Executive summary

Through ARCHIMEDES measure number MNZ 81 ("UTC System in Monza"), several intersections are controlled by the Urban Traffic Control (UTC) System which implements the coordinated and centralised control of traffic lights. The UTC system selected is called RoadManager®. It is designed and implemented by Project Automation, technological partner of the Municipality of Monza in the ARCHIMEDES project. Please see Deliverables R81.1 and T81.1 for details.

Through ARCHIMEDES measure number MNZ 78 ("Bus Management System in Monza"), the 80 buses of the urban Public Transport fleet are localised and monitored closely, i.e. it is known where each bus is with respect to its scheduled timetable. Localisation and Monitoring data are immediately published through a Webservice, whose template has been agreed in the research stage. In particular, data published through the Webservice refer to the stop or the transit of a bus of the fleet at a relevant bus stop of the city Corridor. Please see deliverables R78.1 and T78.1 for details.

This measure MNZ82, Public Transport Priority System in Monza, is concerned with implementing a framework that allows for the traffic light plans of the intersections (managed by the UTC system) to adapt when the actual situation of the buses would benefit from more green time at these intersections (as long as the overall traffic status allows this).

In the RTD stage, a study has been undertaken by Project Automation, in agreement with Comune di Monza and with Nord-Est Trasporti (NET) which is the owner of the Public Transport fleet, to propose a conceptual framework to manage Public Transport Priority at the relevant intersections. Results have been deeply described in Deliverable R82.1**.** In summary, they consist of:

- a first "Decision Module (hereinafter called DM1)" which has the role to receive priority requests issued by buses approaching the intersections of the Corridor and to decide whether to consider them eligible to be served or not;
- a second "Decision Module (hereinafter called DM2)" which filters all the incoming priority requests for each intersection, deciding which of them (one or more, if compatible) will be served by the UTC system;
- an"Interface Module" which must translate the winning priority requests to specific commands that the UTC system can process and activate.

In the demonstration stage, four intersections of the CIVITAS Corridor for Public Transport have been equipped with the devices necessary for them to be put under the control of the UTC system. These devices allow application of the Priority Management scheme that emerges from the study carried out in the research stage, outlined above.

Evaluation activities have been aimed at measuring the results achieved, expressed through the following key results:

- The proposed approach has been successfully implemented; the results, in terms of impact evaluation, have not generated travel time reduction (0%). The main reason is the high level of congestion that is influencing a large part of the city of Monza the corridor belongs to; this is due to a significant reduction of the throughput of the western external ring since 2008 that will continue up to April 2013, when a new 2 km long urban tunnel will be completed. The expectation in April 2013 is that this measure will become fully effective and travel time reduction will be reached.
- As far as social indicators are concerned, the introduction of PT priority is not well known yet, probably due to the recent start-up and to their use only in some lines; it is anyway considered useful and impacting positively on pollution level, but for frequent users this is not enough to change their approach to public transport and use it more and more; probably, only an extended implementation and aware use of these innovations can really change users' approach.
- In terms of process evaluation, some barriers have been encountered, asking more time than expected to design, implement and test the software suite made operational within Archimedes. Nevertheless, the software suite has been successfully completed and will be used after the expiration of Archimedes.

A Introduction

A1.1 Objectives

The measure objectives are:

(A) High level / longer term:

- To render Public Transport more effective and appealing for day-by-day use.

(B) Strategic level:

- To improve commercial speed of Public Transport Fleet.

(C) Measure level:

(1) To experiment on several critical intersections the Public Transport Priority strongly interconnected with the UTC system.

A1.2 Target groups

- Users of public transport
- Car drivers:
  (1) Commuters from outside
  (2) Commuters from inside
- Fleet operators

A2 Description

In the context of encouraging sustainable mobility, the use of Public Transport in the City of Monza needs to be increased. In order to achieve this objective, within the ARCHIMEDES framework a clear decision has been made, which has the full support of the government of the Municipality. This is based on the implementation of technological measures to make Public Transport more attractive to citizens.

Through measure MNZ 81 ("UTC System in Monza"), several intersections have been controlled by the Urban Traffic Control (UTC) System which implements the coordinated and centralised control of traffic lights. The UTC system selected is called RoadManager®. It is designed and implemented by Project Automation, technological partner of the Municipality of Monza in the ARCHIMEDES project. Please see Deliverables R81.1 and T81.1 for details.

Through ARCHIMEDES measure MNZ 78 ("Bus Management System in Monza"), the 80 buses of the urban Public Transport fleet are localised and monitored closely, i.e. it is known where each bus is with respect to its scheduled timetable. Localisation and Monitoring data are immediately published through a Webservice, whose template has been agreed in the research stage. In particular, data published through the Webservice refer to the stop or the transit of a bus of the fleet at a relevant bus stop of the city Corridor. Please see deliverables R78.1 and T78.1 for details.

This measure (MNZ 82, Public Transport Priority System in Monza) is concerned with implementing a framework that allows for the traffic light plans of the intersections (managed by the UTC system) to adapt when the actual situation of the buses would benefit from more green time at these intersections (so long as the overall traffic status allows this). Please see deliverables R82.1 and T82.1 for details.

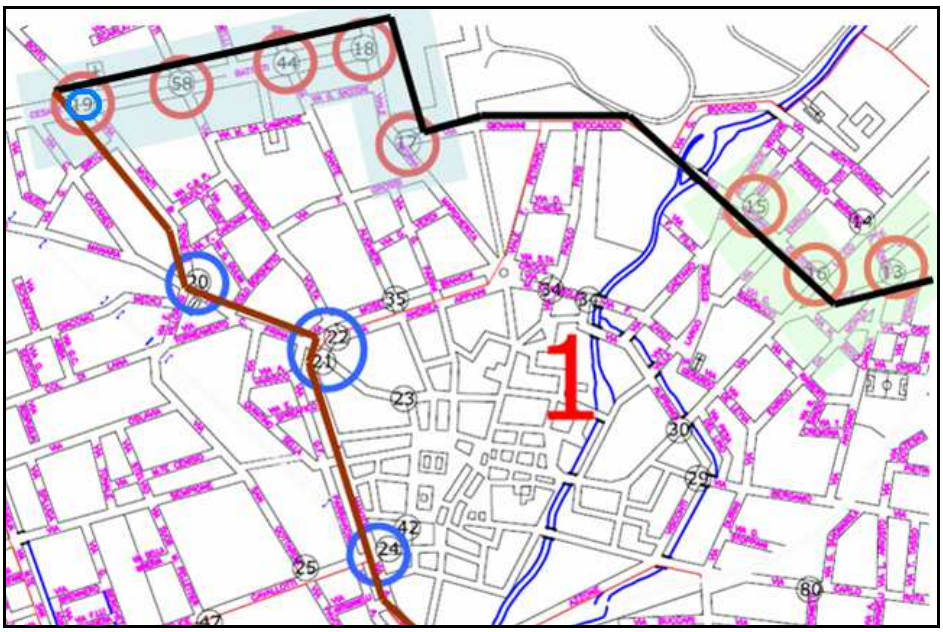

Figure 1 - Monza corridors

In Figure 1 the two Archimedes corridors are presented; the one which is brown-coloured is the Public Transport corridor considered in Measure MNZ 82. The choice for this specific corridor is due to the fact that many Public Transport routes run on it. One intersection (no. 19) is common with the first Archimedes corridor.

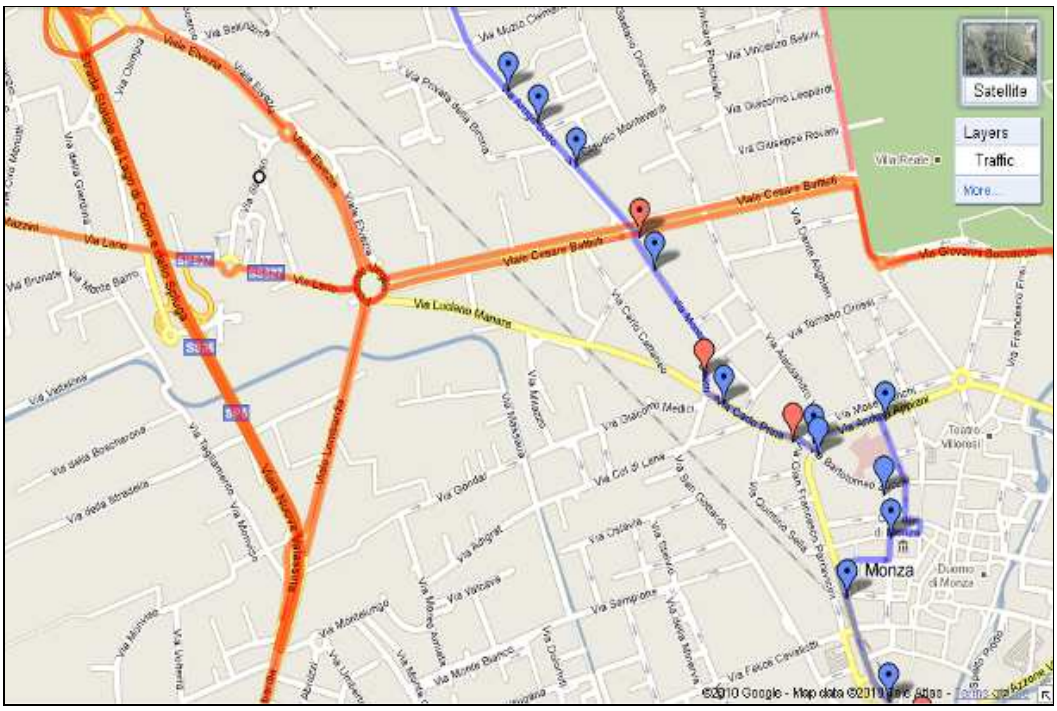

Figure 2 - Bus stops along the Corridor where AVL/AVM data are generated (Automatic Vehicle Location and Monitoring)

In Figure 2 the detailed position of bus stops along the corridor are shown. Each bus stop has an unique identifier; red knots show virtual bus stops: they have been declared to the system in order to gather the position and the delay of the bus when the time spent by the bus itself to complete that stretch of road is too long to provide an affordable data. This is the typical situation of the congested timeframe.

