.

Figure 7 reports the eight acceptance and quality of service indicators measured through the performance rate procedure, which provided the following results:

- Users were generally satisfied with the Dual-Mode Vehicles system, with an average performance rate of 3.6;
- The usefulness and the integration with the other systems were the best rated indicator, with little more than 3.7 as performance rating for both of them;
- The service was perceived as easy to use, with 3.7 as correspondent performance rate;
- The levels of safety and comfort were perceived as fairly high, even if little less rated than the previous three indicators (little more than 3.6 for the first one and 3.6 for the second one);
- Fear of attack, user satisfaction for the on demand service and perceived level of privacy were less rated than the previous indicators, all of them with performance rate little less than 3.6.

The user willingness to pay was also measured within the acceptance indicators, but with a different procedure. People were requested to quantify the money they would be willing to pay to use the service, and the average value that outcome from the survey was 2.20€.

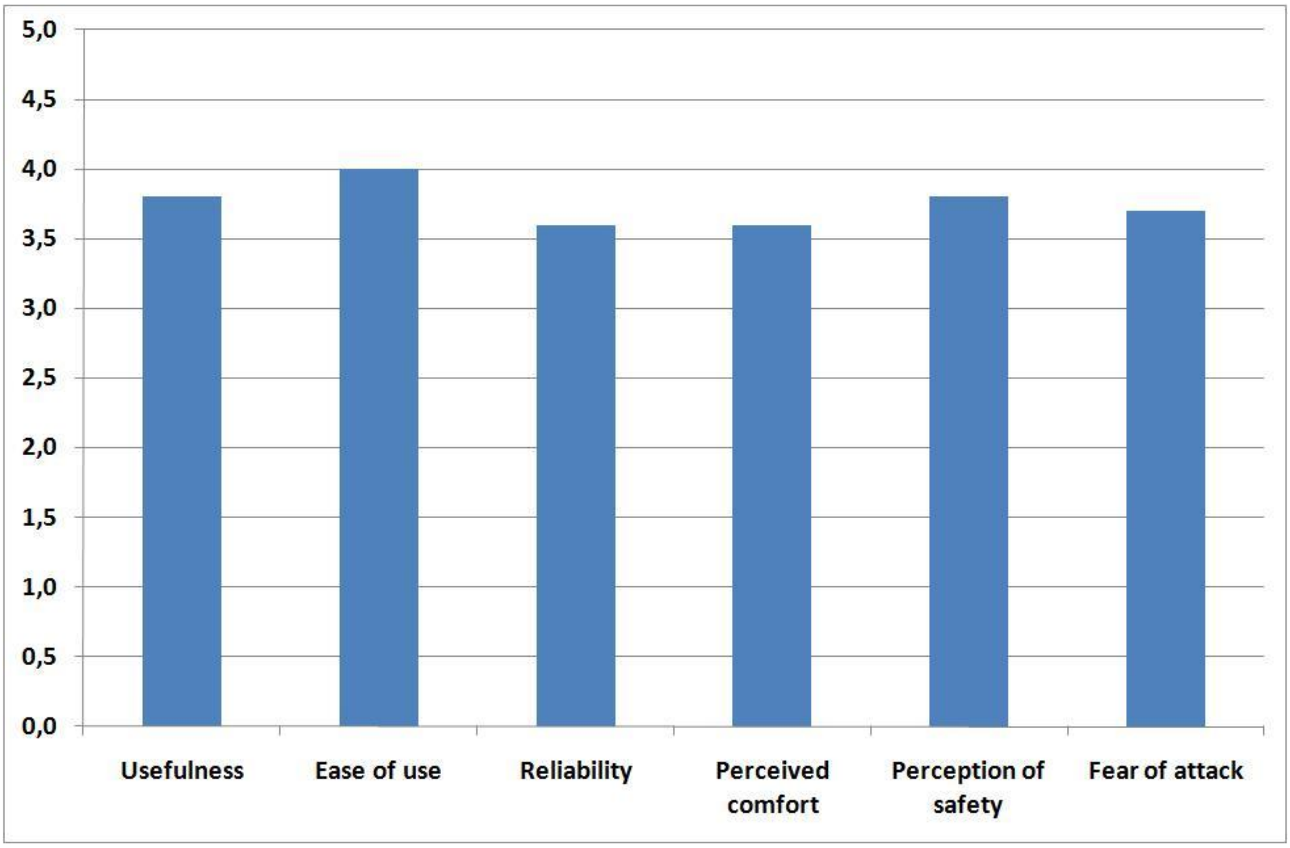

Figure 6 La Rochelle ex-post indicators

One transport pattern indicator was evaluated, system modal share. It provided the outstanding value of 82%, meaning that eight people out of ten would use a Dual-mode vehicle to their travels if they were available in Orta. People were interviewed soon after they had "touched" and "tasted" the new concept of vehicles presented, thus they showed to be completely well-disposed to accept the use of such new vehicles. Even if the value obtained is larger than the real feeling of people, it is however a valid index of the good feelings of Orta people for the use of dual-mode vehicles instead of the conventional vehicles.

Five of the acceptance and quality of service indicators were measured both in La Rochelle and Orta: usefulness, ease of use, perceived comfort, perception of safety and fear of attack.

Four of them (usefulness, ease of use, perception of safety, fear of attack) were rated more performing in La Rochelle than in Orta, respectively 3.8 vs 3.7, 4.0 vs 3.7, 3.8 vs 3.6 and 3.7 vs 3.6, whereas the perceived comfort obtained the same performance rate in both the cities (3.6).

