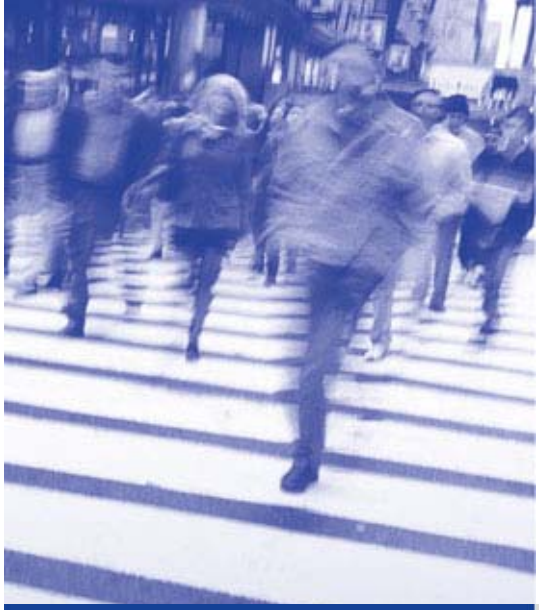

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Measure Evaluation Results

BOL 7.1 City Freight Delivery Plan

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Executive Summary

The 'City Freight Delivery Plan' (approved on March 6, 2006) was the key instrument through which the city of Bologna aimed to rationalise freight delivery in the city centre. The goal was to decrease the number of kilometres travelled while still providing the same services as well as to deploy 'cleaner' freight vehicles. The implementation of the plan covered three phases, of which the first and the second were already accomplished when MIMOSA started:

1. The introduction of more efficient procedures for deliverances of access permits, the establishment of new pricing policies and the enforcement of new policies related to city centre access;
2. The 'pay-to-access' Limited Traffic Zone (LTZ) service;
3. The 'Van Sharing' project, including a 'Technological transit point' pilot project for a specific area of the LTZ

For the success of the plan, supporting actions were essential. The MIMOSA measure was an opportunity for the Municipality to pursue its objective to improve freight distribution in the city and to establish a long-term cooperation with the stakeholders involved. The measure focused on the establishment of the 'Van Sharing' project which consisted on implementing a common logistic platform for freight operators with the aim to optimize and therefore to reduce freight traffic in the city of Bologna. Thereby, the present measure is related to three other MIMOSA measures which shared the same high level objective of improving air quality. The four measures were identified as bundled measures: BOL 1.2 'Cleaner Private Vehicles', BOL 3.1 'Road Pricing Policies', BOL 4.1 'Mobility Managers' and BOL 7.1 'City Freight Delivery Plan'.

Firstly, the Municipality had to encourage small operators who might benefit from its technological platform to come together (Van Sharing). The aim of this measure was thus to encourage own-account operators to join a consortium with integrated information, transportation, inventory, warehousing, and materials handling. Secondly, new access policies for the city centre needed to be planned, in order to favour less polluting vehicles with wider time slot access. Thereby, the measure was implemented in the following tasks:

Task 1: Data collection for evaluation (2008 - 2012) covered freight analysis in cooperation with local stakeholders with the aim at identifying individual trends and scenario modifications.

Task 2: Implementation of the Van Sharing System (2008 - 2010) The After the testing period, the technological platform for the virtual transit point (collection of freight orders, programming and optimising trips and loads) was implemented. At the same time, the new traffic control centre called CISIUM was implemented in the frame of the measure BOL 8.3. The connection between the Van Sharing System and the CISIUM Centre enabled real time information transfer

Task 3: New permits scheme (October 2011 – March 2012) New rules for access into the city centre and a new procedure for selecting parking slot modules was studied.

Task 4 Promotion of the consortium (October 2010 – ongoing) Efforts were made to involve operators in the Van Sharing Consortium to increase the dialogue with small operators, to better understand their conditions and requests and develop an attractive business model.

The evaluation strategy of this measure sought to focus on a number of indicators in the fields of environment, economy and transport. These were measured in different ways: data

obtained from the Municipality's IT control systems and involving all freight vehicles accessing the LTZ, and data obtained from the Van Sharing System involving the small operators which decided to join the consortium. The evaluation approach followed required a large cooperation with freight operators. Since the high level objective of the measure is related to three other MIMOSA measures, a bundled indicator for these four measures was the level of particulate recorded throughout the Municipality. However, the positive trend in this bundled indicator (reduction of PM2.5 and PM10 emissions by 22% and 14% respectively) cannot be attributed to this measure. Due to freight operators resistance to take part in the consortium it never became fully operational and its effects could not be demonstrated.

The main **barrier** encountered was the reticence of freight operators to take part into the Van Sharing Consortium. Indeed, freight operators do not see the benefits of a common logistic platform for their business and are concerned about losing market shares and revenues. One effect of the Van Sharing implementation is to reduce the amount of kilometres travelled while still providing the same services. This meant from the freight operators lower costs but also lower revenues which are perceived as a threat for their business. This aspect has been discussed to late in the development of the Van Sharing concept which led to the failure of the measure.

The main **driver** of the measure was the well conducted Research and Technology Development (RTD) which highlighted the potential of the measure to implement an efficient transit point for freight. The methodology and technology advised by the RTD for the implementation demonstrated that this platform should be promotes since it is appropriate in the context of Bologna.

From the Bologna experience, the main **recommendation** to ensure the implementation of a successful Freight Logistic Strategy is to plan and invest at the earliest stage of the measure, for instance by giving incentive to freight operators and retailers to participate (such as tax benefits). Direct and individual benefits should be visible to balance the potential inconvenience of a common logistic platform such as the loss of flexibility. It is highly recommended to estimate and foreseen the effects of the measure on the market from the operators, retailers and customers point of view.

Even if the participation rate in the Van Sharing Consortium was low, the Van Sharing Platform was implemented and provides an alternative option for goods distribution within the LTZ. A positive outcome of the measure was the identification of around 30 operators which are interested in the project and can be seen as potential pioneer for a future development. In the future, the municipality will support these operators by giving incentives. This public financial support shows the political willingness to improve traffic flow in the city centre and represents the first and main step toward an economically competitive alternative on the market of good distribution.

A Introduction

A1 Objectives

The Measure objectives were:

(A) High level objectives

(1) To improve air quality in the city.

(B) Strategic level objectives

(1) Energy-efficient freight distribution

(C) Specific measure objectives

(1) To demonstrate the impact that a regulatory action on freight distribution can have on urban traffic congestion and pollution levels in the city of Bologna;

(2) To optimise and develop effective integration between road pricing policies (aimed at controlling freight vehicle trips) and technological tools;

(3) To help decrease the number of kilometres travelled while still providing the same services;

(4) To encourage the use of 'cleaner' vehicles for goods deliveries in the city;

(5) To facilitate the completion of the 'City Freight Delivery Plan' and disseminate the new opportunities provided.