A3 Person in charge for evaluation of this measure

Name of person	Paolo Giuseppe CONFALONIERI
Name of organisation	Project Automation SpA (PA)
Direct telephone	+39 039 2806283
e-mail	paolo.confalonieri@p-a.it

B Measure implementation

B1 Innovative aspects

The innovative aspects of the measure are:

- **New conceptual approach** – The capability to exploit the information gathered by AVL/AVM system (Automatic Vehicle Location and Monitoring) and to forward the relevant ones to an Urban Traffic Control system is a new challenge for the city of Monza. The former trial experienced in Monza in the 1990s to unconditionally assign more green to buses was unacceptable. Nevertheless, the need to favour buses in a selective way and only when possible in the overall traffic scenario is very important.
- **Use of new technology/ITS** – UTC Urban Traffic Control system with enriched functions to manage in intelligent way also the dispatching of priority actions for buses of the Public Transport Fleet systems is a classical ITS application for traffic management. As for measure MNZ 81, the adoption of this approach is a new issue for Monza, also on the technological point of view.
- **Targeting specific user groups** – This measure will primarily address the Public Trasport users which will gain shorter travel times. Also car drivers and commuters will benefit from a more intelligent management of Traffic Lights. These user groups are very numerous so the results achieved will have significant impact. Last but not least, the Public Transport Operator might gain benefits increasing the regularisation of the service.
- **New organisational arrangements or relationships** – The adoption of an UTC system with enriched functionality to manage in intelligent way also the dispatching of priority actions for buses of the Public Transport Fleet will lead Traffic managers of the Municipality as well as the managers of the Public Transport Company to define new rules of behaviour. The needs expressed by the two management teams could be antithetical: one of the main objectives of the Public Transport Company is to increase the commercial speed, saving costs and increasing the quality of service; on the contrary, traffic managers of the Municipality must ensure that all the traffic components are correctly managed. Best practices on this issue show that in highly congested road networks, the main objective function is to achieve a good trade off between the needs of Public Transport fleet and private traffic need. The framework that will be carried out in this project will stress this issue.

B2 Planning of Research and Technology Development Tasks

Task 11.8.6 Public Transport Priority Management Study:

A study has been undertaken by PA to define the policies to be applied to the UTC system to prioritise public transport movements to reduce delays to these services. A software module has been accordingly designed and developed. The details are described in the deliverable R82.1. The software module developed consists of:

- a first “Decision Module (hereinafter called DM1)” which has the role to receive priority requests issued by buses approaching the intersections of the Corridor and to decide whether to consider them eligible to be served or not;

- a second “Decision Module (hereinafter called DM2)” which filters all the incoming priority requests for each intersection, deciding which of them (one or more, if compatible) will be served by the UTC system;

- an “Interface Module” which must translate the winning priority requests to specific commands that the UTC can process and activate;

- programming of the UTC system to manage the priority request.

As far as the policies to manage priority requests, such policies have been proposed by the Traffic Managers of the Municipality of Monza, in order to achieve a common view on this issue and to avoid conflicts on the ways to satisfy priority requests for PT fleet. The basic concept is that only buses travelling with a delay of few minutes or more can issue priority requests; preliminary analyses on one significant intersection have shown that if the threshold is 3 minutes, about 15% of bus will issue a priority request; if the threshold increases at 5 minutes, such percentage decrease to 5%.

B3 Situation before CIVITAS

Monza implemented a Priority system for Public Transport buses in the 1990s. This system was constituted of Infrared sensors installed at the intersection able to communicate with the buses approaching such intersections; as the communication was established, the Traffic Light Controller could adjust its timing to extend green time for buses. The system was tested in some circumstances but did not become fully operational; one of the reasons was that the dynamic modification of the traffic light plan without keeping into account the traffic in the neighbourhood caused unmanageable congestions.

B4 Actual implementation of the measure

Task 8.17 Public Transport Priority System

The demonstration stage for this measure has been implemented through the following tasks:

Stage 1: Analysis of actual behaviour of buses *(April 2011 onwards)* – Data made available by Measure MNZ 78 (AVL/AVM system) have been gathered through the Webservice specifically developed for the Archimedes needs; data is continuously collected and stored in a relational database created for this purpose; such data has been collected for the Public Transport lines involved (z206, z266) since April 2011 in order to analyse the respect of timetables as well as the most critical situations.

Stage 2: Collection of measurements from the UTC System *(February 2012 – April 2012)* – In this stage, the intersections managed by the UTC system affected by Public Transport lines have been made operational and loaded with a set of plan able to satisfy priority requests. In particular, the following activities have been achieved:

- (2.1) analysis of actual performances of the Public Transport Lines involved (z206, z266), to study for the relevant intersection which can be the degree of satisfaction of priority requests with respect to profile of private traffic.
- (2.2) confirmation or re-definition of the criteria to be applied in the day-by-day operations concerning the processing of priority requests.
- (2.3) plan coding and laboratory test to allow the installation in the real environment.

Stage 3: Analysis and improvement of the performance of the System *(April 2012 –*

September 2012) – This stage has been devoted to provide data and information to the Evaluation Stage.

Stage 4: Evaluation stage *(May 2012 – December 2012)* - During this stage measurements have been taken to carry out impact evaluation.

B5 Inter-relationships with other measures

The measure is related to other measures as follows:

- **At the site level**: This measure is tightly related to Measure MNZ 81; the UTC system made operational is a prerequisite to manage also PT priority requests.

– **At the measure level**: The Municipality of Monza will refer to Measure DSS 16, "High Quality Bus Corridor in Donostia – San Sebastian" and to Measure IAS 14 "Bus Priority Measure - Iasi" to share the policies adopted to implement PT Priority

C Impact Evaluation Findings

C1 Measurement methodology

C1.1 Impacts and indicators

C1.1.0 Scope of the impact

The indicators chosen in the table below were selected as directly related to the introduction of the measure.

The indicators relate to:

Economy – neither costs nor benefits are considered, since the intersections involved have to be centralised through the UTC as described in Measure MNZ 81 and the economic issues are faced there.

Energy – no indicators of this group are considered: even if a more fluid traffic implies reduction in fuel consumption, and buses cross the intersection quickly, the impact on energy reduction is negligible.

Environment – air quality, noise and emissions are not affected by this measure.

Society – Awareness and acceptance will be assessed through surveys described in the core of the Local Evaluation plan, directed to cover the several issues concerning Public Transport (reduced travel time – this measure, better information – see measure MNZ 79)

Transport – impacts concerning Quality of Service and Transport System are considered and they will be measured, both before and after the interventions, as described in the sequel.

The intersections involved are the following (please refer to Figure 1):

- 19- Battisti – Monti e Tognetti – Boito;
- 20- San Biagio (Monti e Tognetti, Prina, Villoresi, Manara);
- 21/22- Zucchi – Parravicini – Manzoni – Appiani (these two intersections are very close the one to the other, so they are managed as a single intersection, even if numbered by the Municipality as two distinct intersections)
- 24- Cavallotti – Passerini – Manzoni

Measure title: **Public Transport Priority System in Monza**

City: **Monza** *Project:* **ARCHIMEDES** *Measure number:* **82**

C1.1.1 Selection of indicators

NO.	EVALUATION CATEGORY	EVALUATION SUB-CATEGORY	IMPACT	INDICATOR	DESCRIPTION	DATA /UNITS
	SOCIETY					
13		**Acceptance**	Awareness	Awareness level	Awareness of the policies/measures	Index (%), qualitative, collected, survey
14			Acceptance	Acceptance level	Attitude survey of current acceptance of the measure	Index (%), qualitative, collected, survey
	TRANSPORT					
18		**Quality of Service**	Quality of service	Quality of service	Perception of quality of PT service	Index, qualitative, collected, survey
24a		**Transport System**	Time to drive	Route Travel Time	Average travel time of buses over the Public Transport Corridor	seconds, quantitative, measured

Tabella formattata

C1.1.2 Methods for evaluation of indicators

No.	INDICATOR	TARGET VALUE	Source of data and methods	Frequency of Data Collection
13, 14	Acceptance	Evaluating users' awareness and acceptance of the Bus Priority service in Monza	Surveys have been conducted to measure awareness level of users of PT Service in order to measure whether people actually change their behaviour or their attitude because of Info-bus system. Surveys have been organized at bus stops with interviewers who question people about their perception of measure implementation. The survey will cover also qualitative aspects of other PT measures like measure MNZ07 (Hybrid Bus) and MNZ 82 (PT priority) The sample considered has been of 240 people, chosen between normal users of PT service. The face to face method should reduce percentage of mistakes in the survey.	Data will be collected twice: once before the installation of the devices (May 2011) and once after the installation (June 2012)
18, 19	Quality of service	Evaluating customers' satisfaction for Public Transport users	The survey conducted for indicators 13 and 14 will address also the Quality of Service of the users of Public Transport fleet	Data will be collected twice: once before the installation of the devices (May 2011) and once after (June 2012

Tabella formattata

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No.	INDICATOR	TARGET VALUE	Source of data and methods	Frequency of Data Collection
24a	Route Travel Time	Average bus travel time in PT Corridor	AVL/AVM system interfaced through Measure MNZ 78	Data continuously collected and stored into a relational database

C1.1.3 Planning of before and after data collection

EVALUATION TASK	INDICATORS INVOLVED	COMPLETED BY (DATE)	RESPONSIBLE ORGANISATION AND PERSON
Evaluating awareness and acceptance	Evaluating users' awareness and acceptance of the Bus Priority service in Monza	Month 32 (before data) Month 45 (after data)	Comune di Monza - Simonetta Vittoria
Evaluating quality of Service	Evaluating customer satisfaction	Month 48 (after data)	Comune di Monza - Simonetta Vittoria
Evaluating route travel time of Public Transport buses	Route Travel Time	Month 48 (after data)	Project Automation – Paolo G. Confalonieri

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C1.2 Establishing a Baseline

As far as the traffic light plans are managing these intersections, the baseline situation was the following:

- Intersection 19- traffic light plan running in the local traffic light controller not coordinated with any other plan managing neighbouring intersections and unable to adapt its behaviour;
- Intersection 20- traffic light plan running locally at the intersection with four main stages (1-Villoresi-Monti e Tognetti, 2-Prina, 3-Manara, 4- only pedestrians)
- Intersection 21/22 traffic light plan running locally at the intersection;
- Intersection 24- traffic light plan running locally at the intersection;

C1.3 Building the Business-as-Usual scenario

As already mentioned in the MLEP for Measure MNZ 81 (UTC System in Monza), without the implementation of the UTC system and the link with the AVL/AVM system no other approaches for Public Transport Priority have been applied by the Municipality.

Therefore, in the Business as Usual scenario, without Traffic Light management for Public Transport Priority, the situation would be the same as in the baseline framework.

C2 Measure results

The results are presented under subheadings corresponding to the areas used for indicators – economy, environment and transport. The other sections are not relevant with this measure.

C2.1 Economy

Not Applicable.

C2.2 Energy

Not Applicable.

C2.3 Environment

Not Applicable.

C2.4 Transport

As far as the traffic light plans are managing these intersections, the framework proposed within Archimedes is the following:

- Intersection 19: traffic light plan designed and made active within Archimedes measure MNZ 81 through the UTC system; this plan is coordinated with the plans active on the other two intersections on viale Battisti, not affecting Public Transport;
- Intersection 20: traffic light plan running locally at the intersection, specifically redesigned within Archimedes project in August 2011; this intersection has been centralised through the UTC system with the same traffic light plan structure running on the local controller;
- Intersection 21/22: traffic light plan designed and made active within Archimedes project, under the control of the UTC system;
- Intersection 24: this intersection has been centralised through the UTC system with the same traffic light plan structure running on the local controller.