However the differences between the correspondent indicators in the two cities were at most 8%, mainly due to the variety of vehicles available for the La Rochelle showcase, which was very impressive for people who tested them.

Such results mean that the innovations due to this ATS can be applied in the city centre of small/medium cities as La Rochelle and Orta San Giulio with quite good results in terms of users' acceptance and quality of service.

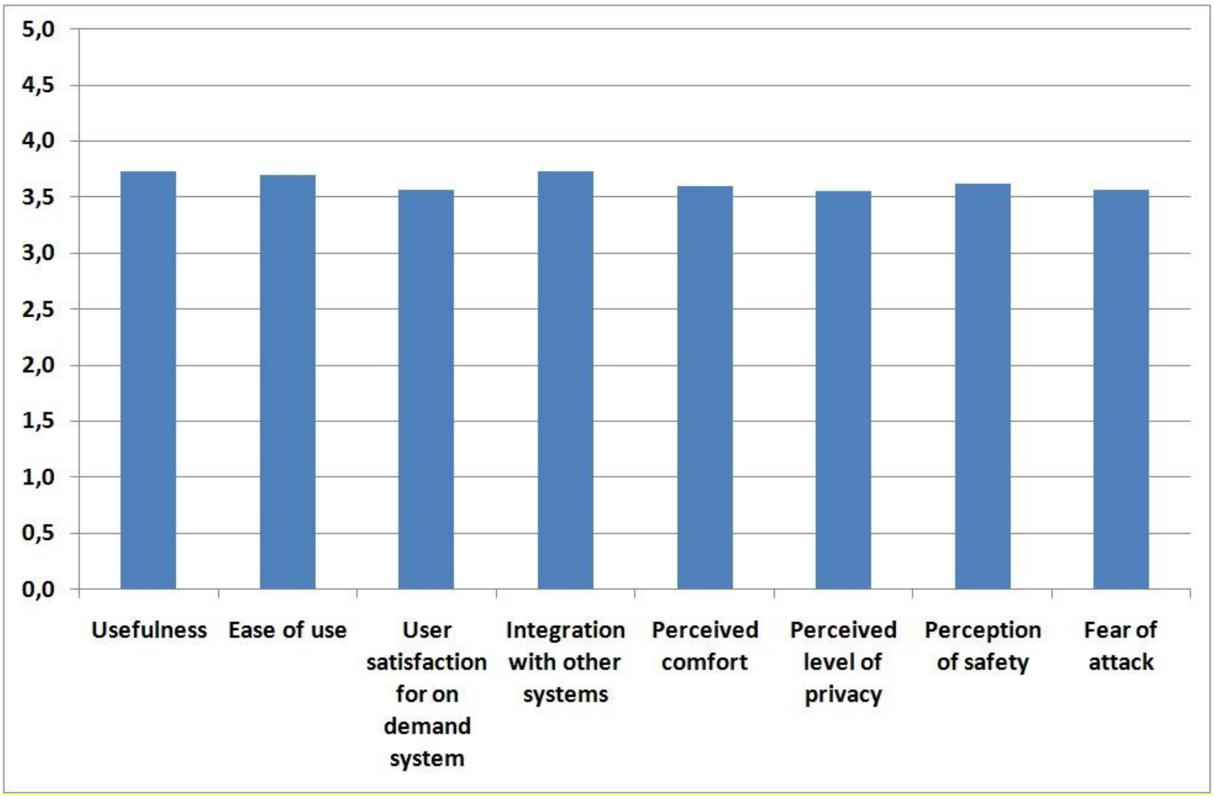

Figure 7 Orta San Giulio ex-post indicators

Inner suburbs to inner suburbs

The same indicators of the La Rochelle city centre to city centre scenario were available for the inner suburbs to inner suburbs scenario, where the technology evaluated is the PRT of the Daventry showcase, whose description and evaluation are reported in the deliverable 5.2.1a.

Figure 8 shows the six acceptance and quality of service indicators measured, which provided the following results:

- The users' evaluation of the PRT tested was quite sufficient, with an average performance rating of 3.2;
- The system was perceived as quite useful and easy to use, with 3.5 as rate of the two correspondent indicators;
- The system was also sufficiently safe (3.2), reliable (3.1) and comfortable (3.0);
- The only indicator not completely sufficient was fear of attack, rated 2.9; it can be due to the fact that the vehicles are fully automatic without a driver, thus people fear that an attack would be easy in such conditions.

Although the vehicles used in the Daventry showcase were not properly PRT, but automatic vehicles similar to cybercars, these results lead to consider that the PRT can be applied with fairly satisfactory results for the users in linking different inner suburbs of a small/medium city as Daventry. The users' fear of attack could be avoided with "ad hoc" campaigns on the security on such vehicles, even if without a driver.

Other than the acceptance and quality of service indicators measured, an economic value was provided about the costs connected with the organization of the showcase: 85 000€ (not including VAT) can be assumed as a reference cost to organize a little scale showcase with PRT linking different inner suburbs.

Considering the comparison between the acceptance and quality of service indicators measured in La Rochelle and Daventry, the differences between them seem to be mainly due to the different kinds of service provided in the two cities.

