Measure title: **Safety Oriented Driving Training in Coimbra**

City: **Coimbra** *Project:* **MODERN** *Measure number:* **05.07**

Executive summary

The measure consists of the implementation of a Driving Centre at the Municipal Public Transportation Services of Coimbra (SMTUC) equipped with a high tech driving simulator tailored to the specific public transport vehicle requirements and in accordance with the European Directive 2003/59 - which establishes continuous driver education (35 hours every 5 years).

The Driving Centre has been implemented in new and dedicated facilities at the SMTUC installations and the simulator has been purchased through an international public tender with the following specific features:

- Real and dynamic cabin that reacts to the driving and movement conditions, three external film screens permitting "all around simulation" and a complete trainee monitoring system with external control and intervention capabilities.
- Virtual reproduction of real driving conditions with high quality graphics, including the simulation of trolleybuses and the possibility of changing traffic and environmental conditions at any time by the trainer, as well as the creation of unexpected occurrences.
- Simulation of the interaction with the passengers, including the passenger entry and their behaviour in the buses during the journey.
- Data storage of driver/trainee performances, including drivers' behaviour and virtual fuel consumption, as well as .pre-programmed lessons or the possibility to program and record new lessons.

A reference group of 25 SMTUC drivers has been set up and trained using the simulator in order to have time to evaluate the impacts of the driving training sessions. As key results it has been obtained that:

- The training using driving simulators led to a 15% reduction in the average operating costs when compared with the training using real buses (from 3,41 €/vkm to 2,90 €/vkm).
- During the driving training sessions using the simulator, a substantial improvement of the average fuel efficiency in mixed circuit was observed, corresponding to a 15% reduction in terms of energy consumption per vkm.
- Using a driving training simulator instead of diesel vehicles in real operational conditions has a significant impact on the average emissions per vkm (-19% of CO2, -85% of NOx and -93% of CO).
- The driving training simulator can help improve transport safety in terms of accident risk. By considering the same circuit and travelling distance covered during two driving sessions in the simulator made respectively before and after the training resulted to have a 33% reduction of the total number of incidents.

The functioning of the Driving Centre will continue in the future. A process of licensing the driving centre for the training of PT drivers from other companies is in course and partnerships with some specialised organisations are presently under consideration.

Due to the lower cost that the driver training would have and the increase in available resources (buses not used for training) that the simulator allows for, a significant raise in the number of training courses

and trainees is expected to happen. The European Directive 2003/59 seems also to be a good driver to increase the driving training activity. There would be fuel savings, pollution reduction, increase of safety, and higher levels of diving quality which would increase passenger comfort.

A Introduction

A1 Objectives

The measure objectives are:

(A) High level / longer term:

- To increase the safety in city and regional transports
- To reduce the fuel expenditures linked to transportation in the city and region
- To improve the air quality in the city and region

(B) Strategic level:

- To improve the quantity and quality of the training of heavy duty vehicles drivers at municipal and regional level (both for PT and freight transport).

(C) Measure level:

(1) To implement a training centre for heavy duty vehicles drivers, equipped with a dynamic driving simulator, that could allow reduce both the accidents rate (at least 5% in SMTUC drivers), as the fuel expenditures (at least 3% in the SMTUC fleet);
(2) To improve 10% the driving training sessions;.
(3) To perform at least 500 training actions during CIVITAS;
(4) To improve the cooperation between SMTUC and others fleet operators (PT operators, Municipality, Driving Schools, etc.).

A2 Description

The measure consists of the implementation of a Driving Centre at the Municipal Public Transportation Services of Coimbra (SMTUC) equipped with a high tech driving simulator tailored to the specificities of public transport vehicles and in accordance with the European Directive 2003/59 - which establishes continuous driver education (35 hours every 5 years) and recommended the use of driving simulators for this effect.

Due the technical complexity of the driving simulator, namely its technical innovation, special attention has been given to the models conception and the definition of technical specifications of the driving simulator as well as to the design of the Driving Centre.

