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1 Executive summary

The present document can be divided in two parts, the first one describes the situation of mobility in the city of Castellón before the implementation of the demonstrator; and the second one presents some features and characteristics of the vehicles used for the Castellón demonstrator within Citymobil project.

The part of the document regarding the mobility situation of Castellón before the implementation of Citymobil demonstrator will show how strong the need for the implementation of new transport means was in the City of Castellón. The situation regarding, for example, the number of daily trips in the urban area of Castellón show that the public transport needs to be incentivized in order to encourage people to change their transport habits from private to public. This information has been obtained from a set of surveys performed by the GVA in 2002. The conclusion of the mobility study that the GVA made in 2002 was that the need for a new public transport mean going from the city centre to the University was obvious. The Citymobil Castellón demonstrator has been included in the new city mobility plan.

The second part of the document shows the vehicles which have been considered for the Citymobil project. The document presents some of the main features of the IRISBUS, as this is the vehicle chosen for Castellón Citymobil demonstrator because of their optimized features due to the requirements given.

2 Situation before installation test

2.1 Mobility data

In 2002 the Public Transport Authority, the “Conselleria d’Infraestructures i Transport” carried out a survey on mobility (EDM) in Castellón and its Metropolitan Area to establish the number of daily trips by: car, bus, on foot, train and motorbike.

Concerning the information from EDM, in the Metropolitan Area of Castellón there are around 656.000 daily trips, of which more than a half are done by car. The following diagram shows the result of journeys and modal split.

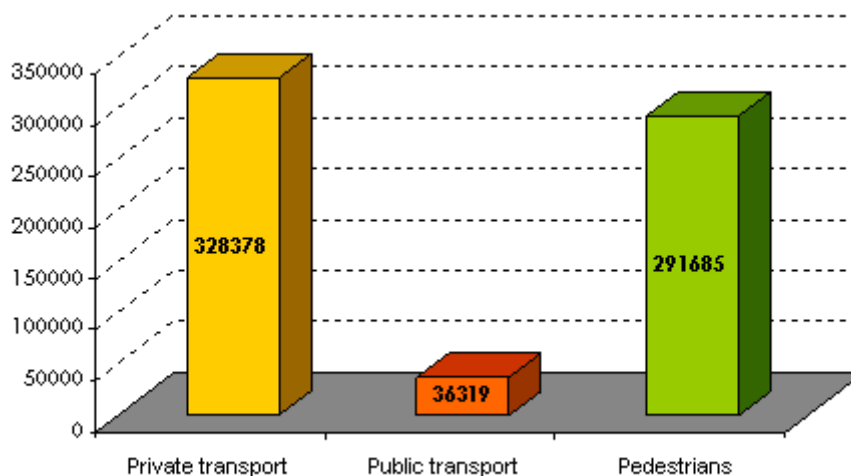


Figure 1. Results kind of trips survey

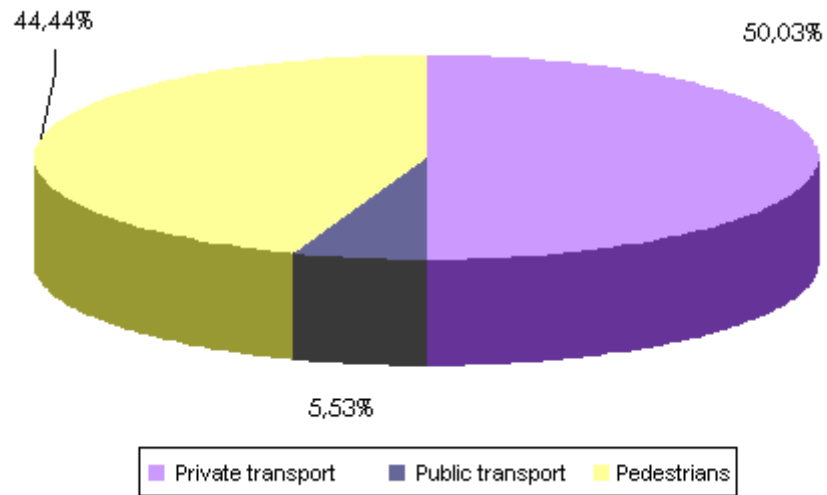


Figure 2. Modal distribution in the urban area of Castellón

Nevertheless, one important conclusion of EDM data analysis is the high percentage of journeys on foot within Castellón: more than 70% of trips are on foot, as it is in the following diagrams:

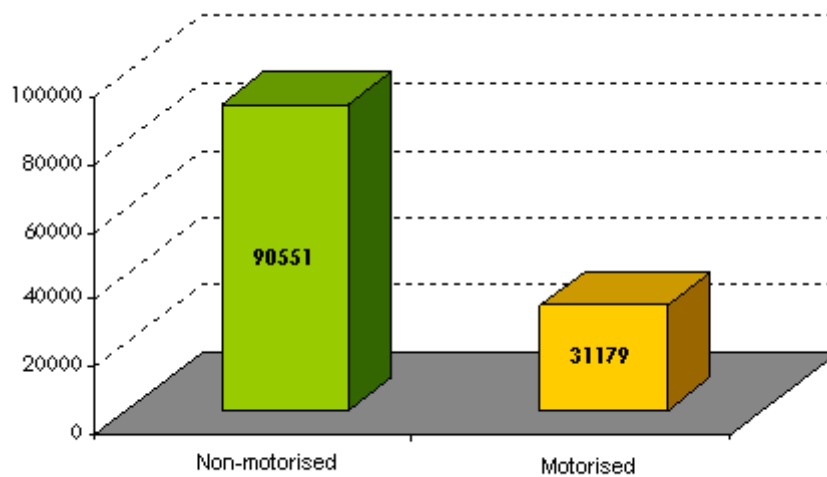


Figure 3. Pedestrian movements in the urban area of Castellón

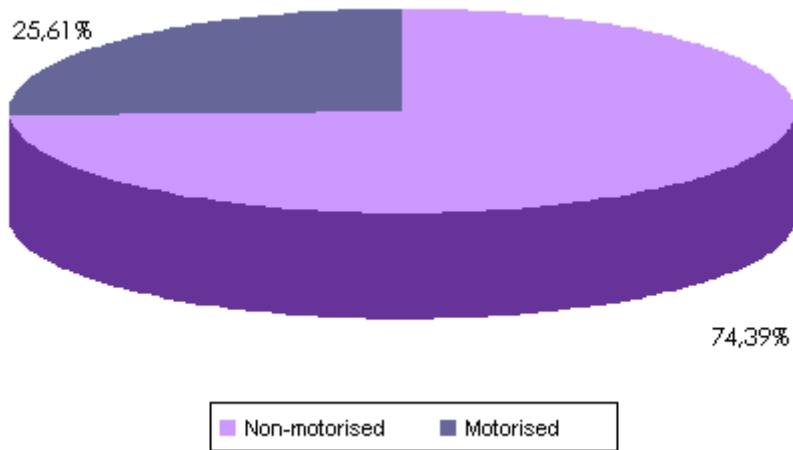


Figure 4. Pedestrian movements in the urban area of Castellón

This information is very important to understand the final result given by the system demand TVRCAS. Absolutely, this system, in its first operation stage, will attract basically part of the demand between the University Jaume I and city areas where it will go by, so the TVRCAS will be attractive to the city users and will improve the mobility system of the city.

2.2 Information from the bus network

Castellón de la Plana urban transport is ran in concession by ACCSA (private operator). The network of Castellón urban transport system counts with 12 bus routes, with 26 buses working on an interval of 30 minutes, (according to provided data by ACCSA).

This network covers the urban area, reaching also the outskirts as Jaume I University, General Hospital, sports center, Lidón Verge's Chapel and the industrial areas of Rafalafena and San Lorenzo.

The area called el Grao de Castelló de la Plana is not covered by the urban network, instead it is covered by an interurban route, ran by an other private operator.

2.2.1 Demand data

In the following table the routes that made up Castellón de la Plana urban bus network are shown, as well as its frequencies and volume on a working day.