A2 Description

In the past, the low capacity of Bologna's mediaeval city centre (e.g. circulation and parking) has often led to heavy congestion, distorting both architectural and environmental values and thus producing a very negative impact on the quality of life within the whole historic centre. Therefore, the Limited Traffic Zone was introduced in 1989. It covers 3.20 km^2, practically the whole of Bologna's historic centre.

The 'City Freight Delivery Plan' approved on March 6, 2006 was the key instrument through which the City of Bologna aimed to rationalise freight delivery in the city area. It was strictly connected with the existing and future IT systems. The overall goal was to decrease the number of kilometres travelled while still providing the same services and deploying 'cleaner' vehicles. Thus, beyond the deployment of 'cleaner' vehicles, the rationalisation of freight delivery was expected to maximise the load of each lorry or truck heading into the city centre. The aim was to deliver a higher number of goods with the same pollution impact and reduce pollution to satisfy the current freight demand.

The main objectives of the Freight Delivery Plan were:

- to rationalise the management of city access permits and introduce new rules for operators normally accessing the city centre for their business;
- to convert and introduce new 'low emission' vehicles to reduce the environmental impact;
- to decrease the volume of vehicle access by rationalising truck loads and freight delivery paths;
- to rationalise road use and the deployment of loading/unloading areas.

The Freight Delivery Plan implementation was divided into three phases:

1. the introduction of faster issuing procedures for access permits, new pricing policies and the enforcement of new policies related to city centre access;
2. the 'pay-to-access' LTZ service;
3. 'Van Sharing', setting up a 'Technological transit point' to be tested in a specific area of the LTZ. A transit point is normally a site where goods from the producer or the main distributor are stored. There is a detailed organization about when and how they will be sent to the final destination. The Bologna project aimed to set up a virtual structure, handling the same task via a technological centre which was in charge of collecting orders, organising loading and unloading trips, searching for optimal paths, dynamically redirecting activities and booking the reserved parking slots.

Before CIVITAS Mimosa, the first two phases of the Plan were accomplished.

With Measure 7.1 the city of Bologna intended to implement supporting actions for the third and final phase of the plan, in order to evaluate it and find inputs for its future development.

The supporting activities included:

- **monitoring and studying the freight distribution trend in the city** (also involving the stakeholders) in order to fine tune the deployment of the technological and organisational system;
- **encouraging the involvement** of small operators who might benefit from the technological platform **to be deployed and validated** by the Municipality; own-account freight operators had a much lower delivery rate (number of loads delivered per time unit and per trip) and saturation rate (capacity level used per vehicle) than third account operators, because of the lack of trip programming and a 'just in time' delivery policy. The aim of this Measure was **thus to encourage own-account operators to join a consortium**, which combined the benefits of being own-accounts (autonomy and independence) with the benefits of being a third-party operator (more efficiency and effectiveness). The consortium was to integrate information, transportation, inventory, warehousing, material handling and packaging. Hence software **was needed** in order to model, analyse, visualize and optimize the logistics services.
- after the introduction of the technological platform, **new access policies were planned for the city centre**, in order to favour less polluting vehicles with wider time slot access permits.

B Measure Implementation

B1 Innovative Aspects

The innovative aspect of the Measure was:

- **Use of new technologies**

The main innovative aspect of the Measure was the integration of road pricing policies and technological tools (the virtual IT platform for freight delivery and the new traffic control centre 'CISIUM', see Measure 8.3) in order to optimise vehicle movements. In the course of this Measure, the implementation of the 'Technological Transit Point' was evaluated.

The Technological Transit Point combined a physically diverse architecture (transit points) with a unified software control scheme. The objective was thus to create a platform doing the same tasks as the main distributors (third-account operators); in addition the platform had to act on a conceptual (virtual) unified centre (the technological platform) and a physically diverse architecture (every structure of the own-account operators).

B2 Research and Technology Development

RTD analysis consisted of a study aimed (i) at correctly describing the current situation of freight distribution in the city; (ii) at illustrating the technological platform in Bologna and the process adopted; and (iii) conducting tests to verify the Van Sharing efficiency and effectiveness.

Based on the current goods distribution conditions in the city, studies and analyses conducted by the Municipality of Bologna (in collaboration with the Emilia-Romagna region and the University of Bologna) showed that a good solution to cope with freight distribution issues would be to create a light-shape consortium made up of a group of small operators to deliver goods in the city centre. The process implementation included a combination of the following elements:

- The Van Sharing System, the IT platform;
- The bookable loading bays implemented and managed by ATC/TPER, the company for Local Public Transport services in the Municipalities of Bologna and Ferrara, in which the main shareholders were the Municipality of Bologna and the Province of Bologna.

As part of the RTD analysis, field tests and simulations were conducted to verify the effectiveness of the Van Sharing system (iii) and the benefits that could be derived from its full deployment.

It accounted for two different methodologies, which configured **two separate tests**.

Test. 1

Test one reported the results of an experiment consisting of practical field testing of the Van Sharing system. The test considered the actual case that took place in March 2010, when a series of delivery orders was posted by three different medium-size operators (O1, O2, O3), subdivided into a set of delivery orders (D1, D2, D3) for a total of 26 orders.

In this case a '**before case**', whereby the three different operators independently performed their set of delivery orders (supported by a simple route optimization tool), was compared to an '**after case**', when the same set of orders was performed by Van Sharing vehicles, using the Platform to conduct route planning. This experiment effectively demonstrated a real example of the positive impacts of order aggregation and, in general, of vehicle routing

optimization using a Van Sharing travel planning tool to accomplish the same deliveries, in terms of:

- overall time spent;
- overall distance travelled;
- number of accesses to the city centre.

In the case studied, all operators had their headquarters at Interporto (both in case of the single operators as well as the Van Sharing operator). Furthermore, there was a single pickup point for all deliveries, located on the outskirts of the city of Bologna, a highly relevant transit point in Bologna's inter-modal network. For each route the first stop had to be at the pickup point, which happened to be the loading site for all of the 26 orders.

Test 1 results

The following table illustrates the results of the comparison between the **before** (the three different operators perform independently) and the **after** solution (the same set of orders is performed by shared vehicles using the actual platform to conduct route planning). As expected, by reducing the number of trips needed to fulfil the entire order, there was a relevant reduction in overall trip duration and overall distance covered. There was also some reduction in distance covered/time spent within the city centre.