Table C2.4.1:

Indicator	Before (date)	BaU (date)	After (date)	Difference: After – Before	Difference: After - BaU
No. 24a: Route Travel Time (to Centre)	Median: 724 seconds 75° percentile: 869 secs 90° percentile: 1129,4 secs	N/A	Median: 744 seconds 75° perc: 870 secs 90° perc: 1118 secs	20 seconds 1 sec -9 secs	N/A
No. 24a: Route Travel Time (to Hospital)	Median: 1020 secs 75° percentile: 1180 secs 90° percentile: 1328 secs	N/A	Median: 1098 secs 75° perc. 1259 secs 90° perc. 1412 secs	78 secs 79 secs 84 secs	N/A

(See Annex I and II for detail)

In this section the attention is devoted to a set of indicators concerning the impact of traffic.

C2.5 Society

In order to evaluate core indicators concerning and society, two qualitative surveys were conducted before (May 2011) and after (June 2012) the start of the implementation stage of the measure.

The first survey, which was conducted on the 4 most frequented PT urban lines and in some neuralgic locations of the city, has interested 240 people in order to analyze their knowledge and their opinion about public transport improvements in progress in Monza thanks to ARCHIMEDES project, as well as detecting potential interest and perception about measures' development and which of the on going measures are considered mostly impacting on respondents mobility habits on going projects (even if they are not known).

A questionnaire of 23 questions was elaborated by statistic technicians according to Municipality of Monza's requirements and concerned not only measure no. 82, but also measures no. 7, no.19 and no. 79.

In June 2012 the second survey was realized on 236 people using public transport at Monza, on lines z206, z266, z202, z201 and at two main bus stop (Piazza Castello e Via Manzoni). The interview had the scope to assess awareness of the implementation of the measure as well as eventual changing of habits in using public transport and in quality of service. The opinions of the respondents were acquired through a questionnaire designed ad hoc.

The sample size guarantees the statistic reliability of the survey, according to the following parameters:

- Significance level: 95%
- Error margin – 5% .

In this section results of the two surveys have been summarized, whilst all findings from the interviews are shown in the Annex 2 to the present document.

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Measure title: **Public Transport Priority System in Monza**

City: **Monza** *Project:* **ARCHIMEDES** *Measure number:* **82**

Indicator	Before (May 2011)	B-a-U (date)	After (June 2012)	Difference: After – Before	Difference: After – B-a-U
No. 13: Awareness	**28%** of surveyed people are aware of PT priority Information has been achieved through local press (**40%**) word of mouth (**31%**), Municipality website (**19%**) or magazine (**9%**)	N/A	**93.6%** did not notice PT priority on 206 and 266 lines **60.2%** did not notice any speed increase	N/A	N/A
No. 14: Acceptance	**94%** think PT priority can improve quality of service Expectations are about: - traffic reduction (**144** people) - better traffic flows (**121** people) - more punctuality (**110** people) - more buses during the day (**47** people) **67%** think improvements can push towards a more frequent PT use **24%** think PT priority is the most helpful measure	N/A	**69,1%** think PT priority is very useful **19.1%** changed their approach to PT **30** people changed their approach to PT thanks to PT priority	N/A	N/A

Below graphs explaining findings of the surveys are reported.

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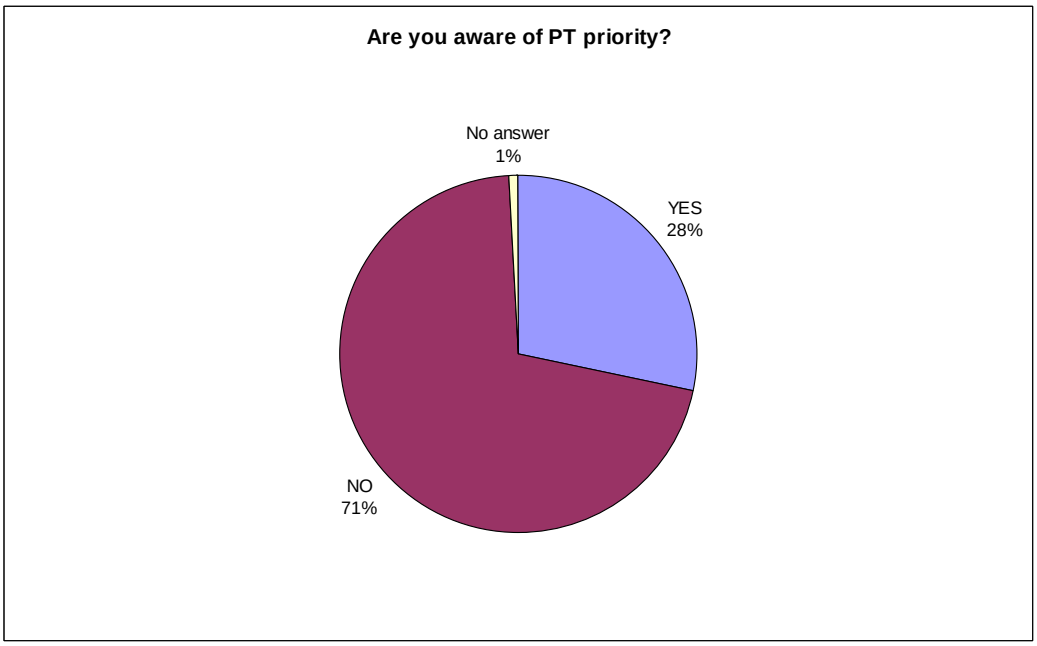

Graph 1 - Awareness of PT priority - May 2011 survey

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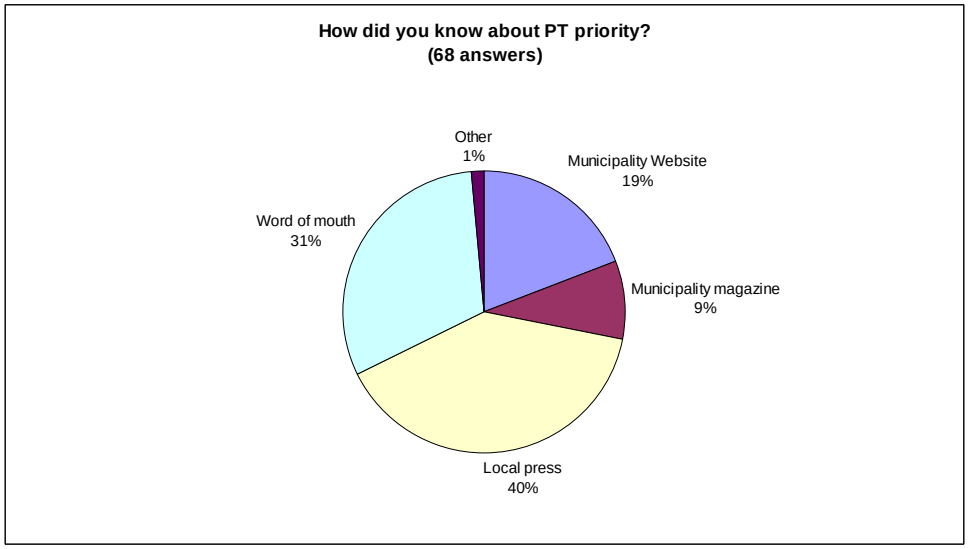
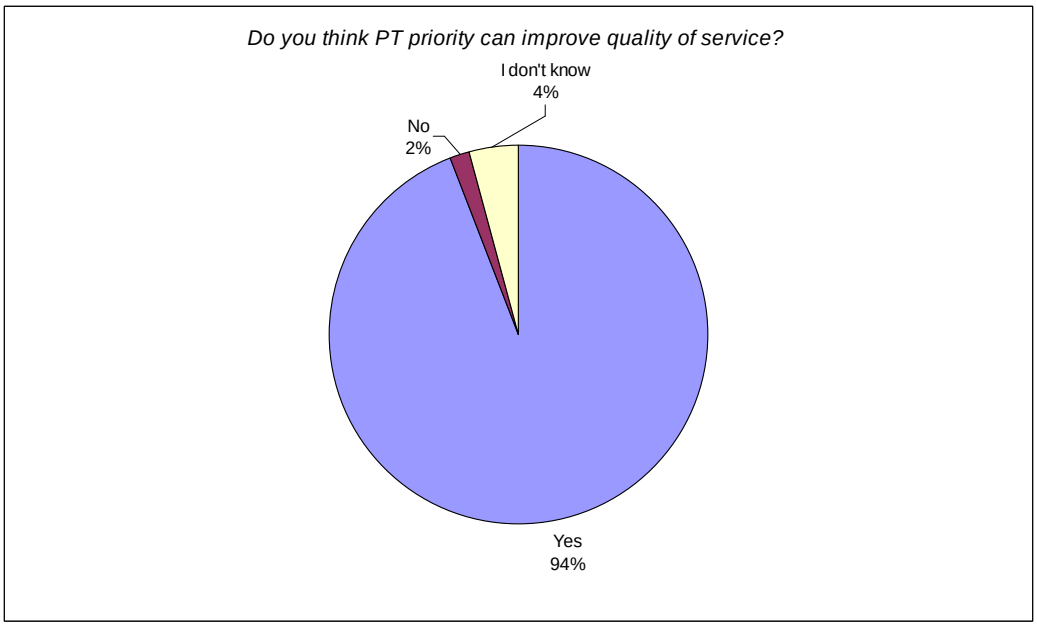
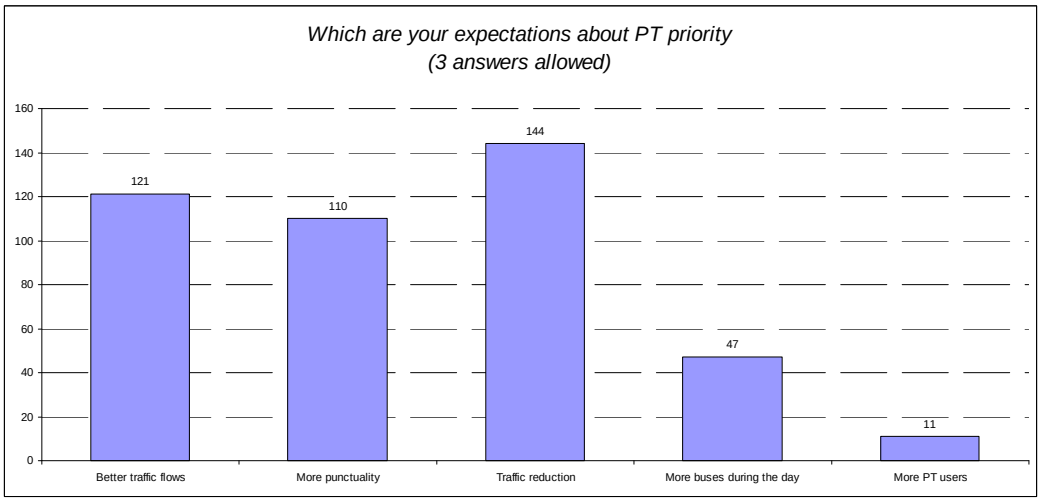