LÍNEA	RECORRIDO	Intervalo Día Laborable	Expediciones día laborable (por sentido)
1	Polideportivo-Hospital General	30 min	30
2	Polideportivo-Hospital General	30 min	28
3	San Agustín-Rafalafena	60 min	13
4	San Lorenzo-Grapa	30 min	28
5	Ribalta-Basílica del Lledó	Sólo fines de semana y festivos	
6	Ribalta-Benadresa	30 min	29
7	Estación de RENFE-Universidad	20 min	19
8	Circunvalación	60 min	15
9	Estación de RENFE-Centro	10 min	97
10	Hospital General-San Lorenzo	60 min	14
11	Rafalafena-Renfe y Universidad	15-30 min	46
12	Rafalafena-Renfe y Universidad	15-30 min	46
Total			

Figure 5. Bus Lines of Castellón (frequency)

In a normal working day the activity is around 21 users / trip. To establish this estimation an average of 15.000 passenger / day by the total number of trips from table 2 has been taken into account. The busiest route is number 12, with an average activity around 26 users / trip on a working day.

Taken into account that urban bus has 60 to 80 seats, the average activity data calculated shows the low use of urban transport system.

2.2.2 Supply data

Castellón de la Plana urban bus network carries daily around 15.000 travellers (according to 2001), being route number 1 the busiest, which goes from north to south across the city from the General Hospital to the sports center, as well as route number 12, which goes from east to west across the centre linking with the University. Both routes exceed 2.000 passengers on a working day, figure to which are nearly routes number 9 and 11.

LÍNEA	RECORRIDO	VIAJEROS/DÍA
1	Polideportivo-Hospital General	2.339
2	Polideportivo-Hospital General	1.564
3	San Agustín-Rafalafena	515
4	San Lorenzo-Grapa	1.420
5	Ribalta-Basílica del Lledó	
6	Ribalta-Benadresa	1.244
7	Estación de RENFE-Universidad	384
8	Circunvalación	541
9	Estación de RENFE-Centro	1.869
10	Hospital General-San Lorenzo	335
11	Rafalafena-Renfe y Universidad	1.928
12	Rafalafena-Renfe y Universidad	2.375
Total		14.514

Figure 6. Castellón's Bus Routes (Passengers / day)

3 Requirements regarding the vehicles

3.1 Hybrid vehicles

After analysing the needs of the system to be implemented in Castellón it was agreed that the vehicles to be used for the project would have to be hybrid. The energy power supply will come either from external suppliers, such as an aerial contact electric line – catenary -, batteries or from an internal combustion engine that should move the electric engines providing them the necessary energy for the correct performing.

The possibility of choosing the electric or fuel mode will be available for every stretch of the lane in the demonstrator, this will provide the system with a high and efficient performance as it will be possible to use the best motion mode for each situation. When the vehicles are running in fuel mode the system should have enough autonomy to cover all the stretches of the route where the aerial electric line cannot be installed and to allow the vehicle to arrive to the garage.

The electric mode will be the most preferable in the major part of the route as it will allow the vehicle to operate at maximum efficiency with a low level of noise and polluting emissions.

The dual-mode operation system should allow the changing of modes in an easy and smooth way so that stopping or manual operation is no needed to change from one mode to the other. This easy and seamless operation will allow the insertion of the vehicles in the urban area, giving the system the possibility to operate most of the time in electric mode and in fuel mode only when needed.

3.1.1 Driving (Vehicles behaviour within/outside the dedicated lane)

The starting is carried out by a three position switch:

- O: stop
- A: auxiliary
- M: departure.

A security system built-up to the driver door allows inhibit traction.

The vehicle can operate in three different driving ways: normal, manoeuvre and autonomous.

3.2 Capacity

The capacity of the proposed vehicle for the test counts with maximum seats of 30% and 4 or 6 people by square metre. In this way, IRIBUS' capacity is 62 seats (taking into account 4 people each square meter), or 83 seats (taking into account 6 people each square meter).

3.3 Size

Width

Civis-Cristalis' vehicle is **2,55 m.** width excluding the rear-view mirror and pilot lights, fulfilling european rules.

The sliding doors are **no wider than 120 mm**.

Height

The interior minimum height is 2m along the vehicle to standing passengers

Length

12 m long.