TABLE B2.1: Test n. 1- Comparison between before and after solutions

		before case solution	after case solution	percentage comparison
number of accesses to the city centre		3	1	-66,67%
overall distance travelled	km	146,35	72,00	-50,80%
whereof in the city centre	km	37,75	35,80	-5,17%
overall trip duration		4h 05	2h 28	-39,59%
whereof in the city centre		1h 44	1h 41	-2,88%
approximated total unload time		2h 10	2h 10	
total shipment time		6h 15	4h 38	-25,87%
total time spent in the city centre		3h 54	3h 51	-1,28%

Source: Municipality of Bologna

Test 2 consisted of a desk simulation, supported by a generic route optimization tool, to account for a more complex mix of pick-up and delivery points and introducing van capacity constraints, which confirmed the benefits of freight flow aggregation. The simulation focused on a slightly more complete example, in which a number of variables were considered:

- the saturation levels of the vans;
- a wider range of operators, with two relatively structured operators (BIG_1 and BIG_2 owning storage facilities and vans of different capacities) and 3 smaller operators (A, B and C), whose vans had a more limited capacity and no additional storage facilities (hence performing same-day-pickup-and-delivery shipments);
- a more heterogeneous mix of deliveries, pickup and pickup-and-delivery shipments had to be performed.

For each of the above-mentioned operators, particular features were found regarding:

- the location of the operational base;
- the shipments to be performed, in terms of pickup location and delivery location addresses;
- the description of shipment routes followed, in terms of:
    - route map;

- o route progress (visit order and load progress);
- o route analysis.

Test 2 results

The second table underlines the differences that occurred in test number two, between the before case solution and the after case solution with the optimised Van Sharing platform.

TABLE B2.2: Test number 2-Comparison between before and after solutions

		before case solution	after case solution	percentage comparison
number of vehicles accessing the city centre		5	2	-60,00%
overall distance travelled	km	125,20	102,80	-17,89%
whereof in the city centre	km	33,55	23,50	-29,96%
overall trip duration		3h 35	2h 42	-24,65%
whereof in the city centre		1h 39	1h 05	-34,34%
approx. total load/unload time		2h 40	2h 40	
whereof in the city centre		1h 30	1h 30	
total shipment time		6h 15	5h 22	-14,13%
total time spent in the city centre		3h 09	2h 35	-17,99%

Source: Municipality of Bologna

The two tests done by the Municipality of Bologna highlighted the importance of a structured system which allows for a more efficient delivery service. The results underlined how important the effects of a Technological Centre for the optimization of goods deliveries would be, allowing for a 60% reduction in vehicles accessing the city centre (66% in test one), -25% in shipment times for the first simulation, - 14% in the second case, and a significant decrease in the overall distance travelled.

B3 Situation before CIVITAS

As reported above, in 1989 the Municipality of Bologna introduced the Limited Traffic Zone (LTZ). All streets providing access to the city centre and the main bus lanes were equipped with cameras to check whether vehicles accessing the city centre were authorized. Inside the LTZ there is another area called the 'T-zone', which is considered very important for public transport; in this area restrictions are higher than in the LTZ. The Municipality of Bologna defined a permit policy in order to limit improper access. Improper access also referred to permits issued for non-continuative deliveries. Research carried out in 2001 showed how the 2800 counted freight vehicles with access permits (named operative marks) accounted for only 5% of deliveries.

The 'City Freight Delivery Plan' was approved on March 6, 2006, before the Mimosa project, with the aim of rationalising freight delivery in the Limited Traffic Zone. For the success of the plan, support actions were essential. As explained above, these were carried out by the Municipality as part of the CIVITAS MIMOSA project.

B4 Actual Implementation of the Measure

The Measure was implemented in the following stages, covering all the planned activities:

Stage 1 Data collection for related evaluation (from October 2008 to the end of the Measure): freight analysis was introduced in cooperation with local stakeholders, continuing throughout the Measure, to identify individual trends and scenario modifications.

Stage 2 Implementation of Van Sharing system

- (October 2008/ October 2009) the technological platform for the virtual transit point (collection of freight orders, programming and optimising trips and loads) was implemented and tested;
- (October 2009/ October 2010) the integration of the new traffic control centre (see Measure 8.3) and the Van Sharing technological platform was completed. The new traffic control centre (CISIUM) sent information on road events (such as road works) to the Van Sharing system in real time.
- Operators can join via the internet: http://77.89.9.122/VanSharing/
- (from October 2010 to date) adoption, by the Municipality of Bologna, of a French study methodology to record and catalogue different types of pull-in areas present in the city. Using an algorithm which considered different parameters, such as the distance of the pull-in areas from the shops and the number of shops close to the area, this study assigned a coefficient to every pull-in area. The first 8 pull-in areas detected by the study (with the higher values of coefficient) were selected for the introduction of advance bookings for companies participating in the Van Sharing.

Stage 3 New permits scheme (October 2011) new rules for access into the city centre and a new procedure for selecting parking slot modules was studied (March 2012).

Stage 4 Promotion of the consortium (from October 2010 to date): attempts were made to involve operators in the Van Sharing Consortium to increase dialogue with small operators, to better understand their conditions and requests and to develop a more appealing business model. At the start of the Measure, 14 operators expressed an interest in participating in the consortium. By the end, 30 more operators were potentially interested. However, the fear of losing market shares (because of having to share clients) and revenues (the recorded volumes did not optimize vehicle capacity) delayed the set up of the consortium. The Municipality, however, planned to introduce a system of economic incentives/disincentives to reduce or break down the economic gap.

B5 Inter-Relationships with Other Measures

Measure 7.1 was part of the Municipality's general strategy, via the PGTU (Urban Traffic Plan), to improve road safety and mobility and reduce pollution. Therefore it is possible to consider this Measure in a more general context which also includes the effects of other measures.

Nonetheless, there is no bundled indicator for this Measure: even though it appears similar to BOL 3.1, it focused on a different issue. Measure 3.1 was aimed at private vehicles, but Measure BOL 7.1 focused on freight delivery operators.

It should be considered that like Measure 7.1, Measures 3.1 (road pricing policies), 4.1 (mobility management) and 1.2 (clean vehicles) also pursued the same high level objective – improving air quality – even though they had their own targets and domain of application. For this reason a bundled indicator for these 4 measures is the level of particulate 10 and particulate 2.5 recorded throughout the Municipality, even where no Mimosa measures were applied. This was an average value based on data collected every day from fixed points.

Obviously this value was influenced by many other factors which were not always connected to the Mimosa project and often unrelated to traffic behaviours (for example, changes in the area around the monitoring station while the Measure was in force). Nonetheless, changes in pollutant emissions could be considered strictly connected to traffic conditions and changes in driver behaviour.