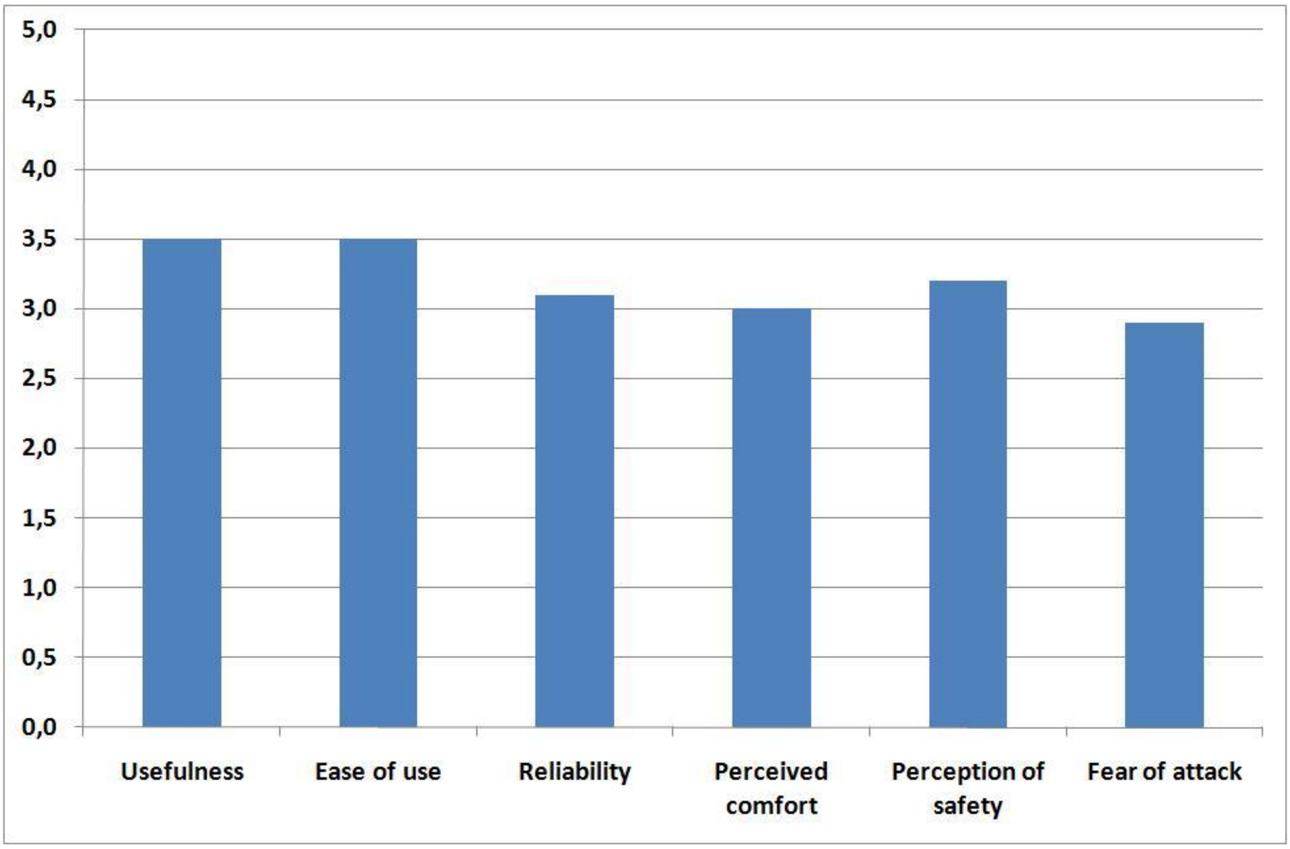

Figure 8 Daventry ex-post indicators

The large number of options of vehicles to be tested in La Rochelle seems also to affect the results in terms of positive user perceptions. This is probably due to the fact that when there are more than one option of vehicle the new concept of transport is taken into account by the users, whereas users consider only the vehicles and not the concept when there are a lower number of available options.

Furthermore, the differences could be also probably due to the different cultures: the global trends of the indicator rates are similar, but those of Daventry seem to be translated to lower values than those of La Rochelle. The same considerations are true for the comparison between Daventry and Orta San Giulio, where the five common indicators were all rated more than in Daventry for the same reasons previously reported.

Outer suburbs to city centre – Outer suburbs to inner suburbs – Major educational or service facility to city centre – Major leisure facility to city centre

For four different scenarios, outer suburbs to city centre, outer suburbs to inner suburbs, major educational or service facility to city centre, and major leisure facility to city centre, the technology evaluated is the High-Tech Bus of the Castellon demonstration, which links the University campus to the centre of Castellon and then to the harbor, passing through the inner and the outer suburbs. The wide description of the demonstration is reported in the deliverables 5.2.1a and 1.4.5.1, where the operating and evaluated stretch 1 between the University campus and the Parc Ribalta is showed.

In the deliverables 1.4.5.2 and 5.2.1b the ex-ante evaluation is reported; the data collections were performed before the CityMobil project start, thus the results obtained have to be properly considered as "before" results, and provided two transport patterns indicators, system modal share and total number of daily trips, respectively 15% and about 20000.

The deliverable 1.4.5.3 reports the ex-post impact assessment of the Castellon demonstration, and the ex-post evaluation is reported in section 3.1 of the present deliverable. The ex-post surveys allowed to evaluate 12 acceptance and quality of service indicators, 13 transport patterns indicators, 7 environment indicators, 8 financial impacts indicators, 2 economic indicators, and 4 technological success indicators.