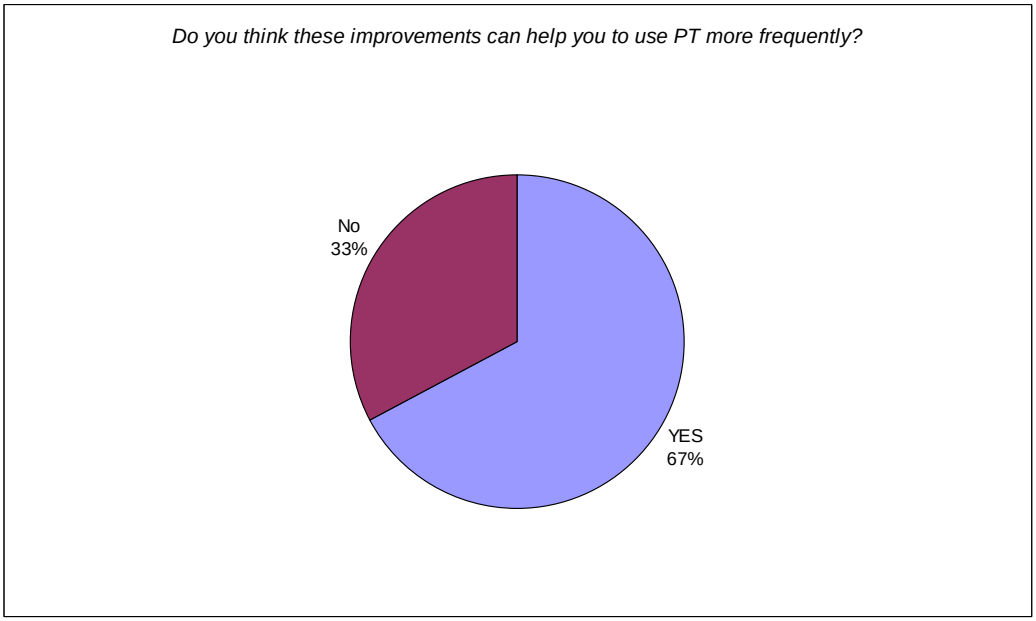
Graph 2 - Means of knowledege - May 2011 survey



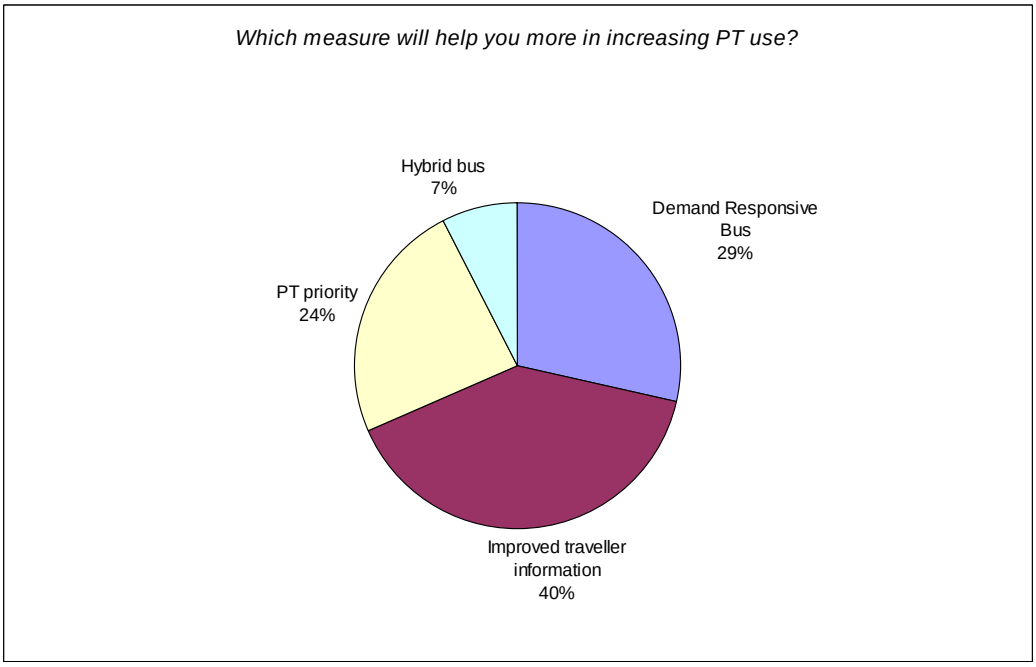
Graph 3 - Improvement of quality of service - May 2011 survey



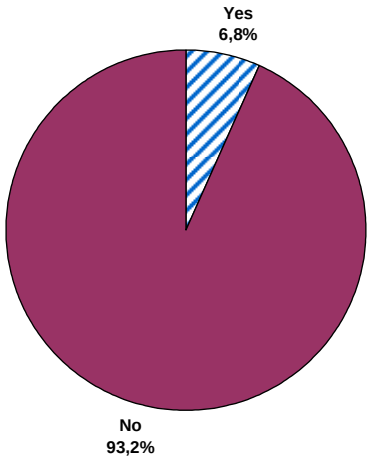
Graph 4 - Expectations about PT priority - May 2011 survey



Graph 5 - Increase in PT use - May 2011 survey



Graph 6 - Influence of PT measures in increasing PT use - May 2011 survey



Graph 7 - Awareness of PT priority implementation - June 2012 survey

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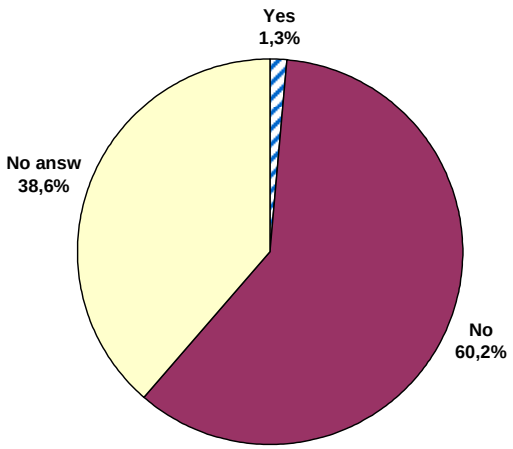
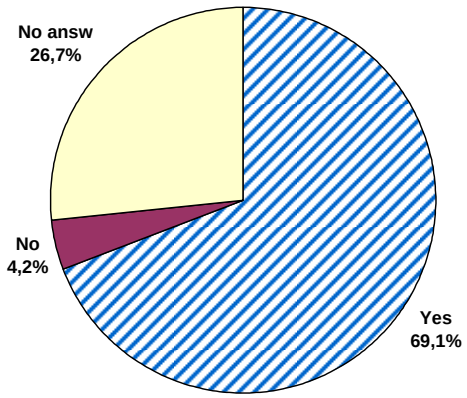
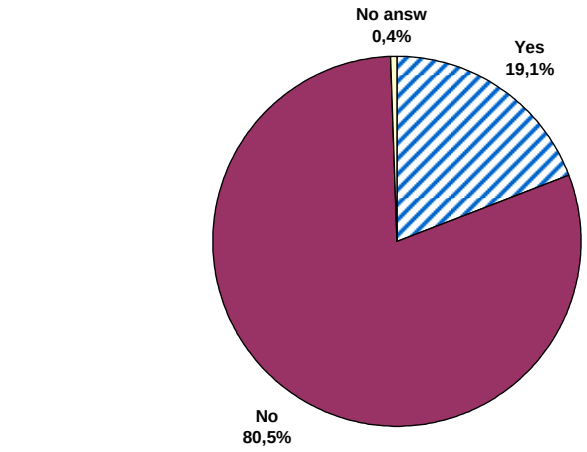


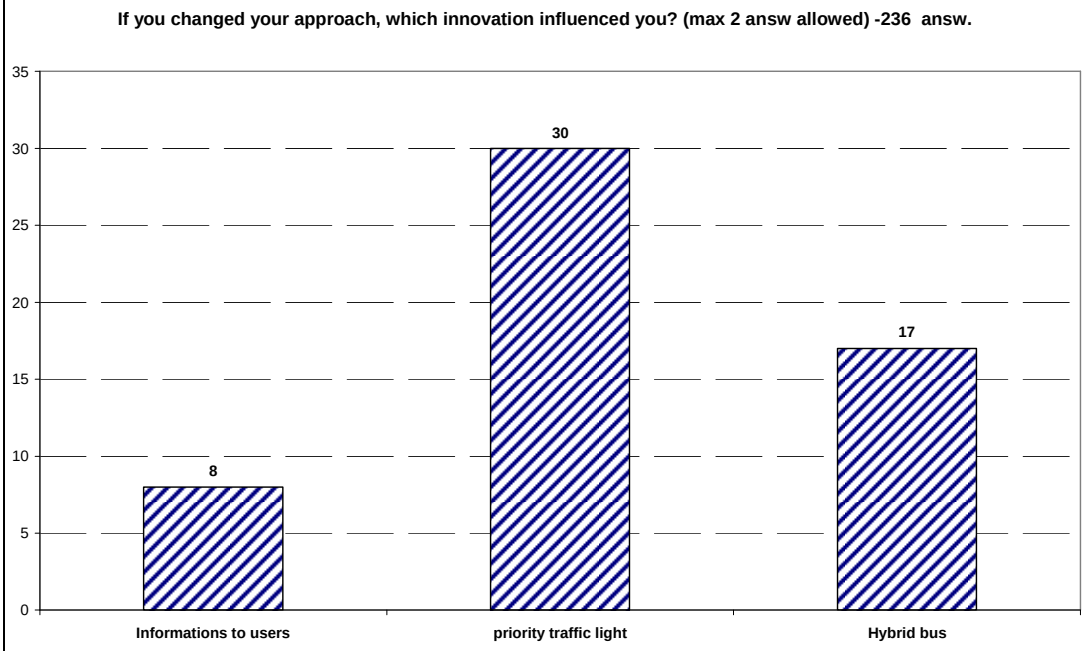
Graph 8 - Perception of improvement of bus speed - June 2012 survey



Graph 9 - Usefulness of PT priority



Graph 10 - Change in PT use after implementation - June 2012 survey



Graph 11 - Influence of PT measures in increasing PT use – June 2012 survey

The survey held in June 2012 has shown that PT priority at traffic lights on line z206 and z266 is difficult to notice it (only 6,8% of surveyed people actually are aware of it) as it is something less visible to passengers; consequently almost noboby could remark any improvement in bus speed. 69% of the respondents find priority traffic light system useful anyway.

Because of the lack of knowledge, only 20% of the respondants think that the implementation of measures concerning PT have changed their approach to public transports at Monza and even if it's actually the least known, priority traffic light system is considered the most effective innovation (30 answers).

The survey has shown that, in conclusion, the introduction of PT priority is not well known yet, probably due to the recent start-up and to their use only in some lines; it is anyway considered useful and impacting positively on pollution level, but for frequent users this is not enough to change their approach to public transport and use it more and more; probably, only an extended implementation and aware use of these innovations can really change users' approach.