C Impact Evaluation Findings

C1 Measurement Methodology

C1.1 Impacts and Indicators

The Measure introduced a set of activities to implement the third part of the freight delivery plan, in order to rationalise freight delivery in Bologna's Limited Traffic Zone. By rationalising delivery, the Municipality intended to obtain a higher quantity of goods delivered with the same pollution impact, or a lower pollution impact to satisfy freight demand in the city centre. Therefore, the first indicators to be evaluated were the level of pollutant emissions generated by freight vehicles accessing the LTZ (indicators 1-4) and the number of vehicles/deliveries recorded in the LTZ (indicators 8-9). In order to demonstrate the efficiency and effectiveness of Van Sharing, economic indicators were introduced with reference to operating costs, duration of delivery and saturation rates (indicators 5 to 7). However, indicator n°6 was deleted fom the list of indicators because it was not available.

As reported above, like Measure 7.1, Measures 3.1 (road pricing policies), 4.1 (mobility management) and 1.2 (clean vehicles) also pursued the same high level objective – improving air quality – even though they had their own targets and domain of application. For this reason a bundled indicator for these 4 measures is the level of particulate 10 and particulate 2.5 recorded throughout the Municipality (indicator 10), even where no Mimosa measures were applied.

TABLE C1.1.1: 7.1 common core indicators

No.	Evaluation area	Evaluation Category	Impact	Indicator	Source of data
1	Environment	Pollution/ Nuisance	Emissions	CO emissions	COPERT estimate
2	Environment	Pollution/ Nuisance	Emissions	CO2 emissions	
3	Environment	Pollution/ Nuisance	Emissions	NOx emissions	
4	Environment	Pollution/ Nuisance	Emissions	particulate emissions	
5	Economy	Costs	Operating Costs	Operating Costs	IT system

TABLE C1.1.2: measure specific indicators

No.	Evaluation area	Evaluation Category	Impact	Indicator	Source of data
~~6~~	~~Economy~~	~~Costs~~	~~Operating Costs~~	~~Mean delivery time~~	~~IT system~~
7	Economy	Costs	Operating Costs	Mean n. of packages for each delivery	IT system
8*	Transport	Transport system	Freight Movements	Total n. of freight vehicle accesses to the LTZ	IT system
9	Transport	Transport system	Freight Movements	Total n. of deliveries per vehicle	IT system

* Indicator No.8 is a specific indicator because it referred to a restricted area of the city

TABLE C1.1.3: Bundled Indicator -7.1-3.1-4.1-1.2

No.	Evaluation area	Evaluation Category	Impact	Indicator	Source of data
10*	Environment	Pollution/Nuisance	Emissions	Particulate emissions	Data registered by fixed stations in the centre of Bologna

* Indicator 10 was chosen to monitor and check polluting emissions for the whole of the Municipality

Indicator 1 - 4 'Environment evaluation area'

Based on the COPERT methodology, the impact of emissions was calculated using the variations caused by the measure. The COPERT method was applied to Bologna's car fleet composition by fuel type, associating a level of emissions with each vehicle type. The driver for these indicators was the number of vehicles recorded by SIRIO (the system monitoring access to the LTZ). The trend of freight vehicles recorded by SIRIO during an average working day was considered. The hypothesis was that the number of vehicles coming in had the same percentage composition as the permits recorded year by year, considering only light duty vehicles divided by fuel types.

Calculations were made after the Measure had been implemented to check on the results. The unit was tons/year, the domain of the analysis was freight delivery vehicles accessing the LTZ.

The following hypotheses were made when applying the COPERT methodology:

- The same percentages and categories of Municipality of Bologna-registered fleet can be applied to light duty vehicles (less than 3.5 tons) used for deliveries in the LTZ.
- One vehicle covers 4.2 km a day inside the LTZ (Van Sharing average data).
- There are 240 working days in one year.
- The average speed in the urban area is 23. 3 km/h (see chapter E (1)).

Indicator 5 'Operating costs'

This indicator focused on changes in operating costs as a result of this Measure and, therefore, on the economic perspective of the intended measure packages. In addition to social and environmental perspectives, the inclusion of the economic perspective was important for a complete assessment of the Measure's sustainability.

Average operating cost was defined as the ratio of total operating costs incurred by a service divided by the total number of goods-km or vehicle-km travelled for that specific service in a

given time period (for example a day, week, month or year). Operating costs included personnel costs, fuel, electricity and maintenance costs for the vehicles involved.

So: A = B / C [Unit: €/pkm or €/vkm]

where: A = Average operating cost for the service (€/pkm or €/vkm)

B = Total operating cost for the service (€)

C = Total goods*kilometres (pkm), or total vehicle*kilometres (vkm), for the service

Method of data collection: The data needed was provided by service operators.

Frequency: Once a year until the end of the project.

Domain: Freight delivery vehicles which joined the Van Sharing and accessed the LTZ.

Indicator 6 'Mean delivery time'

The performance of urban freight systems depends on a variety of factors related to vehicle types, delivery schedules, load optimisation, etc. This indicator focused on the reduction of the average delivery time as a result of this Measure, and therefore on the economic perspective. Mean delivery time was defined as the length of time between the preparation of a product and its delivery to the end consumer. It therefore represents the time required for deliveries, and is a measure of the optimization of the delivery program.

Frequency: Once a year until the end of the project.

Domain: Freight delivery vehicles which joined the Van Sharing and accessed the LTZ.

Indicator 7 'Mean number of packages for each delivery'

This indicator focused on load maximization of the freight vehicles entering the LTZ. Mean number of packages for each delivery was defined as the total number of goods delivered to the end consumers in the course of a delivery.

Frequency: Once a year until the end of the project.

Domain: Freight delivery vehicles which joined the Van Sharing and accessed the LTZ.

Indicator 8 'Total number of freight vehicle accesses to the LTZ'

This indicator provided a simple – though approximate – measurement of the overall impact of freight traffic on the urban transport system. Freight vehicle accesses were defined as the number of freight vehicles accessing the LTZ, recorded by SIRIO cameras (access enforcement system).

Data was recorded by cameras in the LTZ zone. These considered the 'operating permit' stickers which enable drivers to enter the LTZ for business reasons. The windscreen stickers are issued to shop employees as well as freight vehicles.

Unit: Number of movements per day.

Method: The counting of freight movement included mass freight transport and small deliveries.

Frequency: Once a year until the end of the project, data from an average working day.

Target group: All freight vehicles accessing the LTZ.