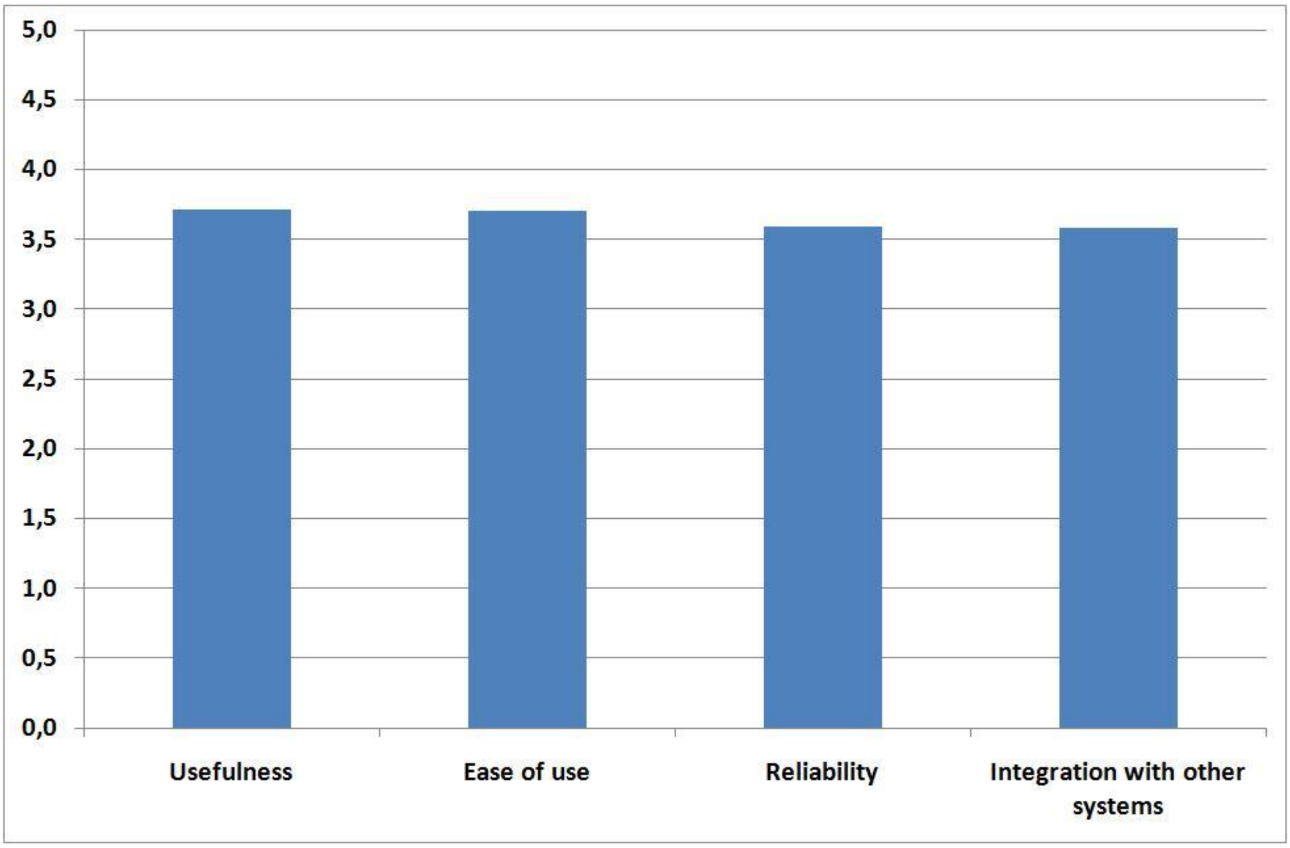

Figure 9 Castellon ex-post user acceptance indicators

The four user acceptance indicators measured, reported in Figure 9, provided the following results:

- Users were generally satisfied with the High-Tech Buses, with an average performance rate of 3.65;
- Usefulness and ease of use are the best rated indicators, with 3.7 as performance rating;
- The service was perceived as reliable and well integrated with the other systems, with both of the corresponding indicators rated 3.6.

The eight quality of service indicators measured, reported in Figure 10, provided the following results:

- Users perceived a high quality of service for the High-Tech Buses, with an average performance rate of 3.7;
- The information to use the system is available and comprehensible, with the corresponding indicators both rated 3.8;
- The system was perceived as comfortable, safe, secure and with a high level of privacy, and the ticketing was quite good (the corresponding indicators being all rated 3.7);
- The cleanliness of the system was also satisfactory (3.6).

The average rate of acceptance and quality of service indicators is little less than 3.7, meaning that the innovations due to the introduction of this ATS are well accepted by the users, who like this system to cover their travels between city centre, inner suburbs, outer suburbs and major educational and leisure facilities.