The Driving Centre has been implemented in new and dedicated facilities at the SMTUC installations and the simulator was purchased in an international public tender with the following specific features:,

- Real, dynamic cabin, three external film screens permitting “all around simulation” and a complete trainee monitoring system with external control and intervention capabilities.
- Real dimensions and customisation of the cockpit.
- Real time dynamic cockpit reaction to the driving and movement conditions.
- Virtual reproduction of real driving conditions with high quality graphics, including the simulation of trolleybuses.
- Simulation of the interaction with the passengers, including the passenger entry and their behaviour in the buses during the journey.

- Possibility of changing traffic and environmental conditions at any time by the trainer.
- Simulation of unexpected occurrences.
- Data storage of driver / trainee performances, including drivers' behaviour and virtual fuel consumption.
- Pre-programmed lessons for the initial training of new drivers or continuous training for the others (recycling courses) or the possibility to program and record new lessons.

However, the lack of funding from the Portuguese government for the driving simulator purchase obliged SMTUC to carry out a long administrative process to assure self-financing through a loan contract. This process delayed the measure implementation obliging to use recovery actions. So, taking into consideration that the training in the driving simulator is being assured by SMTUC trainers, they have been previously trained in the simulators of the driving centre of EMT (Transport Enterprise of Madrid), allowing them to be prepared for the start-up of the new simulator.

Also a reference group of 25 of the 280 SMTUC drivers was set up to have the time to evaluate the impacts of the driving training sessions that began on 26th June 2012. This methodology allowed for more intensive training sessions in the driving simulator and assess the drivers' behaviour modifications in a shorter time span. Other training sessions in the simulator occurred during the measure operation in a total of 262 until November 2012.

In addition, promotional campaigns directed to other fleet operators have been carried out to enlarge the target group of drivers that can benefit from safety and eco-driving training. Several news items were published in newspapers, magazines and websites, as well as several visits were conducted to the driving simulator, with emphasis being given to the Study Tour co-organised with VANGUARD.

The visit made by ANTROP (the Portuguese Association of Public Transport Operators), with the objective of establishing a partnerships for the large scale training of other companies and institutions has been also very important.

B Measure implementation

B1 Innovative aspects

The innovative aspects of the measure are:

- **Innovative aspect 1 – Use of new technology/ITS**
  - There is no driver simulator available in the Centre Region of Portugal, of which Coimbra is the capital, and the 2 simulators existing in Portugal (Lisbon and Porto) are not targeted to passenger transportation because they don't simulate passenger interaction. Also important is the innovation at the international level with the simulation of trolleybuses driving.
  - Increase of the driver training hours in bus driving of public transport, decreasing the energy consumption and the number of accidents.
  - Quicker and better training monitoring due to the fact that the corrections can be more efficiently pointed out to the trainees.
  - Advantage given by the possibility to simulate unpredictable or emergency situations that aren't possible to realize unless using a simulator.

- **Innovative aspect 2 – Targeting specific user groups**
  - We consider that this is the best way to stimulate the continuous education of professional drivers of large vehicles, extendable to private fleet drivers, namely the younger ones that are satisfied with new technologies.

B2 Research and Technology Development

The research and technology development consisted mainly by the following:

- Online and literature research for the state-of-the-art on driving simulators technologies and functionalities with the objective of defining the simulator specifications.
- Development of a state-of-the-art driving simulator with real dynamic reactions in the driver's cockpit and "all around" simulation of the scenario and simulated objects.
- Simulation of the interaction with the passengers, including their reactions to the driving conditions.
- Innovative simulation of graphics and physical level of trolleybuses driving, including the model conception of streets with trolleybus feed lines.

The driving simulator allows for organising training sessions tailored to the specific need of public transportation. These training sessions permit public transportation professionals to respond more resourcefully to real life situations. Some of the specificities that the simulator provide are: different atmospheric conditions; types of roads; traffic levels; 180º visual field with streets, buildings, sign posts; environmental and interior sounds; driving and accident/failure simulation; etc.