Indicator 9 'Total number of deliveries per vehicle'

The performance of urban freight systems depends on a variety of factors related to vehicle types, delivery schedules, load optimisation, etc. This indicator focused on the optimisation of delivery schedules.

Total number of deliveries per vehicle was defined as the total number of goods delivered by each vehicle in a certain period of time (day, week, month, year).

Frequency: Once a year until the end of the project.

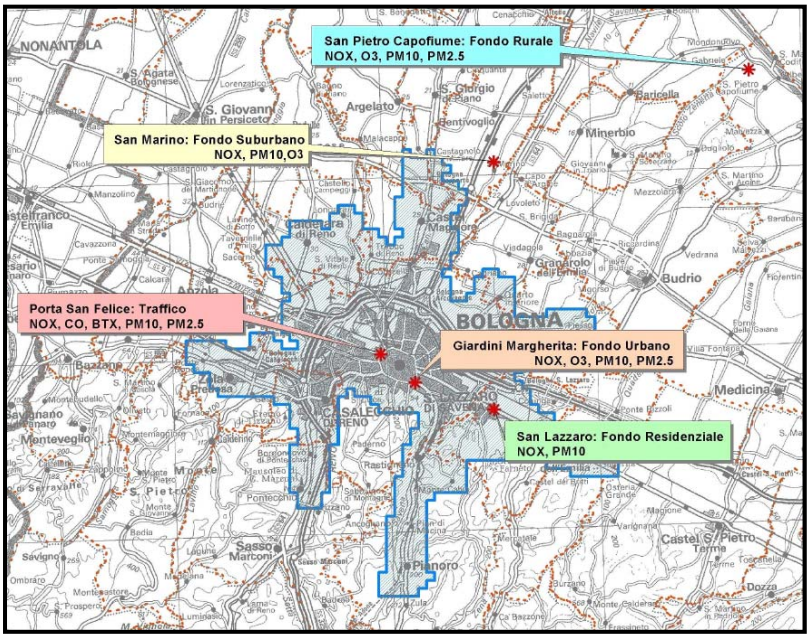
Target group: Freight delivery vehicles which joined the Van Sharing and accessed the LTZ.

Indicator 10 'Particulate emissions' recorded at fixed stations

Indicator 10 was chosen to monitor and check pollutant emissions throughout the Municipality, in common with Measures 3.1, 4.1 and 1.2.

The map below shows the actual location of the fixed stations (in 2011) and their capacity for recording pollutant emissions. Of these, the Porta San Felice station was chosen because it is inside the city centre and had produced a historical trend of PM 10 and PM 2.5 data.

FIGURE C1.1.1: Bologna fixed stations locations



Source: ARPA Regional Agency for the Environment

Frequency: Data was collected every day; data included in this document is the average value of 365 items of data recorded over a year.

Unit: $\mu g/m^3$ (average daily production)

C1.2 Establishing a Baseline

The first two parts of the freight distribution plan were already implemented before Mimosa. The third was monitored and reported during the Mimosa project. The newly deployed traffic regulations produced some good results, representing the starting point for the evaluation phase. In 2004-2005 a study was carried out on the freight delivery system in the centre of Bologna. A campaign was carried out at the *9 city centre entrance points* during winter weekdays (from 7 am to 8pm). The study followed the 'City Port' methodology from 'Community Initiative INTERREG IIIB' and considered all the main goods chains (hospitality industry, dry goods, fresh goods, frozen, non- food). The campaign lasted two years. It contained data regarding freight delivery services for an average weekday. The results were used as the baseline for the Measure.

Indicators 1 - 4 'Emissions' The baseline is the level of emissions before the Measure was implemented. The COPERT method was used for registered freight vehicles entering the LTZ as recorded during the 2004/2005 study.

Indicator number 5 was not available from private operators, as none were willing to reveal their costs. The value was not recorded before Mimosa was in force, but it was kept as an indicator to establish whether the growth in volumes increased the economies of the Van Sharing.

Indicators 6 – 7 – 8 - 9. Data was obtained from the 2004/2005 study, referring to an average weekday.

As explained in the results section, data showed that in spite of a comparable number of accesses to the LTZ, third party operators made nearly twice as many deliveries/pick-ups as own-account operators. The reason was that the own- account service was less organized and less efficient than the third party services, which had technological tools and systems.

Indicator 10 'Particulate emission' recorded at fixed stations. Values of PM10 and PM2.5 recorded at a check point in Porta San Felice during the years before Mimosa are shown in the results section. Data is available from 2003 for PM10, and from 2004 for PM2.5.

C1.3 Building the Business-As-Usual Scenario

Failure to set up the consortium meant that use of the Van Sharing service was very low. Accesses to the LTZ by vehicles requesting the Van Sharing service totalled less than one a day and the coefficients of occupancy of these vehicles were lower than those of single operators. Therefore, the Measure had no effect on other operators' habits: the business-as-usual scenario has been presumed to be equal to the post-Mimosa scenario. However, despite the limited service requests received, it was still decided to proceed with the evaluation of the Measure using the proposed indicators.

Indicator 10 did not cover freight vehicles but, as a bundled indicator, it is useful for checking environmental benefits for residents of Bologna. BaU was built for this indicator using the average value of five years before the Mimosa project (where possible). The fixed station is located in the centre of the city, inside the LTZ.

C2 Measure Results

The results are presented under sub headings corresponding to the areas used for indicators.

C2.1 Economy

Indicator 5 'Operating Costs' The fifth indicator was not assessable before Mimosa, and generally for all operators which did not participate in the Van Sharing. The costs and revenues of individual carriers are not published and no one was willing to reveal them. However, indicator 5 was very important for checking the development of the Van Sharing to be monitored during the measure.

The table below resumes the operative costs spread for different economic/transportation indicators. As mentioned no comparisons can be done with previous data because they are not available yet. Nevertheless indicator allows meaningful considerations about the growth of the consortium and its up-scaling economies. Growing up, the Van Sharing increase its competitiveness with private operators and became more attractive for small its-own carriers.

TABLE C2.1.1: Indicator 5 results- Operation costs of freight delivery vehicles which joined the Van Sharing and accessed the LTZ

FREIGHT DELIVERY VEHICLES	Unit	Baseline	2010	2011	2012*
Indicator 5 Operating Costs	€/delivery	Not assessable	126,17	74,62	N.A.
	€/trip	Not assessable	642,18	455,43	N.A.
	€/packages	Not assessable	33,64	17,94	N.A.
	€/kg	Not assessable	2,06	1,22	N.A.
	€/m^3	Not assessable	451,75	314,35	N.A.
	€/km	Not assessable	8,01	3,24	N.A.
	€/day	Not assessable	331,72	280,74	N.A.