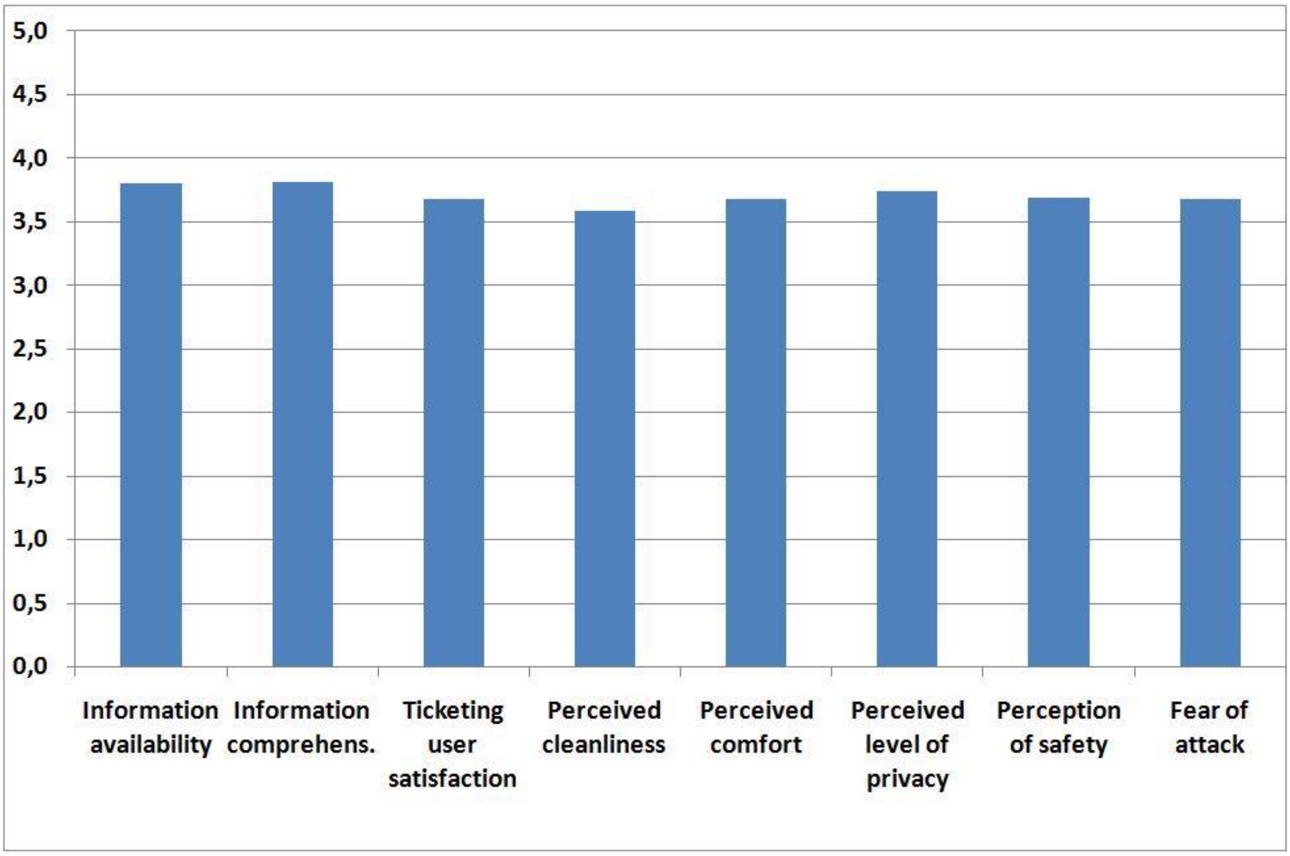

Figure 10 Castellon ex-post quality of service indicators

The system showed 15% modal share, with more than 1500 daily trips and more than 2200 daily passenger·km travelled, and 10% average vehicle occupancy. 12 minutes were required to cover the entire network in one direction, and the average interchange time required was little more than 2 minutes and a half. There were no delays per trip, because the system works on dedicated lanes.

The average waiting time was between 5 and 8 minutes during the weekdays, and the consequent system capacity was little less than 1000 passengers/hour.

The daily consumption of the vehicles was little less than 1000 kWh, with an energy efficiency of 0.44 kWh/pax·km. The Civis Cristalis did not produce noxious emissions in loco, thus the consequent emissions from the production of electricity of the system are NO_x =1.84 g/km, PM_{10} and/or $PM_{2.5}$=0.25 g/km, CO=0.15 g/km, CO_2=960 g/km. The acoustic emissions were about 74 dB, less than the 96/20 EC limit (80 dB).

The system resulted to be safe and required the same workload required for a conventional system. Only one manual correction of the automatic driving was required each 2-3 travels, and no repairs were required during the measurements.

The start-up costs of the system were about 23 000 000€, the correspondent operating and maintenance were about 438 000€/year.

The consequent financial Cost-Benefit Analysis (CBA) of the system with 20 year time horizon provided a Net Present Value (NPV) of -21 000 000€.

A socio-economic CBA was also done, to take into account the safety effects and the environmental benefits due to the introduction of the new high-tech bus system and to include such benefits for the community in the analysis of the system. Such benefits were made of three terms and monetized as follows: 1 360 000€/year as safety benefits, 241 000€/year as noxious emission reduction benefits, and 45 000€/year as benefits due to a better use of resources.

The consequent socio-economic CBA of the system with 20 year time horizon provided a NPV of 12 000 000€.

Such value means that the new system is socio-economically viable and that the installation of the system is convenient for the community. Considering the user acceptance of the system, such ATS appears to be socially convenient for the community and well accepted by people to cover their travels using it instead of the conventional systems.

Major transport node to city centre

In the major transport node to city centre scenario the technology evaluated is the Cybercar system of the Vantaa showcase, based on a public transport feeder service in the new area of Marja-Vantaa, whose description and evaluation are reported in the deliverable 5.2.1b.