From an operational point of view the simulator has numerous aptitudes and functions such as the faithful reproduction of environmental conditions, as well as the simulation of different bus models and existing trolleybuses. This is possible due to the quick and straightforward exchange of real bus components (e.g., instrument panel, steering wheel, pedals), which gives SMTUC the possibility of providing training to drivers from other companies and which use other models.

The new simulator offers a real qualitative enhancement to the level of instruction provided to public transportation drivers because it allows for safely simulating risk situations – for instance, adverse weather or traffic conditions. It also increases the teaching flexibility since SMTUC is no longer reliant on available vehicles or external conditions for organising training sessions. Also, the new training centre allows for establishing an evaluation process cased on objective and measureable criteria.

Using the simulator to carry out the driver training also offers SMTUC greater leverage in controlling fuel consumption. Moreover, the use of the simulator allows for reproducing extreme scenarios (e.g., accidents and break downs) without putting the trainees in jeopardy.

The trainees' evolution can be assessed throughout the multiple sessions due to the automatic production of reports which are indexed to the different drivers. Some of the indicators whose progression can be monitored are fuel and brakes consumption and number of accidents / incidents.

This type of training can contribute to an effective reduction of traffic accidents and a real cutback in fuel consumption in the SMTUC bus fleet, leading to significant fiscal savings and improved environmental conditions.

Despite the authenticity of the simulation experience, the only drawback is the fact that it can never replicate exactly all the features of real life driving. In effect, the absence of any real peril and consequences can undermine the training, leading to indifference and a nonchalant attitude to the risk, especially when trainees are not reminded of the need to act as if they were in real life settings.

However, even though this seems to be a disadvantage, the absence of risk and the requirement of an initial period of adaptation to the simulated environment – the first session should not exceed three minutes in order to avoid nausea and a subsequent trainee negative response – it can be considered that the adaptation to driving in real conditions would be much longer. Therefore, simulator training can lead to quicker results than training in real life conditions, especially in the case of more inexperienced drivers.

The advantages and disadvantages can be summarised as:

- Advantages:
  - Savings in energy consumption and reduction in emissions due to the fact the training sessions are conducted in a simulator rather than a real vehicle;
  - Training sessions are not reliant on the availability of vehicles, nor imply their stoppage;
  - Greater quality of the training provided due to the fact that it is possible to simulate different driving conditions instantaneously (weather conditions, traffic level, driver aggressiveness, passenger volume and behaviour, bus failures, etc.), as well as the consultation of automatic reports on the trainees performance (road accidents, passenger accidents, fuel consumption, breakage, etc.);
  - Improved trainnee evaluation due to the above factors related to the training reports;
  - Contribution to the increase in the driving training quality and quantity resulting in a reduction in road accidents and pollution levels;

- Allows for training sessions for begginers without having the risks inherent in real driving sessions.

- Disadvantages:
  - Driving in simulated settings is never an authentic reproduction of real life conditions;
  - Simulator training requires an initial period of adaptation.

B3 Situation before CIVITAS

In Coimbra, the training of the public transport drivers of the different companies was mainly constituted by initial training, concerning bus brands and specifications and the network and routes, essentially those existing in the urban area.

There was little continuous training and the one occurring is conducted involving the driving of real buses (the major part of the other professional drivers of large motor vehicles do not have continuous education).

Therefore there was need to provide continuous education for professional drivers. The education given so far had high costs because it involved the use of a vehicle that it is, during training periods, unavailable for public service. This also implies fuel consumption and human resource costs, not only in the practical courses but also in the attribution of vehicles for that purpose. There is also the aspect of pollution involved in using real buses.

Generally there is a lack of good professionals among the driver population for recruiting for training.

B4 Actual implementation of the measure

The measure was implemented in the following stages:

Stage 1: Model's conception and definition of technical specifications for the driving simulator *(October 2009 – February 2010) – Knowledge acquisition on training centres for heavy vehicle drivers and driving simulators, including technical visits to Driving Centres equipped with advanced simulators similar to the desired by SMTUC (Porto and Madrid)* .