C3 Achievement of quantifiable targets and objectives

No.	Target	Rating
13	Awareness about the measure	O
14	Acceptance of the measure	*
24a	Route travel time on the bus corridor	*

NA = Not Assessed O = Not Achieved * = Substantially achieved (at least 50%)
**** = Achieved in full *** = Exceeded**

C4 Up-scaling of results

To understand the impacts of the measure if it was applied to a larger area or number of services etc. the observed results need to be up-scaled.

What has been achieved in Measure MNZ 82 can easily be upscaled; the prerequisite for the extensions are the following:

1. The traffic lights managing new intersections to be included in the measure must be put under the control of the existing UTC system, allowing the remote control of the traffic light controller.

Since the UTC system is operational, it is quite easy to add new intersections to the UTC. The process of adding a new intersection to the system requires the following steps: revamping of Traffic Light Controller, installation of an industrial PC, establishment of a Communication Line with the UTC Server; then plan coding, configuration of the new intersection in the UTC system and test.

2. Other bus lines can be tracked through their AVL/AVM systems; their localisation and monitoring data detected at the relevant bus stops need to made available following the specifications described in Measure MNZ 78. This means that a new Webservice must be developed by the owner of new fleets to make available to this measure its data.

3. To configure the software component that implements the measure;

4. To configure the traffic light plans for managing the intersections.

C5 Appraisal of evaluation approach

Evaluation activities have been aimed at:

- Assessing awareness, acceptance and quality by users;
- Measuring or estimating quantitative indicators;

During the sessions of performance monitoring, the use of data automatically collected has been strengthened; in particular, data originated by Measure MNZ 78, concerning the transit of every bus at each one of the bus stops considered in MeasureMNZ 82 have been collected in a relational database.

To summarise before and after data, some basic statistical indicators have been selected: the median (50% percentile), 75% percentile, 90% percentile. Detailed data are available on request and in Annex <<< xx >>> an example of such data is presented.

C6 Summary of evaluation results

The proposed approach developed in the RTD stage has been successfully implemented in the demonstration stage, but travel time reduction hasn't been achieved (0%). The main reason is the high level of congestion that is influencing a large part of the city of Monza the corridor belongs to; this is due to a significant reduction of the throughput of the western external ring since 2008 that will continue up to April 2013, when the new 2 km long urban tunnel will be completed. The expectation in April 2013 is that this measure will become fully effective and travel time reduction of the buses may be reached.

As far as acceptance and awareness are concerned, the introduction of PT priority is not well known yet, probably due to the recent start-up and to their use only in some lines; it is anyway considered useful and impacting positively on pollution level, but for frequent users this is not enough to change their approach to public transport and use it more and more; probably, only an extended implementation and aware use of these innovations can really change users' approach.

C7 Future activities relating to the measure

The measure will remain active even at the end of the Archimedes project, waiting for a less critical traffic situation that will likely produce travel time reduction for the buses.

D Process Evaluation Findings

D.0 Focused measure

X	0	No focussed measure
	1	Most important reason
	2	Second most important reason
	3	Third most important reason

D.1 Deviations from the original plan

There have been no major deviations from the original plan. Some delays were produced during the project, mainly for the complexity and the novelty of the RTD stage; new algorithms have been designed, developed and tested before starting the demonstration stage.

D.2 Barriers and drivers

D.2.1 Barriers

Preparation phase

- Barrier 1 – **(4_Problem related)** Conceptual issues have been found more complex than expected, mainly in designing the Decision Module 2.

Implementation phase

- Barrier 1 – **(4_Problem related)** Software development required more time than expected.

Operation phase

- Barrier 1 – **(4_Problem related)** The starting stage required much time at the intersection to assess that the plan adjusted for extending green time was not critical for private traffic.

D.2.2 Drivers

Preparation phase

- Driver 1 – **(1. Strategic)** Strong need to test the real effectiveness of this measure in Monza context

Implementation phase

- Driver 1 – **(1. Strategic)** Strong technological commitment to achieve the measure.

Operation phase

- Driver 1 – **(1. Political_Strategic)** strong political commitment

D.2.3 Activities

Preparation phase

- Activity 1 –**(4_Problem related)** Methodology identification
- Activity 2 –**(4_Problem related)** Software design
- Activity 3 –**(4_Problem related)** Assessment of prerequisite components (Urban Traffic Control for Traffic Light Centralisation from Measure MNZ81), gathering of localisation and monitoring data from Measure MNZ 78;

Implementation phase

- Activity 1 – **(4_Problem related)** Software development and testing

Operation phase

- Activity 1 – **(4_Problem related)** Validation of the entire software suite developed
- Activity 2 – **(7. Planning)** Execution of supervised sessions at corridor intersections.

D.3 Participation

D.3.1. Measure Partners

- **Measure partner 1 –** Project Automation: author of the RTD studies and designer of the software and implementation process.

D.3.2 Stakeholders

- **Stakeholder 1 –** Comune of Monza
- **Stakeholder 2** – Public Transport Company "Nord-Est Trasporti": owner of the PT fleet, in charge of the buses operation in Monza.

D.4 Recommendations

D.4.1 Recommendations: measure replication

- **Planning**: The proposed approach can be replicated by other cities with a not trivial effort. The two basic prerequisites concern the availability of an UTC system to accomplish centralized and coordinated traffic light control and the operation of an AVL/AVM system to localize the buses. Traffic light management is an important leverage to accomplish traffic control strategies in urban road networks; dissemination actions will help other cities to realize this concept, so other cities can plan the adoption of this approach;
- **Concept**: A lower level of replication can be carried out exploiting only the methodology; it is described in detail in the deliverable R82.1
- **Full scope of the measure**: A centralized mobility centre may be very helpful to provide tools and techniques to manage all the aspects of urban mobility with an ITS perspective (demand

management, traffic light control, variable message signs to provide real time information, parking policy, access control to city centres, traffic measurement,…).

D.4.2 Recommendations: process

- **Planning**. Optimisation of travel time for public transport fleet requires the cooperation with all relevant stakeholders: public bodies committing the service, municipalities involved by the routes, Public Transport companies. Each one must play its role.
- **Sustainable Urban Traffic Plan**: Urban mobility planning driven by a strong commitment towards sustainability is a sound basis to promote the use of Public Transport.
- **Dissemination to stakeholders**: The results achieved need to be shared with local population, city users and local media (traditional and Web newspapers) to spread across the city the consciousness that important mobility processes are managed.

Annex 1 – Data Details

Focus is on indicator 24a, i.e. the time spent by the buses of the Public Transport to cross the four intersections. Such data are made available accessing the Webservice developed within Measure no. 78 and then stored in a relational database.

As far as indicator 24a is concerned, a specific relational database has been designed and implemented in the Archimedes server which hosts also the following software components:

- the UTC system with all its components (application server, relational database, software modules to communicate with the traffic light controllers spread across the city, GUI, UTC system configurator,…);

- the software modules which access the Webservice implemented within Measure no. 78 to gather localisation and monitoring data of the buses of the Public Transport fleet;

- the software modules of this Measure (please refer to deliverable T82.1 for details) which manage the real time aspect, as described above in section B4 of this MERT.

For this purpose a lean and effective relational database has been implemented aside of these components, to ensure that all localisation and monitoring data of the corridor stretches selected are stored; this allow to analyse the Public Transport performances along time. Data stored in the database are the following.

line	*run_id*	*vehicle*	*stop_id*	*stop_descript*	*timestamp_unit*		
	timestamp_acc		*timestamp_plan*		*timestamp_real*		*slot*
	delta_time	*total_time*					
z206	20604603	7512	NET120	Boito - Pero	2012/05/17-16:23:45		
	2012/05/17-16:23:52		2012/05/17 16:20:07		2012/05/17 16:22:48		2
	161	65					
z206	20604603	7512	NET118	Boito-Beethov	2012/05/17-16:24:24		
	2012/05/17-16:24:32		2012/05/17 16:21:24		2012/05/17 16:23:39		2
	135	54					
z206	20604603	7512	NET116	Boito-Montev	2012/05/17-16:24:24		
	2012/05/17-16:24:32		2012/05/17 16:22:22		2012/05/17 16:24:00		2
	98	33					
z206	20604603	7512	NET117	Boito - Battisti	2012/05/17-16:25:24		
	2012/05/17-16:25:32		2012/05/17 16:23:10		2012/05/17 16:24:36		2
	86	57					
z206	20604603	7512	NET480	MonTogn-Sirt	2012/05/17-16:26:48		
	2012/05/17-16:26:52		2012/05/17 16:24:17		2012/05/17 16:26:38		2
	141	15					

where:

- Line: represents the line of the bus (e.g. z206)
- Run_Id: represents the actual run for the line (e.g. 20604603) within the day; each time a bus perform a run it has assigned a different Run_Id; in working days the same Run_Id's hold; in Saturdays a different set of Run_Id hold; in Sundays and holydays yet another set of Run_Id holds;
- Vehicle: Bus Id;
- Stop_Id: represents the "Bus Stop Id"; each bus stop is uniquely identified within the system;
- Stop_Descript; Description of the Bus_Id;
- Timestamp_Acc: Timestamp concerning the timestamp when this data was accessed;
- Timestamp_Unit: Timestamp concerning the timestamp when this data was produced;
- Timestamp_Plan: Timestamp concerning the planned detection following the timetable for such Run_Id;
- Timestamp_Real: Timestamp concerning the actual detection, specified by the attributes below;
- Slot: Type of "traffic profile", as determined by the study carried out in the RTD Stage (please see deliverable R82.1 for detail);
- Delta_time: actual delay of the bus detected at the bus stop with respect to the planned timestamp, as reported in the timetable;
- Total_time: actual delay of data availability; if such value is high, it can't be used. Please see MERT MNZ 78 for detail.

In the sequel, before data concerning several relevant contexts are presented. This short scheme shows five records concerning data gathered in four bus-stops before the intersection no. 19 (NET120, NET118, NET116, NET117) and at the bus-stop just after the intersection no. 19 (NET480).