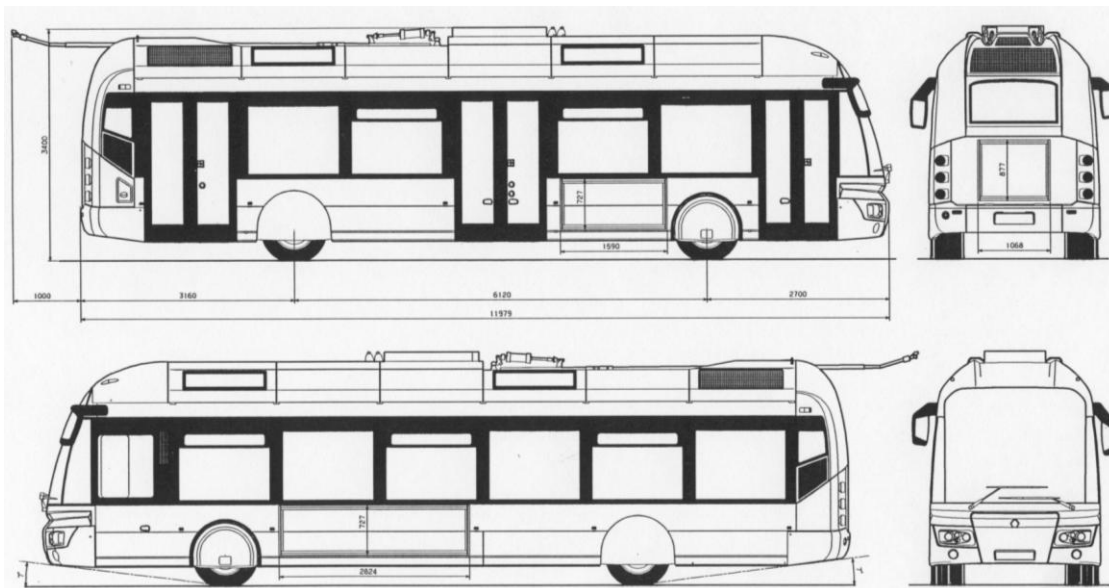


Figure 7. Buses size

Turning radius

The external and internal turning radius is lower than 12m and 6m respectively.

Weight

Restrictions considered for urban vehicles addressed to public transport:

Two restrictions by Spanish regulations are taken into account and one technical.

- Total authorized weight: 20.000 kg.
- Total authorized weight against rear axis 13.000 kg,
- Total authorized weight 7.245 kg against leading axle.

In the table below are shown weights:

	Empty (stimated, in kg)	Loaded (1st stimation, in kg)
Total weight	13.334	19.726
Leading axle weight	4.499	7.225
Rear axis weight	8.835	12.501

Thermal insulation

There is double insulation in equipment and circuits. Also, the vehicle counts with triple insulation in doors and handle doors.

The vehicle proposed fulfils CEI 94 insulation regulations.