Conceptualization of the model envisioned for the SMTUC Driving Centre, including the spatial distribution and organization, and the simulator technical specifications that also includes a description of the formative capabilities of the simulator and the requirements for its installation (Fig. B1). The simulator should allow the instructors to plan and manage the various types of exercises, namely defining the initial vehicle conditions, environmental conditions, program line, traffic conditions, and different incidents throughout the exercise. Equally it should provide adequate vehicle simulation behaviour, in accordance with the parameters selected by the instructor in the edition mode, including the boarding and exiting of passengers, as well as their reactions to the different driving conditions. The simulation of driving a trolleybus is one of the innovative aspects that was assumed in the technical specifications of the simulator despite this additional feature was not included in the original work-plan.

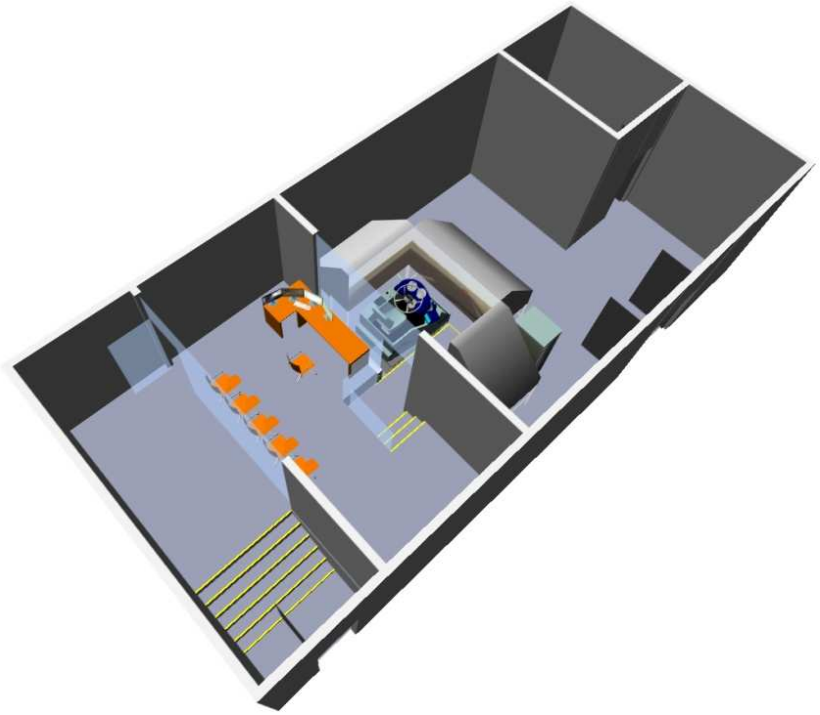


Fig. B.1 - Design of the Driving Centre – Building for the driving simulator installation

Release of the technical specifications and the preliminary version of the tender documents at internal level, including the driving centre facility.

Stage 2: Simulator's purchase and installation process *(November 2009 – June 2012) – Despite the first positive informal contacts with the Portuguese Institute for Mobility and Inland Transport (IMTT) since July 2007, for demanding the national co-financing for the purchase of the driving simulator, it was during the end of 2009 that several working meetings with the Chairman of the IMTT took place to point out the importance of installing this equipment in Coimbra (in the centre of the country). Due to a change of opinion concerning national financing, these initiatives and others during 2010 had no positive results, reason for which the Municipality and SMTUC opted for establishing a loan contract to cover the remaining part of the simulator financing not supported by CIVITAS.*

The loan process had the following phases: The adjudication took place on 14th June 2010 and the validation by the Municipal Assembly on 29th June. The loan contract was signed on 9th August 2010. The validation of the loan contract by the National Court of Accounting was foreseen until 28th October 2010 (or 15 days afterwards if the Court demand any additional explanations). Without any valid explanation the validation only took place in the end of December 2010.

SMTUC and the Municipality sped up the process to release the final version of the tender process for the purchase and installation of the driving simulator, demanding in the specifications that the installation should be divided into 2 phase;, the first allowing for the start of the driving training 4 month after the beginning of the installation (October 2011), the 2nd phase foresaw the development of the simulation of trolleybus driving.