Context no. 1: behaviour of buses at Intersection no. 19 toward the City Centre

- Type of data: Before Data
- Indicator: Route Travel Time (24a), analysed through:
  - "delta_time" between planned time and actual time BEFORE THE INTERSECTION (blue line); the optimal result should be 0 for the entire sample considered (this would mean that the bus fully respect the expected time table)
  - "delta_time" between planned time and actual time AFTER THE INTERSECTION (magenta line); the optimal result should be 0 for the entire sample considered (this would mean that the bus fully respect the expected time table)
- Period of data: May 30th and 31st (working days)

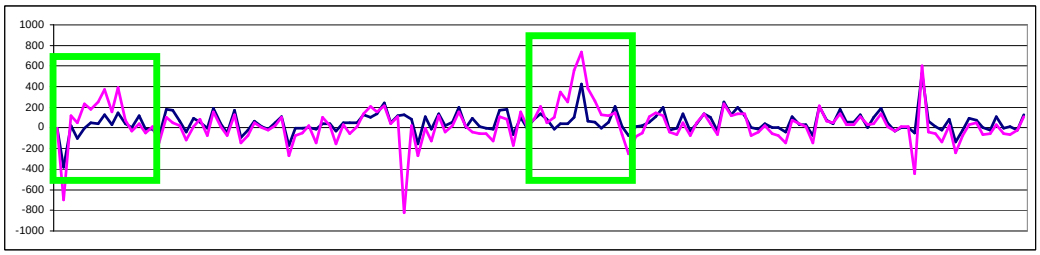


Figure 3 - Before data, Int. no. 19 to City Centre, Delta time before and after the intersection

When the blue and magenta lines overlap, this mean that the intersection crossing does not provide further delay; the two situations pointed out through the green boxes refer to morning peak hours. The concrete problem assessed is that the carriageway after the intersection in the City Centre direction can't accept all the vehicle that enter it, so it will be carefully evaluated if the green time extension could help at improving this situation or not. All detailed data is however available in the database.

Context no. 2: behaviour of buses at Intersection no. 19 toward the City Hospital

- Type of data: Before Data
- Indicator: Route Travel Time (24a), analysed through:
    - "delta_time" between planned time and actual time BEFORE THE INTERSECTION (blue line); the optimal result should be 0 for the entire sample considered (this would mean that the bus fully respect the expected time table)
    - "delta_time" between planned time and actual time AFTER THE INTERSECTION (magenta line); the optimal result should be 0 for the entire sample considered (this would mean that the bus fully respect the expected time table)
- Period of data: May 30th and 31st (working days)

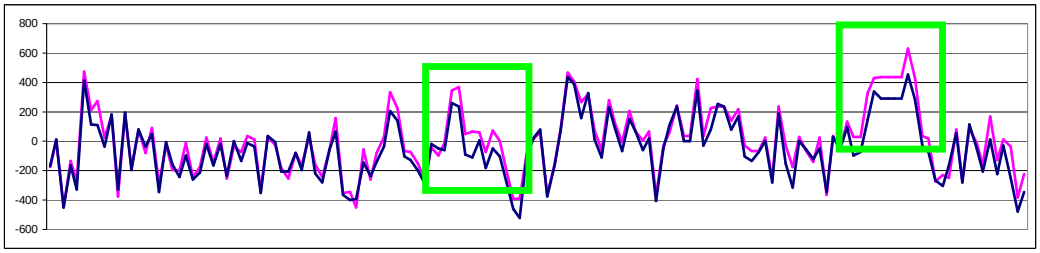


Figure 4 - Before data, Int. no. 19 to City Hospital, Delta time before and after the intersection

When the blue and magenta lines overlap, this mean that the intersection crossing does not provide further delay; the two situations pointed out through the green boxes refer to evening peak hours, even if this situation is less critical than the one detected in the morning peak hours. More in detail, in this situation the carriageway after the intersection can accept all the vehicle that enter it, so the green time extension provided through this measure would look effective. All detailed data is however available in the database.

Context no. 3: behaviour of buses on the entire bus CIVITAS Corridor toward the City Centre (East)

- Type of data: Before Data
- Indicator: Route Travel Time (24a), analysed through:

- "delta_time" between planned time and actual time BEFORE THE INTERSECTION (blue line); the optimal result should be 0 for the entire sample considered (this would mean that the bus fully respect the expected time table)
- "delta_time" between planned time and actual time AFTER THE INTERSECTION (magenta line); the optimal result should be 0 for the entire sample considered (this would mean that the bus fully respect the expected time table)

- Period of data: May 30th and 31st (working days)

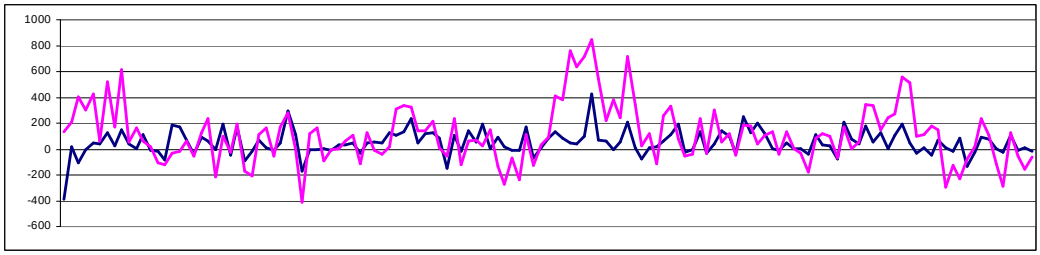


Figure 5 - Before data, Corridor to City Centre (East), Delta time before and after the corridor

Eliminato: 7

When the blue and magenta lines overlap, this mean that the intersection crossing does not provide further delay; the picture shows a significant variability across the day; the expectation is that through Measure MNZ 82 this variability could be reduced. All detailed data is however available in the database.

Context no. 4: behaviour of buses on the entire bus CIVITAS Corridor toward the City Hospital

- Type of data: Before Data
- Indicator: Route Travel Time (24a), analysed through:
  - "delta_time" between planned time and actual time BEFORE THE INTERSECTION (blue line); the optimal result should be 0 for the entire sample considered (this would mean that the bus fully respect the expected time table)
  - "delta_time" between planned time and actual time AFTER THE INTERSECTION (magenta line); the optimal result should be 0 for the entire sample considered (this would mean that the bus fully respect the expected time table)
- Period of data: May 30th and 31st (working days)

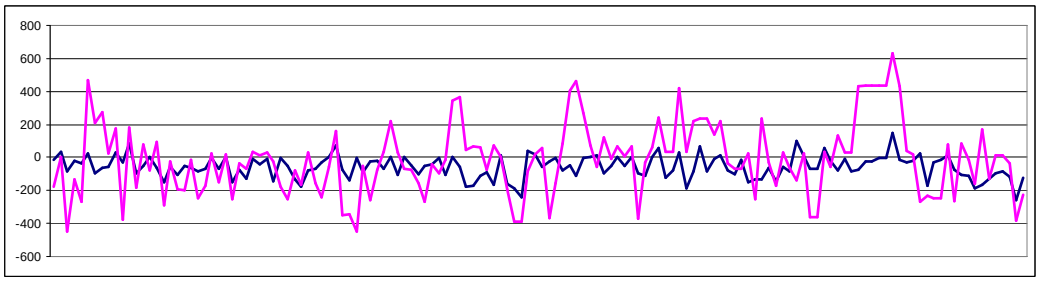


Figure 6 - Before data, Corridor to City Hospital, Delta time before and after the corridor

Eliminato: 8

When the blue and magenta lines overlap, this mean that the intersection crossing does not provide further delay; the picture shows even in this context a significant variability across the day; the expectation is that through Measure MNZ 82 this variability could be reduced. All detailed data is however available in the database.

A general consideration encompassing contexts no. 3 and no. 4 is that an improvement along the entire corridor needs as necessary condition (but not automatically sufficient condition) the improvement in each single intersection submitted to Measure MNZ 82.

Annex 2 – Database and queries

The database designed and implemented to collect all localisation and monitoring data has been queried through the following query:

```
SELECT ein.linea bus_line, substring(ein.corsa,13,8) run, ein.vehicle,
ein.id_fermata stop_in,
ein.timestamp_plan ts_plan_in, ein.timestamp_real ts_real_in,
 day(ein.timestamp_real) _day_in, hour(ein.timestamp_real) _hour_in,
minute(ein.timestamp_real) _minute_in,
second(ein.timestamp_real) _second_in,
 ein.fascia slot, ein.delta_time dt_in,
eout.id_fermata stop_out, eout.timestamp_plan ts_plan_out, eout.timestamp_real
ts_real_out,
 eout.delta_time dt_out, hour(eout.timestamp_real) _hour_out,
minute(eout.timestamp_real) _minute_out,
second(eout.timestamp_real) _second_out
FROM esercizio ein, esercizio eout
where ein.timestamp_acc between '2012/11/06 06:00:00' and '2012/11/09 23:00:00'
and dayofyear (eout.timestamp_plan) = dayofyear (ein.timestamp_plan)
and ein.linea in ('z206', 'z266')
and ein.id_fermata = 'NET387'
and eout.id_fermata = 'NET121'
and ein.linea = eout.linea
and ein.corsa = eout.corsa
and ein.vehicle = eout.vehicle
order by ein.timestamp_plan
limit 500
```

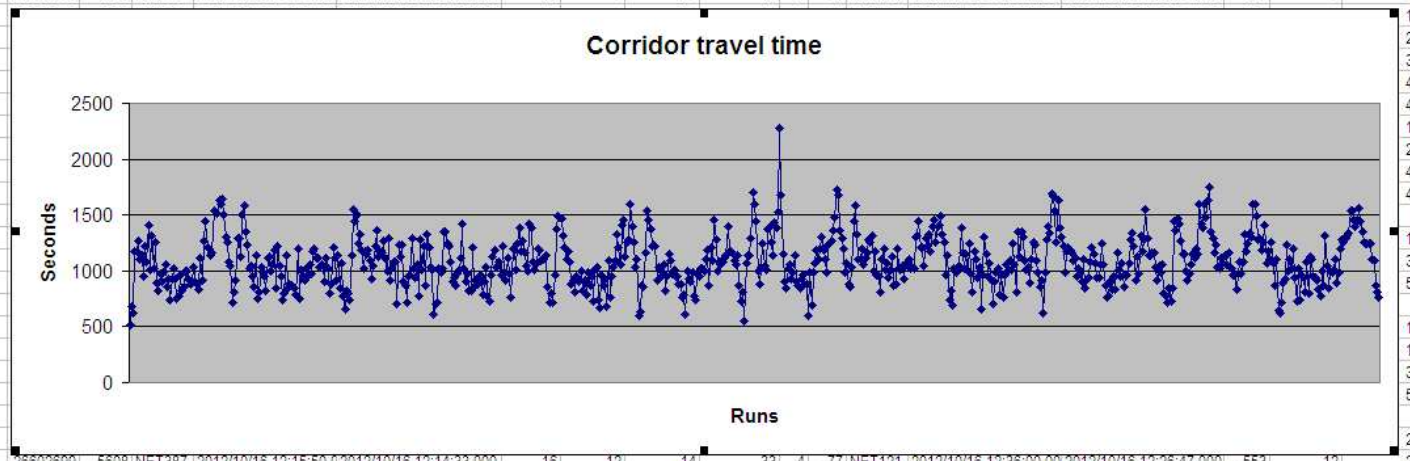
This query produce a recordset that database designed and implemented to collect all localisation and monitoring data has been queried through the following query:

Measure title: **Public Transport Priority System in Monza**

City: **Monza** *Project:* **ARCHIMEDES** *Measure number:* **82**

Microsoft Excel - 121217_M82_01.xls

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	bus_line	run	vehicle	stop_in	ts_plan_in	ts_real_in	_day_in	_hour_in	_minute_in	_second_in	slot	dt_in	stop_out	ts_plan_out	ts_real_out	dt_out	_hour_out	_minute_out	_second_out	Ser_in
2	z206	20605182	1505	NET387	2012/10/16 06:00:05.0	2012/10/16 06:00:15.000	16	6	0	15	4	10	NET121	2012/10/16 06:13:01.00	2012/10/16 06:08:48.000	-253	6	8	48	0.2501
3	z206	20605162	113	NET387	2012/10/16 06:30:05.0	2012/10/16 06:29:36.000	16	6	29	36	4	-29	NET121	2012/10/16 06:43:01.00	2012/10/16 06:40:51.000	-130	6	40	51	0.2705
4	z206	20605194	7515	NET387	2012/10/16 07:01:46.0	2012/10/16 07:00:27.000	16	7	0	27	1	-79	NET121	2012/10/16 07:15:01.00	2012/10/16 07:10:44.000	-257	7	10	44	0.2919
5	z206	20605173	1505	NET387	2012/10/16 07:38:26.0	2012/10/16 07:37:15.000	16	7	37	15	1	-71	NET121	2012/10/16 07:53:01.00	2012/10/16 07:56:44.000	223	7	56	44	0.3175
6	z266																		10	9	0.3267
7	z206																		28	14	0.3383
8	z266																		30	23	0.3416
9	z206																		41	45	0.3491
10	z266																		46	45	0.3547
11	z266																		11	57	0.3691
12	z266																		28	45	0.3825
13	z206																		43	27	0.3888
14	z266																		46	42	0.3957
15	z206																		2	51	0.4033
16	z266																		11	39	0.4129
17	z266																		33	42	0.4255
18	z266																		51	45	0.4422
19	z206																		0	0	0.4488
20	z266																		11	54	0.4553
21	z206																		18	51	0.4609
22	z266																		31	54	0.469
23	z266																		53	33	0.4832
24	z266																		9	15	0.4964
25	z206																		20	6	0.5031
26	z266	26602699	5608	NET387	2012/10/16 12:15:50.0	2012/10/16 12:14:33.000	16	12	14	33	4	-77	NET121	2012/10/16 12:36:00.00	2012/10/16 12:26:47.000	-553	12	26	47	0.5101
27	z206	20605191	7513	NET387	2012/10/16 12:25:55.0	2012/10/16 12:24:39.000	16	12	24	39	4	-76	NET121	2012/10/16 12:40:01.00	2012/10/16 12:40:03.000	2	12	40	3	0.5171
28	z266	26602680	5653	NET387	2012/10/16 12:35:50.0	2012/10/16 12:34:54.000	16	12	34	54	4	-56	NET121	2012/10/16 12:56:00.00	2012/10/16 12:51:51.000	-249	12	51	51	0.5242
29	z266	26602689	5654	NET387	2012/10/16 12:55:50.0	2012/10/16 12:54:42.000	16	12	54	42	4	-68	NET121	2012/10/16 13:16:00.00	2012/10/16 13:10:15.000	-345	13	10	15	0.5379
30	z206	20605198	7515	NET387	2012/10/16 13:05:55.0	2012/10/16 13:06:06.000	16	13	6	6	4	11	NET121	2012/10/16 13:20:01.00	2012/10/16 13:18:34.000	-87	13	18	34	0.5459
31	z206	20605177	1505	NET387	2012/10/16 13:25:55.0	2012/10/16 13:25:36.000	16	13	25	36	4	-19	NET121	2012/10/16 13:40:01.00	2012/10/16 13:38:33.000	-88	13	38	33	0.5594
32	z266	26602697	5608	NET387	2012/10/16 13:35:50.0	2012/10/16 13:35:30.000	16	13	35	30	4	-20	NET121	2012/10/16 13:56:00.00	2012/10/16 13:51:35.000	-265	13	51	35	0.5663
33	z206	20605192	7513	NET387	2012/10/16 13:45:55.0	2012/10/16 13:44:51.000	16	13	44	51	4	-64	NET121	2012/10/16 14:00:01.00	2012/10/16 13:58:35.000	-86	13	58	35	0.572
34	z266	26602681	5653	NET387	2012/10/16 13:55:50.0	2012/10/16 13:54:27.000	16	13	54	27	4	-83	NET121	2012/10/16 14:16:00.00	2012/10/16 14:08:39.000	-441	14	8	39	0.5794
35	z206	20605169	7512	NET387	2012/10/16 14:05:55.0	2012/10/16 14:04:51.000	16	14	4	51	4	-64	NET121	2012/10/16 14:20:01.00	2012/10/16 14:21:33.000	92	14	21	33	0.5867



Aft_to_HSG | Aft_from_HSG | Bef_to_HSG | Bef_from_HSG | Raw | Raw2_to_Centre | Raw2_to_HSG

Pronto NUM

ANNEX 3 – SURVEY DETAILS

In order to evaluate core indicators concerning transport and society, and to assess mobility habits of surveyed people, two qualitative surveys were conducted before (May 2011) and after (June 2012) the start of the implementation stage of the measure.

The first survey, which was conducted on the 4 most frequented PT urban lines and in some nevralgic locations of the city, has interested 240 people in order to analyze their knowledge and their opinion about public transport improvements in progress in Monza thanks to ARCHIMEDES project, as well as detecting potential interest and perception about measures' development and which of the on going measures are considered mostly impacting on respondents mobility habits on going projects (even if they are not known)

A questionnaire of 23 questions was elaborated by statistic technicians according to Municipality of Monza's requirements and concerned not only measure no. 7, but also measures no. 19, no. 79 and no. 82.

In June 2012 the second survey was realized on 236 people using public transport at Monza, on lines 206, 266, 202, 201 and at two main bus stop (Piazza Castello e Via Manzoni). The interview had the scope to assess awareness of the implementation of the measure as well as eventual changing of habits in using public transport and in quality of service. The opinions of the respondents were acquired through a questionnaire designed ad hoc.

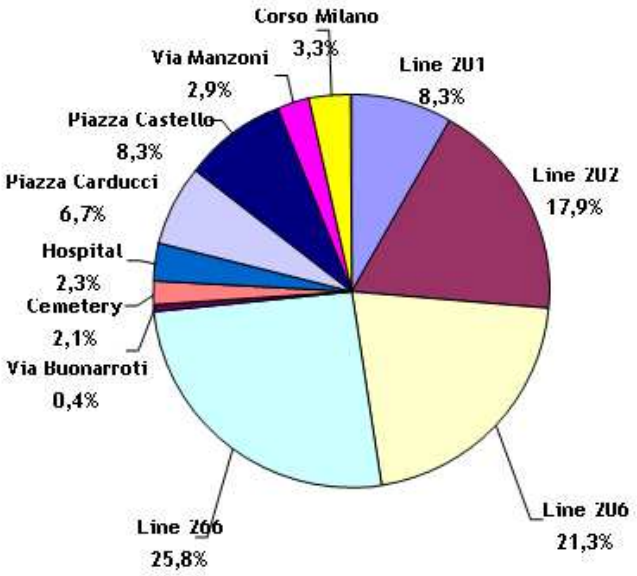
The sample size guarantees the statistic reliability of the survey, according to the following parameters:

- Significance level: 95%
- Error margin – 5% .

Formattati: Elenchi puntati e numerati

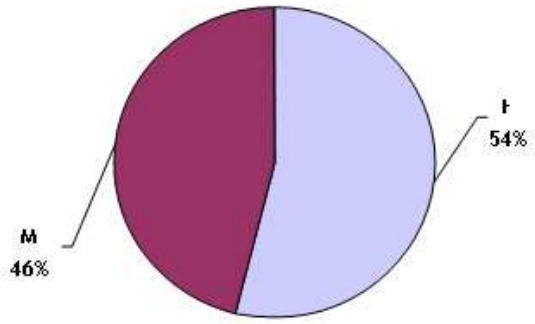
BEFORE DATA – May 2011 (sample size- 240 people)

Graph no. 1 shows the percentages of surveyed people for each public transport line and each city location.



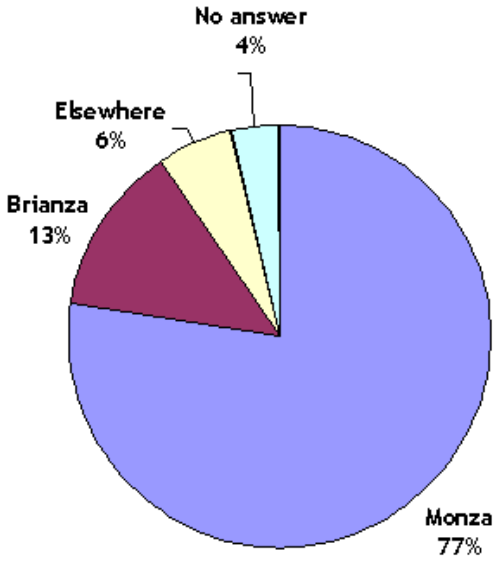
Graph 12 - Percentage of surveyed people for each PT line and location

The sample size (240 people) was made up by 46% of males and 54% of females.



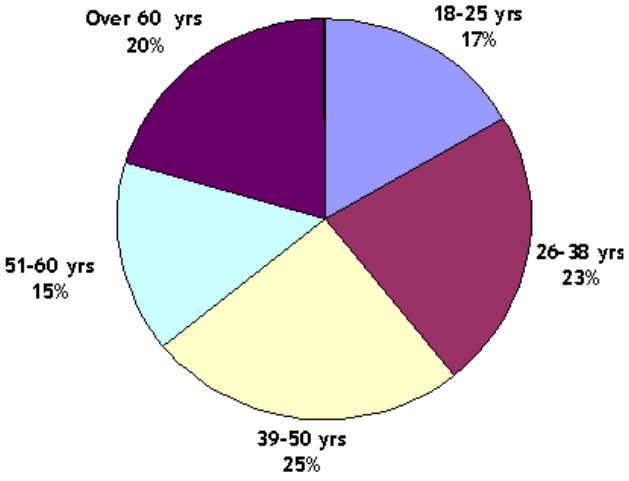
Graph 13 - Sex of surveyed people

77% of surveyed people live in the city of Monza, 13% live in Brianza and 6% live elsewhere: 4% of the sample did not answer to the question.



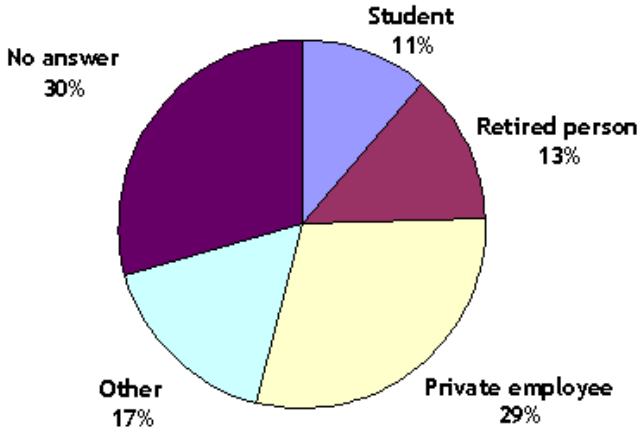
Graph 14 - Residence of surveyed people

Age of surveyed people is shown in the below graph.