3.4 Automated Guidance

Guidance Principle

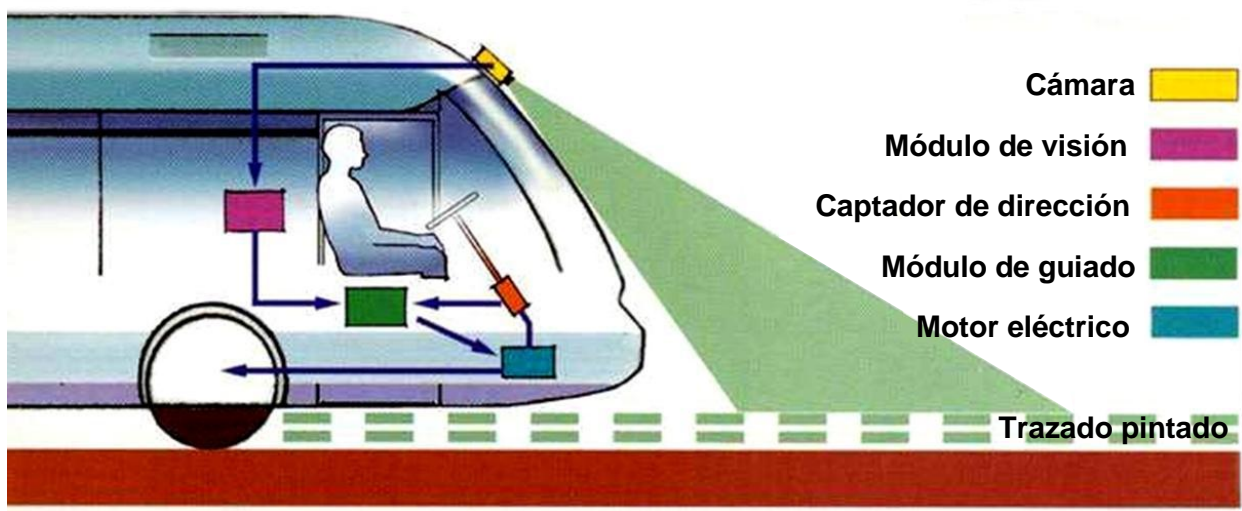


Figure 8. Optical Guidance

An optical guidance system CIVIS is proposed that allows following automatically an identified trajectory through ground marks, acting against vehicle's direction, while the driver is controlling the vehicle and keeping the itinerary watched.

The mark is read thanks to a video camera located on the front side of the vehicle, and is analysed instantly with the aim to set the difference between the real trajectory and the reference one. A servo-control device includes a motor that acts against the steering with the aim to cancel this difference.

The guidance system ensures high quality services, guarantee minimum trajectory detour and good stop alignment.

4 Available vehicles

There are different kinds of proposed vehicles to be used in TVR system platform. Technical information of different vehicle manufactures has been searched for Castellón system. A TVR/GLT system has been ruled out since entails magnetic or physical guidance system, because they will not be installed in the network platform of Castellón. So, it has not been taken into account the vehicles features such as TVR by Bombardier, with wheel turning tyre but total or partial physical guidance, like TRANSLOHR, that only can be operated with physical guidance through the central lane.

The vehicles chosen in the present document are:

- CIVIS/CRISTALIS by IRISBUS.
- TROLLINO by SOLARIS.
- A330T by VANHOOL.
- Vehicles of Neoplan, MAN and HESS Vehicles BT-N3 of HESS – VOSSLOH – KIEPE

The following pictures depict the different models to be chosen for the proposal:



Figure 9. CIVIS/CRISTALIS model from IRISBUS



Figure 10. TROLLINO model from SOLARIS



Figure 11. A330T model from VANHOOL

All of them fulfil speed and acceleration/deceleration requirements needed to run at the platform. The maximum length, depending on the model, goes between 12,00 to 18,00 for the articulated ones. It is not foreseen in Castellón the use of articulated vehicles at this stage, nevertheless it has been tested, in the maximum height sign analysis, that turning radius and obstacles are compatible with vehicles of different lengths.

Each vehicle has several curves of speed/time and consume/time. Several curves have been consulted, shown in the simulation section, but for the functional analysis it has adopted an acceleration kind that can be considered as enclosure in most graphics studied.

So, the acceleration/deceleration and speed in simulation has been:

$$a = 1,3 - 0,03 \cdot t \quad a \text{ in } m/s^2, v \text{ in } m/s$$

$$v = 1,3 \cdot t - 0,03 \cdot t^2$$

Maximum speed restriction V_{max} in each stretch is 20, 40 ó 50 km/h. The braking rate has a value of $1 m/s^2$ constant.