Procedure authorization by the SMTUC Board of Directors for the simulator purchase occurred in 25th February 2011.

During this period the market research and architectural project for the building of the Training Centre took place., It had been decided to install the simulator in a new building instead of adapting an already existing facility. This building has been a soft construction (pre-building pavilion) with the design already defined. In June 2011 the first pavilion of the Training Centre was concluded (the facility for the theoretical training) and the works for the installation of the pavilion for the driving simulator began.

An excessively long period between the adjudication of the driving simulator purchase (21st June 2011) and the contract signature (11th October 2011) resulted from administrative reasons, producing a new delay, aggravated by the fact that the validation of the purchase procedure by the National Court of Accounts only took place on 10th January 2012.

At this date the process of development and construction of the driving simulator began.

Additionally, to speed up the installation process and have more time available for evaluation, the division of the implementation process in 2 phases was demanded: the first allowing for the start of the driving training 4 month after the beginning of the installation; , the 2nd for the development of the trolleybuses driving simulation tool.

The development of the driving simulator for standard buses and the installation of the main pavilion for the driving centre finished on May 2012. Subsequently the process of the driving simulator installation began.

During the 3rd week of June 2012 the installation of the driving simulator and the tests of the equipment were concluded (Fig. B3).

Fig. B3 – Driving simulator tests at SMTUC site

Stage 3: Training of the trainers and technical personnel *(October 2011 – June 2012) – The initial training for trainers and technical personnel took place on 11th October 2011 with the theoretical presentation of the simulator and its functionalities, with special attention given to the aspects related to the planning of the training sessions.*

Another theoretical session took place on 3rd November and one practical session using a similar driving simulator took place in Spain (EMT - Transportation Enterprise of Madrid)

from 28th to 30th November. So, with respect to the original schedule, this activity was anticipated and carried out in parallel with the implementation phase. The training in EMT included the measure leader and technical personnel of the training centre that also had a 1 day meeting to visit the supplier site and see the progress of the simulator development, as well as to plan the following activities, including recovery actions. New training sessions for the trainers and technical personnel were carried out in June 2012.

Stage 4: Training of the public transport drivers *(July 2011 – February 2013) – Taking into consideration that an important objective for the implementation in Coimbra of a Training Centre devoted to PT is to apply European Directive 2003/59, and that SMTUC has drivers subject to this law since mid-2011, when the driver simulator wasn't yet operational, a different planning was considered. It was decided that a complete set of training sessions according to the directive (35 hours) involving 5 SMTUC drivers on July 2011 and 15 on November 2011 was to be provided by an external company.*

But the training in the SMTUC driving simulator began on 26th June 2012.

A reference group of 25 of the 280 SMTUC drivers was set up to have the time to evaluate the impacts of the driving training sessions. This methodology allowed for having more intensive training sessions in the driving simulator and assess the drivers' behaviour modifications in a shorter time span.

In this matter, the driving training activities in the simulator consisted in two different tests, conducted in July and repeated in September 2012. The first test was performed in a mixed circuit, with negligible traffic in order to promote the adaptation of the drivers to the driving simulator and to the first concepts of eco-driving. The second test was performed in an urban circuit with traffic, with the main objective of introducing the drivers to the principles of defensive driving.

An assessment was made by comparing the results achieved in the first set of the 2 tests, with the results achieved by the drivers in the second set of the same 2 tests, which gives an overview of the progress and results achieved by the reference group of drivers.

Stage 5: Promotion towards potential users *(October 2011 – February 2013) – A first set of promotional actions has been launched with the contract signature in October 2011, namely through a press release and technical information sent to all Portuguese media and several stakeholders.*

After the installation of the driving simulator a public presentation was made in June 2012 with media coverage. Also during the European Mobility Week the Mayor of Coimbra visited the Driving Centre and other visits have been carried out, with emphasis on the Study Tour co-organised with VANGUARD.

The visit made by ANTROP, the Portuguese Association of Public Transport Operators, with the objective of establishing of partnerships for the large scale training of other entities, has been also very important.