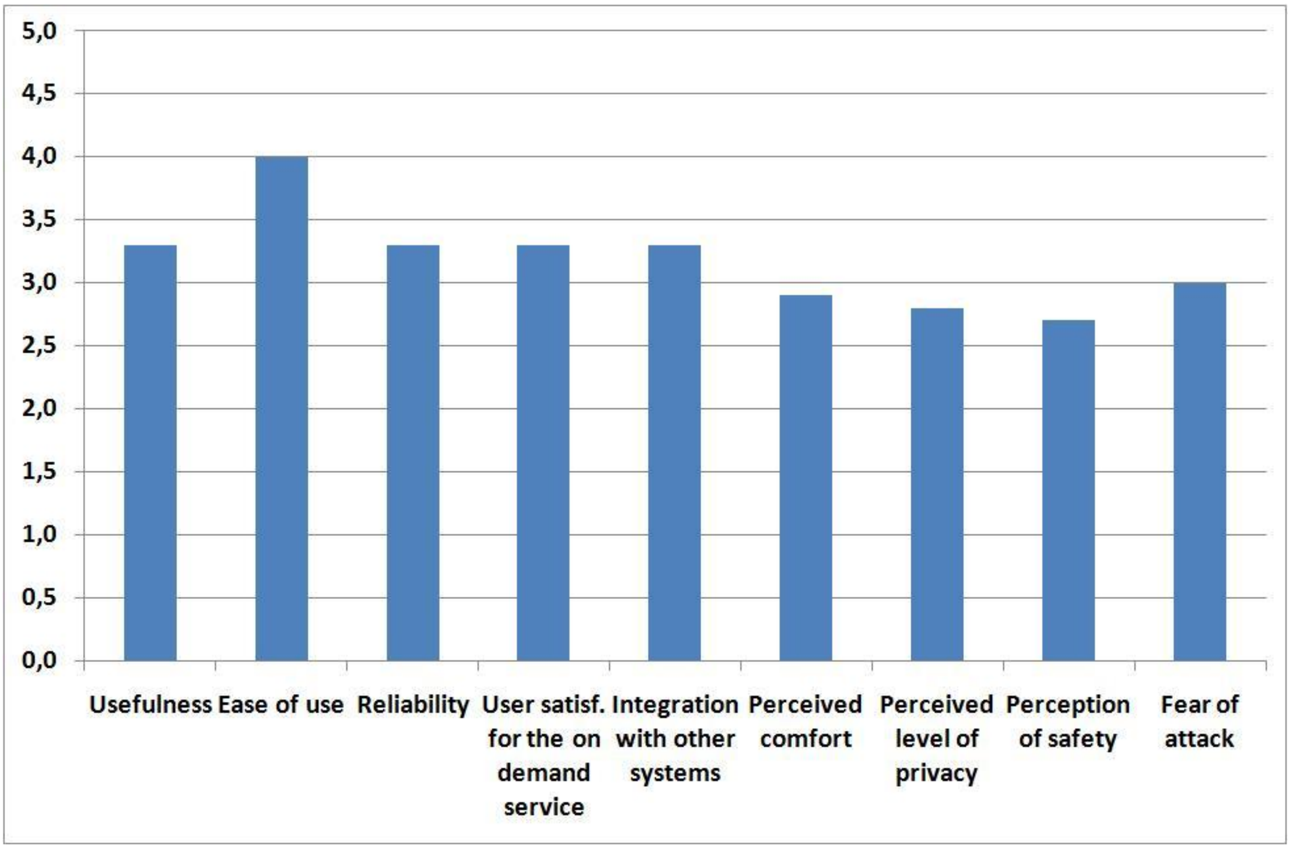

Figure 11 Vantaa ex-post indicators

Figure 11 shows the nine acceptance and quality of service indicators measured, which provided the following results:

- The users' evaluation of the Cybercars tested was sufficient, with an average performance rating of 3.2;
- The acceptance of the system was generally high, with ease of use as the best rated indicator (4.0) and an average value of 3.4 for the five indicators included;

- The quality of service has to be improved: the average rate of the four indicators was little less than sufficient (2.9), with fear of attack as the only one sufficient (3.0), even if the remaining three indicators very near to be sufficient.

The vehicles used in the Vantaa showcase were not last generation prototypes and they were not closed. Probably such features produced not positive impacts on the users for what concerns comfort, privacy, safety and security, as showed by the correspondent indicators.

However the results obtained lead to consider that the system tested in Vantaa can be applied with fairly satisfactory results for the users in linking major transport nodes to the city centre of a small/medium city as Vantaa. The problems linked with the users' low perception of quality during the showcase can be solved by using modern cybercars, more comfortable and safe than those used in the tests.

Major educational or service facility to major educational or service facility

In the major educational or service facility to major educational or service facility scenario the technology evaluated is the Cybercar system of the Trondheim showcase, based on a service provided in the St. Olav Hospital complex, whose description and evaluation are reported in the deliverable 5.2.1b.