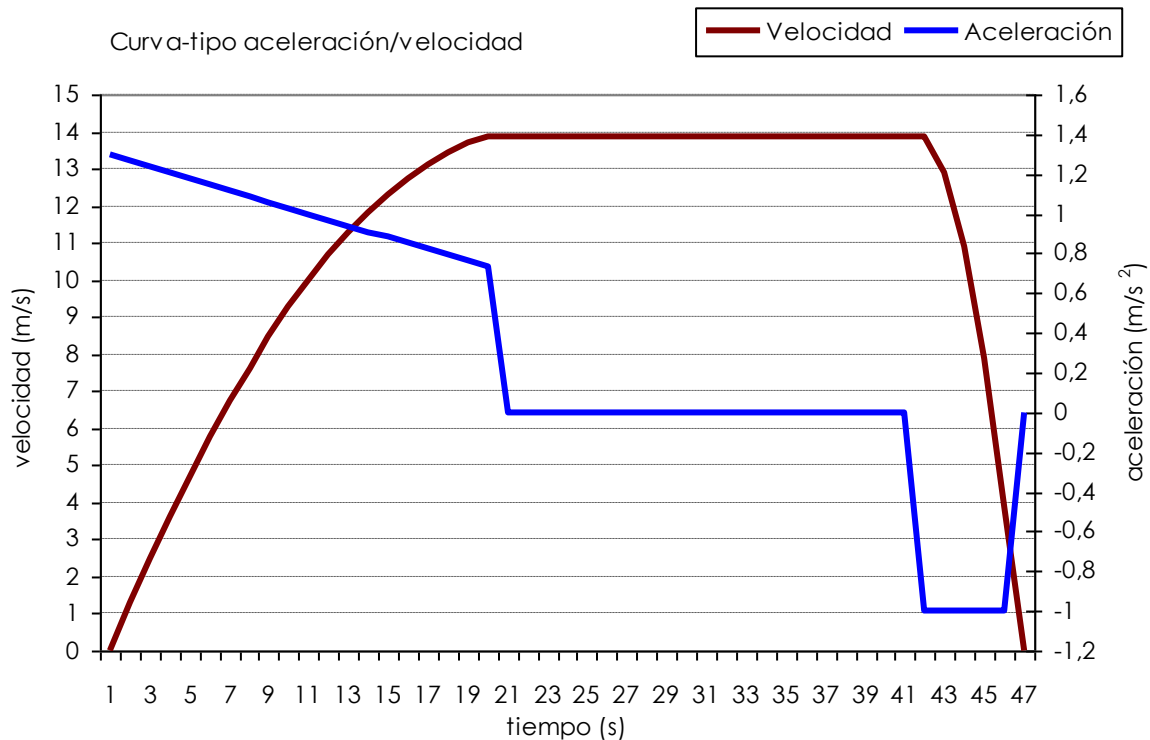


Figure 12. Acceleration / Speed curve

5 Rolling Stock

The last part of the document shows the vehicles which have been considered for the Citymobil project, and through the document, some of the main features of IRISBUS vehicle are described, as this is the vehicle chosen for the project because of their optimized features due to the requirements given.

The ideal chosen vehicle for Citymobil project has been the Civis-Cristalis dual-mode operation vehicle proposed by IRISBUS.

This dual mode vehicle allows operating by overhead electric power supply or in autonomous diesel mode (restricted to 2 km).

The rolling stock is made up with three Iveco's "Civis" units, this has meant an investment of 2,626,014 € and one "Elettrico Panteon U620E" unit made by Tecnobus which has meant an investment of 263,900 €

5.1 IVECO Civis

The vehicles selected for the line are 12m-long Civis new-generation trolleybuses manufactured by Irisbus Iveco. They feature electric wheel-motors housed in the rear wheels: this eliminates bulky components such as the gearbox and driveshaft, thus creating a low, flat floor right along the bus. Castellon's Civis buses have full airconditioning and Iveco medium-power diesel engines, which provide necessary power when their trolley poles are not connected to the overhead power lines.

Accommodating 22 seats, including two wider seats for persons with reduced mobility, and a space for a wheelchair passenger, these vehicles are capable to transport up to 78 passengers.



Figure 13. Civis bus in Castellon Demonstration

5.2 Elettrico Panteo U620E

This is an electric battery engine vehicle. Its maximum speed in urban route is 30 km/h. The vehicle is 6.2 meters long and is capable to transport up to 24 passengers and one person with reduced mobility.

Fortified by the excellent driving range results already obtained by our vehicles in the base version equipped with acid lead batteries, TECNOBUS has further differentiated its bus models so as to offer its clients quite a number of alternatives. Actually, such fundamental parameter can be considered as almost unlimited, even in practical terms, during the bus daily service, thanks to the exclusive battery pack replacement system which makes that one operator can very easily replace the empty batteries in a matter of just a few minutes and without any special tool other than a transpallet, even the manual type.



Figure 14. Pantheon in Castellón Demonstration

6 Conclusions

Through the document, it can be observed the good criteria used in choosing the vehicle from IRISBUS, due to its optimal performance in the required features of the Citymobil project.

As a conclusion, it must be stated the thought that the implantation of the Citymobil Demonstrator in Castellón will help to increase public transport use regarding the private transport use. This will, with no doubt, have positive consequences in decreasing the traffic density of the area, as well as increasing the use of an environmental friendly transport mode having an expected positive impact on users and Castellón inhabitants' satisfaction.

7 Sources

7.1 Reference List

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