* Operating costs are not available for 2012.

Indicator 6 'Mean delivery time (duration)' and Indicator 7 'Mean number of packages for each delivery'

TABLE C2.1.2: Indicator 7 results-Freight delivery vehicles which joined the Van Sharing and accessed the LTZ

FREIGHT DELIVERY VEHICLES	Baseline*	2010	2011	2012**
Indicator 7 Mean n. of packages for each delivery	6,1	3,75	4,16	51,05

Source: Municipality of Bologna

* Data for the Baseline are from the survey between private operators did in 2004- 2005.

** Data for 2012 is from the first half of the year; it has been included in the MRT for completeness, but the scenarios were compared using the latest full year values available (2011). Data from 2012 was not fully comparable with the years before because the Van Sharing was used to forward stationeries, which imply a large number of packages in that single delivery which raise the indicator value for 2012.

Private operators are represented in the table by baseline values, where the survey investigated exclusively private businesses. Data from the survey was not complete because private operators did not publicise their own costs/revenues. With reference to indicator number 7, the comparison between pre and post Mimosa results showed that not only were the daily moved volumes lean but that their optimization was also not as good as private forwarders' (data show a better process optimization for private owners, who are able to have more packages for each delivery).

TABLE C2.1.3: Economic indicators, comparison between scenarios; freight delivery vehicles which joined the Van Sharing and accessed the LTZ

FREIGHT DELIVERY VEHICLES	Unit	Pre Mimosa (Baseline 2004 - 2005)	BaU	Mimosa (2011)
Indicator 5: Operating Cost	€/delivery	-	-	74,62
	€/trip	-	-	455,43
	€/packages	-	-	17,94
	€/kg	-	-	1,22
	€/m^3	-	-	314,35
	€/km	-	-	3,24
	€/day	-	-	280,74
Indicator 7: Mean no. of packages in each delivery		6,1	6	4,16*

Source: Municipality of Bologna

* Indicator 7 data from 2012 is from the first half of the year; it has been included in the MRT for report completeness but the two scenarios were compared using the latest full year values available (2011) and the baseline data.

C2.2 Energy

Not applicable.

C2.3 Environment

The following table shows the results of pollutant emissions indicators, applying the COPERT method and the hypotheses presented in part C.1.

TABLE C2.3.1: Emission [ton] results for whole years-all vehicles entering the LTZ

FREIGHT DELIVERY VEHICLES		2010	2011	2012
Indicator 1- 4	CO [ton/year]	N.A.	23,286	28,296
	Co_2 [ton/year]	N.A.	1.592,371	1937,716
	NO_X [ton/year]	N.A.	7,454	9,069
	$PM_{2.5}$ [ton/year]	N.A.	0,677	0,824
	PM_{10} [ton/year]	N.A.	0,755	0,919

Source: TeMA calculations using COPERT data and method

TABLE C2.3.2: Pollutant Emissions [ton] Results-2011- all freight vehicles entering the LTZ

FREIGHT DELIVERY VEHICLES		**Pre Mimosa** (Baseline 2004 - 2005)	**Mimosa** (2012)	**Λ Mimosa vs. Pre Mimosa**
Indicator 1- 4	CO [ton/year]	22,876	28,296	+ 5,42
	CO_2 [ton/year]	1.565,017	1.937,716	+ 372,699
	NO_X [ton/year]	7,325	9,069	+ 1,744
	$PM_{2.5}$ [ton/year]	0,666	0,824	+ 0,158
	PM_{10} [ton/year]	0,742	0,919	+ 0,177

Source: TeMA calculations using COPERT data and method

The results show that there was no optimization of pollutant emissions from freight traffic. This is because the trend of accesses/ kilometres recorded in the LTZ (with reference to freight vehicles) increased in the last two years. The Van Sharing incapacity to became competitive and lure market didn't improve the accesses of deliveries and rather the increasing demand of goods coming from the LTZ tells a growth of accesses and the pollutions emissions. This result comes from the actual insistence of alternative attractive solution to private forwarders.

Indicator 10 'Particulate emissions' recorded at fixed stations

Concerning the bundled indicator, values of PM 10 and PM 2.5 were recorded at the check point in Porta San Felice and are shown in the following table.

TABLE C2.3.3: Average PMx daily emissions (µg/m3)

PORTA SAN FELICE	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
PM 10 (µg/m^3)	45	40	42	45	42	37	34	34	37
PM 2.5(µg/m^3)	-	28	30	31	28	25	22	21	23,1

(*)Threshold Limit Value (PM10): 40 µg/m3; for PM2.5: 25 µg/m3 to be achieved by 2015 (Decree 155/2010)
Source: ARPA Regional Agency for the Environment

A comparison between 2006-2011 pollution data shows a decreasing trend, with a slight increase in 2011. Data is from the unique fixed station in the centre of Bologna and resume the average daily values registered every day during one year. As the graph below shows, values pre Mimosa wave around 42/43 *µg/*m^3 that is higher than values during MIMOSA's project where it was around 38 *µg/*m^3. Considering the analysis is restricted to a single station, it is difficult understand the concrete contribution of MIMOSA to this bundled indicator, nevertheless it can be certainly affirm with Mimosa the air quality improved, probably thanks to the grouping of all the measures implemented.

FIGURE C2.3.1: average daily PMx emissions (µg/m^3)

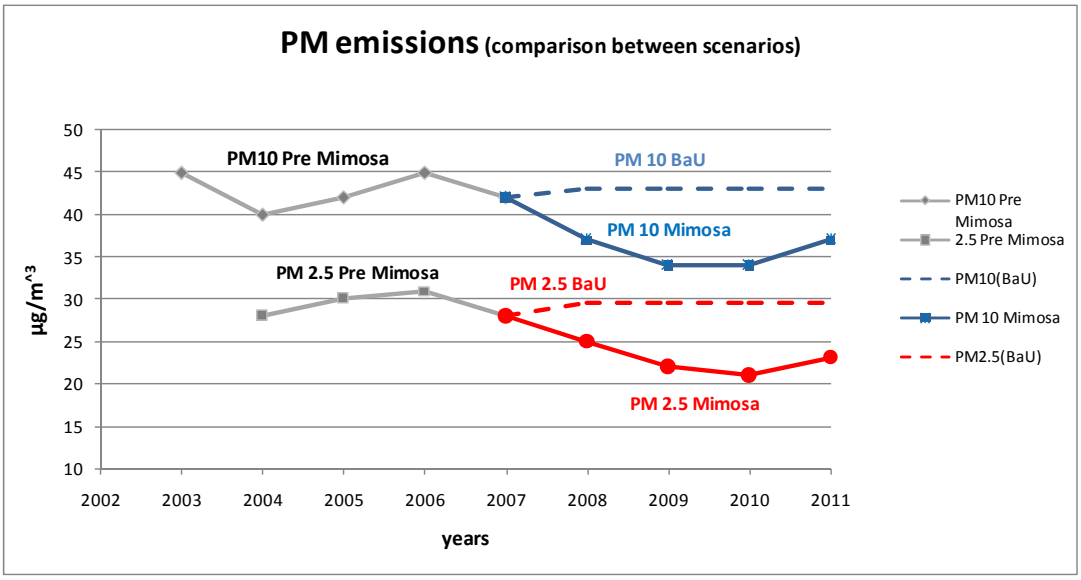


TABLE C2.3.4: PMx emissions, comparison between scenarios (µg/m3)