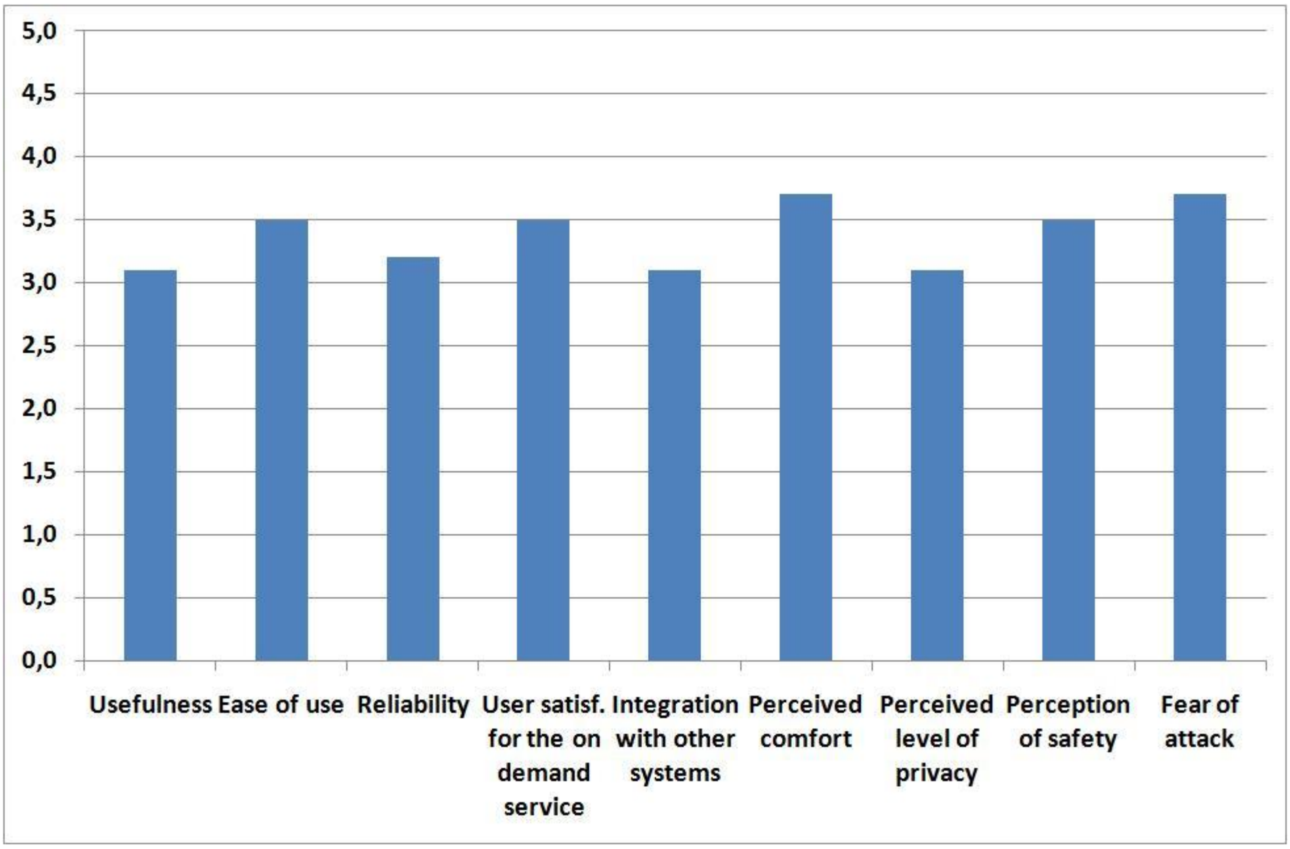

Figure 12 Trondheim ex-post indicators

Figure 12 shows the nine acceptance and quality of service indicators measured (the same considered in Vantaa), which provided the following results:

- The users' evaluation of the Cybercars tested was fairly good, with an average performance rating of 3.4;
- The acceptance of the system was generally high, with ease of use and user satisfaction for the on demand service as the best rated indicators (3.5) and an average value of 3.3 for the five indicators included;

- The quality of service resulted to be also high: the average rate of the four indicators was 3.5, with perceived comfort and fear of attack as the best rated indicators (3.7), a high perception of safety (3.5) and a sufficient level of privacy (3.1).

The vehicles used in the Trondheim showcase were the same type of vehicles used in Vantaa, beside a parkshutte. The parkshuttle presence can be directly seen by looking at the quality of service user perception, with indicator rates very higher than those obtained in Vantaa.

The results lead therefore to consider that the Cybercar system tested in Trondheim can be applied with very good results for the users in linking major educational/service facilities of a small/medium city as Trondheim, both in terms of acceptance and quality of service.

Major transport node to major transport node

In the major transport node to major transport node scenario the technology evaluated is the PRT of the Heathrow airport, designed to conduce people from the Business Car-park of the airport to the new Terminal 5 and vice-versa, whose description is reported in the deliverable 5.2.1a and the ex-ante evaluation is reported in the deliverable 5.2.1b.

Figure 13 shows the seven acceptance and quality of service indicators measured, which provided the following results:

- The users' evaluation of the PRT was quite good, with an average performance rating of 4.0;
- The ease of use was considered as the best feature of the system, with a rate of 4.3;
- Perception of safety and reliability was also considered as quite good, with rates of 4.1 and 4.0 respectively;
- The four remaining indicators were also good, with integration with other systems last rated, but with a high rate of 3.7.

Two further indicators (not included in acceptance and quality of service categories) were measured through the ex-ante interviews: perception of environment-friendliness and modern image of the airport. Both of them were quite sufficient, with rates of 3.5 for modern image of the airport and 3.2 for perception of environment-friendliness.

These results lead to consider that the potential users are well disposed for the PRT system for the Heathrow airport, which they consider as easy to use, comfortable, reliable, well integrated and without any problems due to its fully automatic configuration.

Major parking lot to suburban centre - Major parking lot to major transport nodes

For two different scenarios, major parking lot to suburban centre and major parking lot to major transport nodes, the technology evaluated is the Cybercar system of the Rome demonstration, which links the main car-park of the new building for the Rome exhibition to the railway station and to the building entrance. The wide description of the demonstration and the ex-ante evaluation are reported in the deliverable 5.2.1a.

Concerning the acceptance and quality of service indicators, only one of them (usefulness) has been rated with a different method, by expressing people satisfaction in a percentage scale, from 0 to 100%. The usefulness rate for Rome was 94%. For the other indicators of such categories, the interviews allowed to calculate the reference case and the threshold for success, to be used once the system will be operated and the ex-post evaluation will be done.

Another indicator, specific of the Rome demonstration, was rated with the same procedure: illegal parking tendency, showing a 62% rate.

Three transport pattern indicators were measured: 1) modal shift from private car to Cybercar system (60%), 2) daily passenger·km travelled (3200), and 3) Daily trips (14000).

Concerning the financial and economic indicators, the start-up costs of the system are 3 300 000.00€ and the operating costs 455 000.00€/year. With 25 000.00€/year as revenues, the Net Present Value of the Cost-Benefit Analysis (CBA) of the system with a time horizon of 10 years is about -7 000 000.00€.