B5 Inter-relationships with other measures

The measure is related to other measures as follows:

- **Measure no. 01.03 - Alternative fuels in Coimbra** – Alternative fuels in Coimbra could be related with measure 05.07, given the eco-driving dimension of the new Safety Oriented Driving Training, so it also has the potential to generate impacts on SMTUC fuel consumption and, therefore, on SMTUC emissions. Thus, measures 01.03 and 05.07 could be identified as a group of measures. However, while measure 05.07 is focused on every SMTUC drivers, measure 01.03, during CIVITAS period, it is only focused on a small part of SMTUC bus fleet. Therefore, the effects of the implementation of these measures will be easily separated from each other (this is why these measures were also not identified as a bundling of measures for impact evaluation purpose, although they have a strong interrelationship).

C Evaluation – methodology and results

C1 Measurement methodology

C1.1 Impacts and Indicators

Table C1.1: Indicators.

No.	Impact	Indicator	Data used	Comments
1	Operating Costs	Average Operating Costs	Total operating costs incurred by SMTUC driving training system; Total vehicle-km	SMTUC Data
2	Costs	Capital Costs	Total capital costs expended in setting up the measure	SMTUC Data
3	Fuel consumption	Vehicle fuel efficiency – Training Effect	Energy consumed by the driving training buses and simulator system; Total vehicle-km	SMTUC Data
4	Fuel consumption	Vehicle fuel efficiency – Eco-driving Effect	Energy consumed by the virtual buses during the driving simulator training sessions; Total vehicle-km	SMTUC Data
5	Quality of Service	Driving Service Quality	Driving service quality Index	SMTUC Data
6	Transport Safety	Accident Risk	Total number of recorded transport injury accidents and casualties; total vehicle-km	SMTUC Data
7	Emissions	CO Emissions	Fuel/Electricity consumption; Type of buses; Vehicle-km;	SMTUC Data EMEP/European Environment Agency (EEA)
8	Emissions	CO_2 Emissions	Fuel/Electricity consumption; Type of buses; Vehicle-km;	SMTUC Data EMEP/European Environment Agency (EEA)
9	Emissions	NOx Emissions	Fuel/Electricity consumption; Type of buses; Vehicle-km;	SMTUC Data EMEP/European Environment Agency (EEA)
10	Emissions	Small Particulate Emissions	Fuel/Electricity consumption; Type of buses; Vehicle-km;	SMTUC Data EMEP/European Environment Agency (EEA)
11	Awareness	Awareness level – drivers	Total number of drivers with knowledge of the measure; Total	SMTUC Data

			number of respondents	
12	Acceptance	Acceptance level – drivers	Total number of drivers who favourably receive the measure; Total number of respondents	SMTUC Data

A lack of funding from the Portuguese government for the driving simulator purchase delayed the measure implementation because a long administrative process occurred to assure alternative funds. A reference group of 25 of the 280 SMTUC drivers was set up to have the time to evaluate the impacts of the driving training sessions that began on 26th June 2012. This methodology allowed to for more intensive training sessions in the driving simulator and to assess the drivers' behaviour modifications in a shorter time period.

Has been selected 25 drivers to represent almost 10% of the entire SMTUC drivers and to allow providing each set of driving sessions during a week (each daily session has been attended by 5 drivers – the recommended number to participate in the driving training at the same time).

The driving selection has been based in the average number of accidents per driver during 2011 for the total of SMTUC driver (288/280=1,03) and for the reference group (26/25=1,04). Also the average age of the group has been balanced with the total average age (43,3 years in 2011).

So, it must be referred that for some of the indicators mentioned above (3 to 10), the evaluation methodology was mostly based on the assessment of the results achieved by this reference group of 25 SMTUC drivers, as a result of the driving training activities conducted in the simulator.

In this matter, the driving training activities in the simulator consisted in two different tests, conducted in July and repeated in September 2012. The first test was performed in a mixed circuit, with negligible traffic in order to promote the adaptation of the drivers to the driving simulator and to the first concepts of eco-driving. The second test was performed in an urban circuit with traffic, with the main objective of introduction the drivers to defensive driving principles.