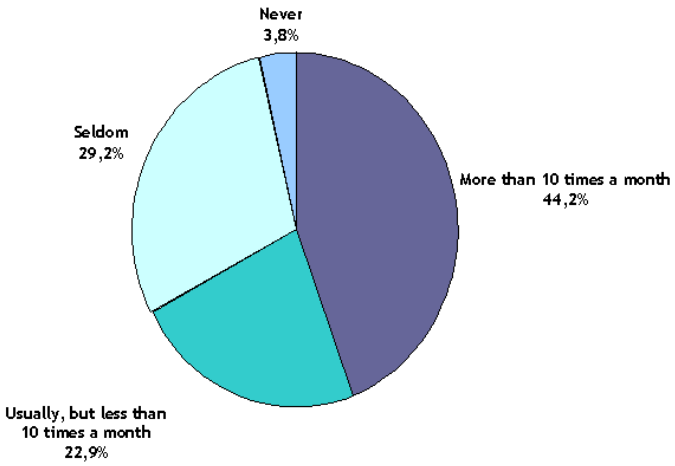


Graph 15 - Age of surveyed people

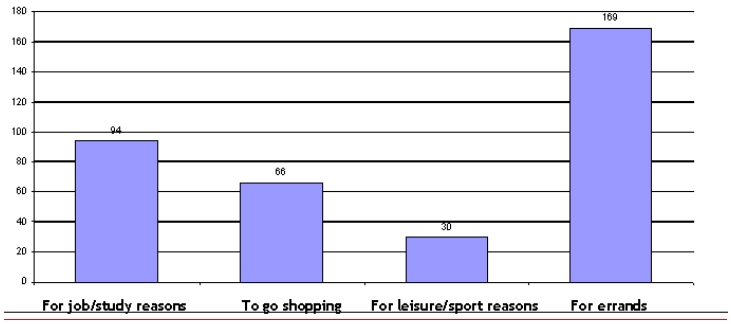
The following graph shows the professional condition of interviewed people: several different conditions are represented, even though the 30% of surveyed people did not answer.



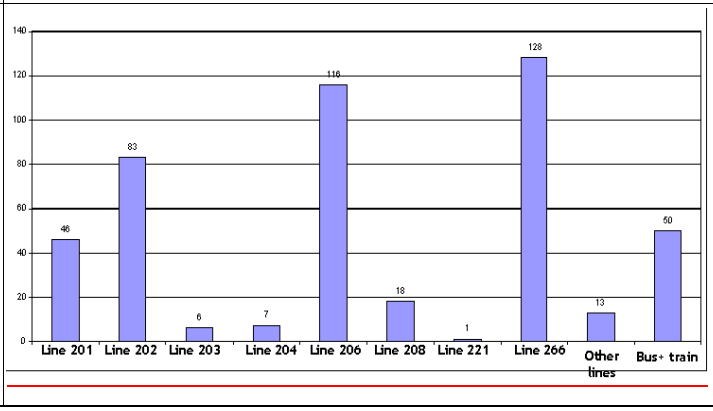
Mobility habits

Question asked	Answers
How often do you use public transport?	

Why do you use public transport?

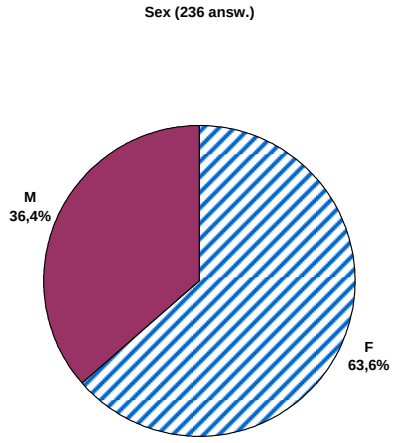


Which line do you use more often?



AFTER DATA – June 2011 (sample size- 236 people)

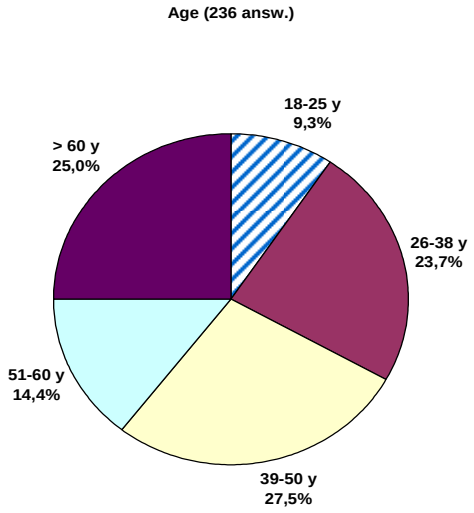
SEX OF SURVEYED PEOPLE



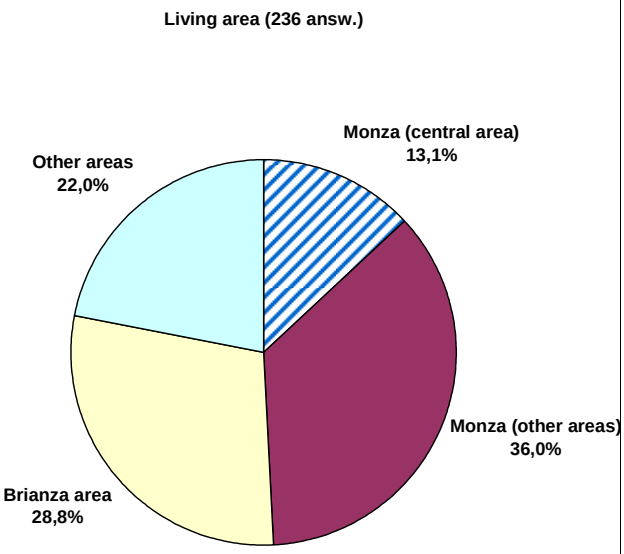
Measure title: **Public Transport Priority System in Monza**

City: **Monza** *Project:* **ARCHIMEDES** *Measure number:* **82**

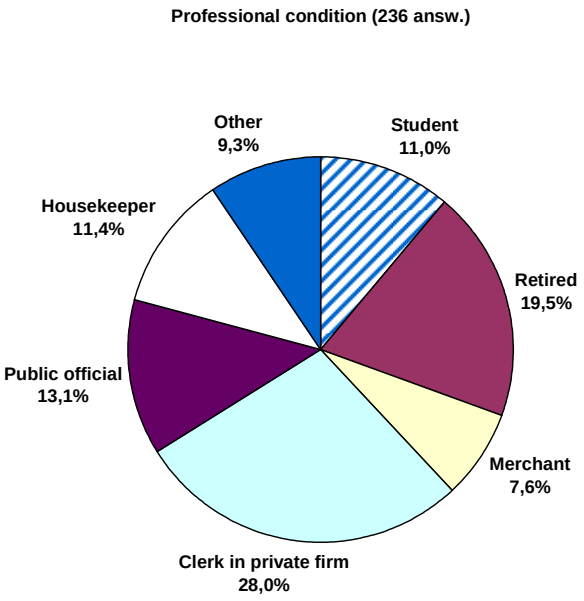
AGE OF SURVEYED PEOPLE



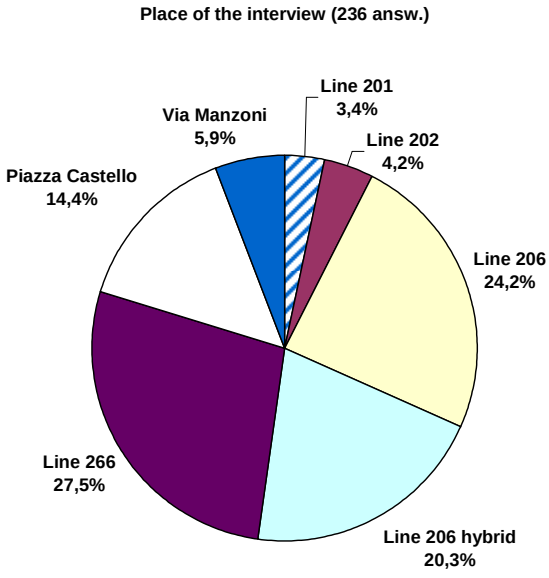
LIVING AREA



PROFESSIONAL CONDITION



INTERVIEW SITE



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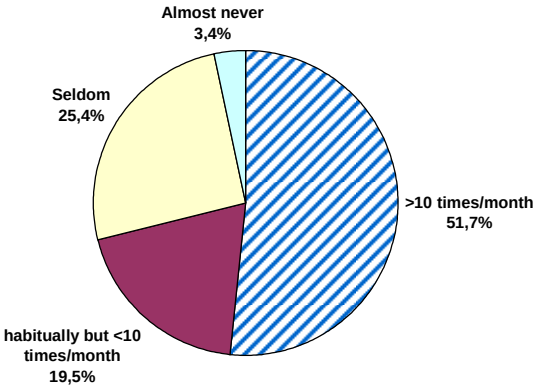
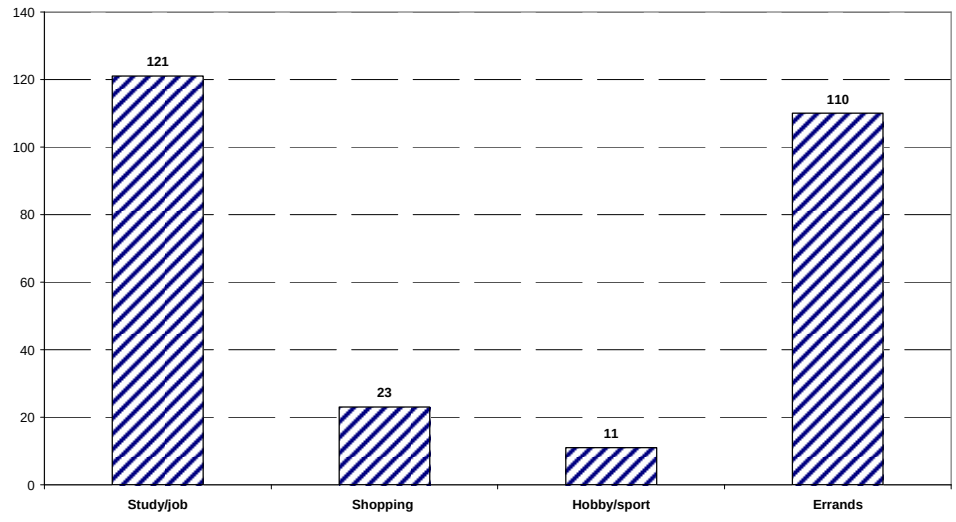
MOBILITY HABITS

How often do you use public transport at Monza? (236 answ.)



MOBILITY HABITS

Reasons to use public transport at Monza (multiple answ. allowed)



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MOBILITY HABITS