The main results that outcome from the demonstration and showcase evaluations made can be summarized as the following:

- The ATSs tested were generally perceived as easy to use and useful to solve mobility problems in different contexts;
- The ATSs were also evaluated as reliable, mainly in those applications with a driver (High-Tech bus and Dual-Mode vehicles);
- The evaluations of comfort, privacy, safety and security are directly affected by the number and kind of vehicles available for demonstrations and showcases:
    - When there were a large number of options of vehicles available (La Rochelle and Trondheim), users considered the new concept of transport represented by the showcases and evaluated the indicators as positive;
    - When there were few kinds of vehicles available (Daventry and Vantaa), users took into account only the vehicles tested and did not consider the entire concept of transport, thus feeling not positive about such indicators.
- The different cultures can probably influence the evaluations of such new systems. Considering La Rochelle and Daventry, the indicator trends of the two showcases were similar, but the rates of those concerning Daventry seem to be translated into lower values than those concerning La Rochelle.

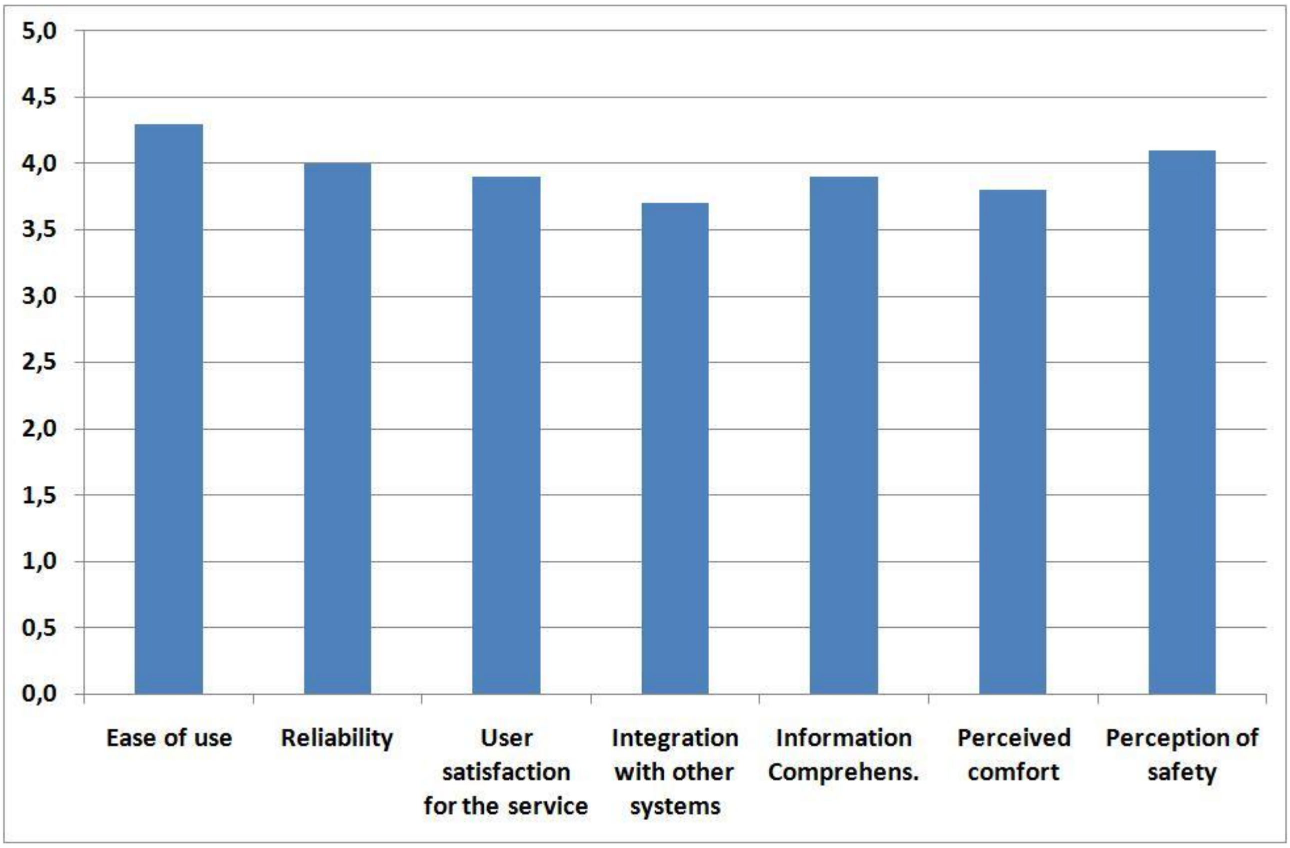

Figure 13 Heathrow ex-ante indicators

The complete Passenger Application matrix is reported in section 5 of this deliverable. It is the fourth release of the matrix, filled with the demonstrations and showcases evaluated at the moment in the WP5.2, and with the case studies reported in the deliverable 5.3.1b.

The matrix is on-going, because it is continuously filled with the data provided by the site evaluations; therefore each one of the future SP5 deliverables will show a further release of the matrix, filled with the data provided by the evaluations included in the deliverable, other than the data yet included in the matrix.

For example, in this deliverable the fourth release of the matrix is reported and includes both the ex-ante and the ex-post evaluations of Castellon in the cells regarding such demonstration, with the indicators measured and evaluated in both such evaluation phases.

Summarizing what concerns the rest of the Workpackage 5.2, two further deliverables will be made:

- D5.2.3 – Second ex-post report (focus on Heathrow) – delivery date: March 2011;
- D5.2.4 – Final ex-post report (focus on Rome and small demonstrations) – delivery date: April 2011.

In each one of them a new release of the Passenger Application Matrix will be reported, further filled with the data coming from the latest evaluations reported.