The assessment was made by comparing the results achieved in the first set of the 2 tests, with the results achieved by the drivers in the second set of the same 2 tests, which gives an overview of the progress and results achieved by the reference group of drivers during the 100 training sessions carried out in 2 months.

Detailed description of the indicator methodologies:

- **Indicator 1** (*Average Operating Costs*) – Ratio of total operating costs incurred by the SMTUC driving training sessions, divided by the total vehicle-km performed during the driving training sessions (€/vehicle-km).

  A = B / C, where:

  - ✓ A = Average operational costs of the driving training sessions (€/vehicle-km)
  - ✓ B = Total operational costs of the SMTUC driving training session, including fuel/energy costs directly related to the implementation of the driving training sessions, both in buses and simulator system, human and hardware maintenance costs, personnel costs necessary to the operation of the driving training sessions, all expressed in €.
  - ✓ C = Total vehicle-km performed during the driving training sessions (vkm).

  The collected data is related to the SMTUC driving training system and to the buses allocated to driving training activities. Results of vehicle-kilometres, vehicle and simulator training

activities, have origin in SMTUC records and on driving training system software report. The data reliability is maximised due to an objective data collection among SMTUC records on performed trips on training activities, which in turn are recorded following reliable procedures and due to an objective data collection on the simulator reporting system.

- **Indicator 2** (*Capital Costs*) – Total capital costs expended in setting up the measure (€).

  Expenditures with the purchase and installation of the necessary equipment and software for the SMTUC driving training system (including the financing costs, i.e., interests paid due to the loan contracted to the purchase of the simulator) and with the preparation of the facilities where the simulator driving activities take place (€).

  All data are related to the overall SMTUC driving training system. The data reliability is maximised due to an objective data collection.

- **Indicator 3** (*Vehicle fuel efficiency- Training Effect*) – Ratio of energy consumed in the driving training sessions, divided by the total vehicle-km (MJ/vehicle-km).

  A = B / C, where:

  - ✓ A = Average vehicle efficiency of the driving training sessions (MJ/vkm)
  - ✓ B = Total energy consumed in the driving training sessions (MJ)
  - ✓ C = Total vehicle-km performed during the driving training sessions

  All data are related to the SMTUC driving training sessions. Results from energy consumption by the SMTUC vehicles used in driving training activities are quantified by means of SMTUC regular procedure of registering fuel consumption by these vehicles every time each vehicle is fuelled after being used in these activities. The equivalent energy consumption is calculated with conversion factors. The data reliability is maximised due to an objective data collection among SMTUC records on performed trips on training activities. The energy consumption in the driving simulator training sessions is estimated using SMTUC regular procedure of registering total electricity consumed by the simulator.

- **Indicator 4** (*Vehicle fuel efficiency- Eco-driving Effect*) – Ratio of energy consumed by the buses in the driving training sessions using the driving training simulator, divided by the total vehicle-km performed by this virtual buses (MJ/vehicle-km).

  A = B / C, where:

  - ✓ A = Average vehicle efficiency of the driving training sessions using the driving training simulator (MJ/vkm)
  - ✓ B = Total energy consumed by the virtual buses in the driving training sessions (MJ)
  - ✓ C = Total vehicle-km performed by the virtual buses during the driving training sessions.

  All data are related to the SMTUC driving training activities of the reference group in the driving simulator. Results from energy consumption and vehicle-kilometres performed on simulator come from simulator software report. The data reliability is maximised due to an objective data collection among SMTUC records on performed trips on training activities, which in turn are recorded following reliable procedures and due to an objective data collection on the simulator reporting system.

- **Indicator 5** (*Driving Service Quality*) – Measured as the average rating given by the driving training instructor to the drivers, in each training session. The driving service quality index is based on the average of 5 parameters:

1. Signalling the change of direction manoeuvre;
2. Reckless invasion of another route;
3. Traffic signals compliance;
4. Driving sudden;
5. Use of mirrors.