Average daily value (µg/m^3)	Pre Mimosa (baseline 2007)	BaU (average of 3 years before)	Mimosa (2011)	Mimosa VS. baseline	% Mimosa VS. baseline	Mimosa VS. BaU	% Mimosa VS. BaU
PM 10	42	43	37	-5	-12%	-6	-14%
PM 2.5	28	29,6	23,1	-4,9	-17,5%	-6,5	-22%

C2.4 Transport

The data on post Mimosa implementation for indicator no. 8 considered all vehicles accessing the LTZ in order to evaluate the effects of the Municipality of Bologna's road pricing policies for freight vehicles. For additional information, Van Sharing data referring to indicator no.8 is shown in brackets.

Indicator 9 refers to Van Sharing information, considering that bigger operators (third party) are better organized and more efficient than smaller operators. The 2004/2005 study showed that in spite of a comparable number of accesses to the LTZ, third party operators made nearly twice the number of deliveries/pick-ups as own account operators. Third party operators made 13.37 deliveries per vehicle vs 9.1 for own account operators and 2.63 pick-ups/vehicle vs 1.34 pick-ups/vehicle for own account operators. The monitoring of van sharing data should make it possible to show an improvement in the direction of third party operators' levels.

TABLE C2.4.1: Transport indicators Results

FREIGHT DELIVERY VEHICLES		Baseline (2004/2005)	2010	2011	2012*
Indicator 8 – all vehicles (Van Sharing)	N. of accesses to the LTZ (7-20) (average **daily***)	**1.782 (-)**	**N.A (0,5)**	**4.913** (0,6)**	**5.981**
Indicator 9A – Van Sharing	Deliveries/vehicle	**11,35**	**5,09**	**6,1**	**4,62**
Indicator 9B – Van Sharing	Pick-ups/vehicle	**2,02**	**19,09**	**25,39**	**235,81**
Data for 9A/B –(Van Sharing)	*N. of deliveries in LTZ - average daily*	*20.231*	*(3,0)*	*(3,6)*	*(3,13)*
Data for 9A/B -(Van Sharing)	*N. of pick-ups in LTZ – average daily*	*3.604*	*(9,8)*	*(14,9)*	*(159,7)*

* Data was calculated considering 230 working days in a year. (**) In 2011 two studies were carried out on average working days in May and November. Data shown refers to the May study.
*2012 dat is from the first half of the year.

The values shown above (particularly indicator 8) show the small scale of Van Sharing and the fact that it is still not integrated in Bologna's delivery dynamics (the project moved more or less 0.01% of all deliveries in Bologna's LTZ). Comparisons between the BAU and the Mimosa scenario are not significant due to the small volumes moved by the Van Sharing .

C2.5 Society

Not applicable.

C3 Achievement of Quantifiable Targets and Objectives

No.	Target	Rating
1	To demonstrate the impact that a regulatory action on freight distribution can have on urban traffic congestion and pollution levels in the city of Bologna	★
2	To optimise and develop effective integration between road pricing policies (aimed at controlling freight vehicle trips) and technological tools	★
3	To help decrease the number of kilometres travelled by freight delivery vehicles while providing the same services	**O**
4	To encourage the use of environmentally friendly goods delivery vehicles in the city	**O**
NA = Not Assessed; **O** = Not Achieved; ★ = Substantially achieved (at least 50%) ★★ = Achieved in full; ★★★ = Exceeded		

The evaluation results did not state that the Measure was not appropriate or well conceived, but only that the Measure was not able to encourage operators to participate in the consortium.

Only with increased participation and thus more data would it be possible to verify the benefits of the two hypotheses studied in the first phase of the Measure (RTD analysis). In the future the Municipality will support this Measure with incentives for small private operators, helping the consortium: this is the first and main step in making it economically competitive in the goods distribution market.

C4 Up-Scaling of Results

Up-scaling was not possible for this Measure because it already covered the whole Limited Traffic Zone as a destination and starting point, involving all available stakeholders.

C5 Appraisal of Evaluation Approach

The evaluation approach followed in this Measure was strictly linked to cooperation with freight operators. The Municipality made efforts to study the possibility of such a new technology and opportunity. However, the lack of participation, due to the operators' fear of losing market shares by having to share clients and losing revenues (the volumes recorded do not optimize vehicle capacity) prevented the Measure from being implemented and evaluated correctly. Perhaps financial incentives are the only way to persuade small operators to participate.

Some of the indicators chosen before the Measure start-up were found to be not entirely appropriate at this stage of implementation. The operating costs of freight operators who were not in the Van Sharing were obviously not available, therefore it was not possible to compare Van Sharing costs with outsiders' costs. The barriers incurred did not lead to a change in the evaluation approach. Instead they were thought to be connected to the Measure itself. The approach of the Mimosa project does not seem to provide enough incentives at present to be successful.

C6 Summary of Evaluation Results

The key result is the following:

- the **weak market impact** jeopardised the implementation of the Measure.

Freight distribution operators were not attracted by the Van Sharing. Operators were reluctant to lose some of their autonomy, regardless of the economic advantages resulting from the participation in the consortium. The Municipality of Bologna now has to face this problem in order to clearly show the benefits of participation.

The Measure helped show the limitations of the initiative and gave inputs for further developments to city freight delivery plans.

C7 Future Activities Relating to the Measure

Based on the guidelines provided by Bologna's new City Councillor for Mobility, the 'T-Day' event (the closure of the city's central 'T-Zone': Via Rizzoli, Via Ugo Bassi and Via Indipendenza) became a fixed date on May 12, 2012. Every weekend and on public holidays, the 'T-zone' will remain open to cyclists and pedestrians only from 8:00am to 10pm. During these days, freight deliveries will take place between 6 to 9 am. As part of this project, additional restrictions for freight operators access to the centre were introduced, such as the possibility of paying more to access the centre.

In this sense the Van Sharing platform should become more viable, and this might be a good incentive to make the consortium more attractive in the future.

D Process Evaluation Findings

D1 Deviations from the Original Plan

- **The barriers prevented the Measure from taking off**- barriers encountered (see below) hindered the correct implementation and evaluation of the Measure.
- **Indicator n°6 was deleted from the indicator evaluation list** because data was not available.

D2 Barriers and Drivers

D2.1 Barriers

Overall barriers

weak market impact – The consortium, which was supposed to include freight operators and goods dealers, was not set up. There were different reasons for this:

- small freight operators were afraid to lose market shares because they would be sharing clients;
- potential customers (dealers) had to face higher costs for delivery in the start-up phase (+30%), because there was no critical mass (a minimum of customers that would have made it possible to obtain economic benefits).

distrust towards the scheme proposed - the added value of the Van Sharing was not well perceived, whereas the current service performed by small operators was very flexible and much appreciated. This was because the Van Sharing scheme created transhipment points in order to optimize deliveries. The result was that the Van Sharing enabled a decrease in the kilometres travelled for every delivery to provide the same services, but also meant lower revenues for freight operators.

The two barriers reported above were overlapping conditions common to all the Measure phases, from preparation to implementation. They represented the **main criticalities** that prevented the Measure from taking off. The initial results showed widespread resistance among small operators to creating a consortium as was originally planned.

D2.2 Drivers

Overall Drivers

The city of Bologna tried to enhance aspects which might increase the attractiveness of the consortium to potential operators, focusing on its tangible benefits:

New traffic regulations introducing access barriers to polluting vehicles: access rules for Bologna's 'T-zone' (a very important area in terms of history, business and tourism, comprising 3 streets that form a T- junction) were extended to the whole of the LTZ. In this case small operators, only having old and polluting vehicles, would encounter access restrictions for commercial areas**.**

Availability of the first online booking for parking slots: the parking slots were reserved for vehicles belonging to the Van Sharing and were monitored in real time through innovative technological devices, checking availability and avoiding unauthorised parking.

D2.3 Activities

Overall activities

- The activities undertaken in the course of different Mimosa phases were aimed at tackling the two aforementioned barriers which prevented the Measure from being successfully implemented.
- **Continuing close consultation with operators -** this activity started in the preparation phase and it was continued and intensified during the implementation and operation phases. The objectives were to finalise economic agreements and meet the needs of the potential participants. In addition, the Van Sharing system was promoted by contacting 21 operators (companies and administrations). The purpose of these initiatives was to share and promote the advantages of the system.
- C**onceding more benefits to the participants -** this activity was linked to the second driver mentioned above. The parking slots, reserved for vehicles adopting the Van Sharing, are monitored in real time through innovative technological devices to check availability and prevent unauthorised parking. In addition, based on a French study (see part B4) 8 pull-in areas were selected for the introduction of advance bookings for participants in the Van Sharing consortium. The Municipality of Bologna is waiting for permission from the city's Office for Cultural Heritage to install the booking stations in the historic centre. The installation of the booking stations in these 8 pull-in areas is expected by winter 2012. These actions were taken in order to further develop the project, increasing its added value and consequently the number of future participants joining the consortium.
- **Limiting access to the city centre –** this activity is connected to the first driver mentioned above. **Under** Measure 3.1 (road pricing policy), a new permit scheme based on renewed tariffs and access rules was put forward to Bologna's new Mobility Councillor. Restrictions were included for freight operator access to the city centre, such as limiting access to specific time slots and charging more for to access the centre. This strategy seems to be the most important means of increasing the participation in the consortium.

D3 Participation

D3.1 Measure Partners

- **Municipality of Bologna technicians** involved in the 'City Freight delivery Plan' and the support activity planned in this Measure.
- The **Emilia Romagna Region** supported the local policies and contributed to the analyses and the evaluation phases.
- **Gestione Servizi Interporto SRL**, a company fully owned by Gruppo Interporto S.p.A., a public-private company whose main shareholders are the Municipality of Bologna and the Province of Bologna. The company designed the IT platform.

D3.2 Stakeholders

- **Freight operators,** including own-account and third-party operators. Own-accounts ran freight services by themselves; third-party logistics involved external operators

performing logistic activities. According to this definition, third-party logistics included any outsourcing of logistic activities previously performed in-house.

- **Van Sharing operators**, logistic stakeholders equipped with vehicles and technologies to interact automatically with the Van Sharing centre. They were to provide transportation services according to the plans transferred by the platform and track all activities with on-board devices, for which they were to receive appropriate remuneration.

D4 Recommendations

D4.1 Recommendations: Measure Replication

- **Manage the resistance to change –** The initial results showed widespread resistance among small operators to creating a consortium. This failure is common to other European cities attempting to implement these kinds of measures. Despite the consortium not being set up, from a methodological and technical point of view the Measure was correctly implemented. RTD tests showed that the technological transit point would work and would have good effects on efficiency, the objective of the project. But the market effects and people's/companies' 'psychology' was overlooked when analyzing the possible effects. Probably the Measure failed because there was not the right incentive for freight operators to participate, for example fiscal benefits or other direct economic incentives. Cities interested in these kinds of interventions must concentrate their efforts on the difficulties of involving freight operators.
- **'Captive' participants–** Another strategy to be followed, after having offered economic benefits to the potential participants, is to radically limit access to the city centre and the flexibility that now characterizes urban freight services. This intervention, to be included in a general city context of 'sustainable mobility', substantially forces small freight operators to adopt more 'collective' means of delivery.

D4.2 Recommendations: Process (Related to Barrier-, Driver- and Action Fields)

- **To promote new technologies and the new system of rules**: efforts are needed as regards communication and promotion to study the possibility of this type of new technology, a new opportunity and a new plan for city centre deliveries. This means consulting very closely with small freight operators in order to finalise economic agreements.
- **To find objective benefits.** Cities interested in introducing these kinds of measures must find objective benefits from an economic point of view for potential participants (freight operators and retailers too) to make up for their loss of flexibility. Increasing the efficiency of the platform (with an average reduction in km driven with the new IT platform) decreases the number of kilometres travelled to provide the same services. This means, from the freight operators' point of view, **lower costs but also lower revenues** and fewer possibilities to maintain their market shares.

E References

- (1) M. Capobianco, G. Zamboni (Università di Genova), '*Valutazione del parco circolante, delle percorrenze urbane e dei fattori emissivi dei veicoli stradali nella città di Genova*', VII Expert panel Emissioni da Trasporto Stradale, Rome 16 January 2003