- **Indicator 6** (*Accident Risk*) – Ratio of total number of recorded transport injury accidents and casualties recorded, divided by the total vehicle-km (number of accidents or casualties/vehicle-km).

  A = B / C, where:

  - ✓ A = Transport Safety Operation (number of accidents + casualties/vkm)
  - ✓ B = Number of recorded accidents or casualties recorded
  - ✓ C = Total vehicle-km performed during the driving training sessions

  Results from accidents/casualties and number of vehicle-kilometres, have origin in SMTUC data.

- **Indicator 6** (*CO Emissions*) – Average CO emissions per vehicle-km of driving training sessions (g/vehicle-km).

  A = B / C, where:

  - ✓ A = Average CO emissions per vehicle-km (g/vkm)
  - ✓ B = Total CO emissions resulting from driving training sessions, namely electricity/fuel consumption associated to vehicles and driving training simulator, (g)
  - ✓ C = Total vehicle-km performed in driving training sessions (vkm)

  For driving training vehicles, the CO emissions calculation is based on average European emission factors, for pollutant and type of vehicle technology (e.g. Conventional, Euro 1, ...), according to the EMEP/European Environment Agency (EEA) emission inventory guidebook 2009, updated May 2012, on exhaust emissions from road transport[1]. These average European emission factors were determined using the Tier 3 methodology (based model with COPERT) which follows in using typical values for driving speeds, ambient, temperatures, highway-rural-urban mode mix, trip length.

  The CO emissions resulting from electricity consumption of the driving training simulator, are estimated by means of implied emission factors, expressed in tons of CO per GWh of electricity consumed, and are based on country data given by the Portuguese Environment Agency (Portuguese National Inventory Report on Greenhouse Gases).

  Results from vehicle-kilometres coming from SMTUC records . The data reliability is maximised due to an objective data collection among SMTUC records on performed and scheduled trips, which in turn are recorded following reliable procedures.

- **Indicator 7** (*CO_2 Emissions*) – Average CO_2 emissions per vehicle-km of driving training sessions (g/vehicle-km).

  A = B / C, where:

[1] http://eea.europa.eu/emep-eea guidebook

- ✓ A = Average CO_2 emissions per vehicle-km (g/vkm)
- ✓ B = Total CO_2 emissions resulting from driving training session, namely electricity/fuel consumption associated to vehicles and driving training simulator, (g)
- ✓ C = Total vehicle-km performed in driving training sessions (vkm)

The calculation of total CO_2 emissions from driving training vehicles is based on country data given by the Portuguese Environment Agency (Portuguese National Inventory Report on Greenhouse Gases), more precisely, a historical series (1990-2009) of CO_2 implied emission factors expressed in grams per kilometre. These emission factors were determined using the Tier 3 methodology (based model with COPERT).

The CO_2 emissions resulting from electricity consumption of the driving training simulator, are estimated by means of implied emission factors, expressed in tons of CO_2 per GWh of electricity consumed, and are based on country data given by the Portuguese Environment Agency (Portuguese National Inventory Report on Greenhouse Gases).

Results from vehicle-kilometres coming from SMTUC records. The data reliability is maximised due to an objective data collection among SMTUC records on performed and scheduled trips, which in turn are recorded following reliable procedures.

- **Indicator 8** (NOx *Emissions*) – Average NOx emissions per vehicle-km of driving training sessions (g/vehicle-km).

A = B / C, where:

- ✓ A = Average NOx emissions per vehicle-km (g/vkm)
- ✓ B = Total NOx emissions resulting from driving training sessions, namely electricity/fuel consumption associated to vehicles and driving training simulator, (g)
- ✓ C = Total vehicle-km performed in driving training sessions (vkm)

For driving training vehicles, the NOx emissions calculation is based on average European emission factors, for pollutant and type of vehicle technology (e.g. Conventional, Euro 1, ...), according to the EMEP/European Environment Agency (EEA) emission inventory guidebook 2009, updated May 2012, on exhaust emissions from road transport[2]. These average European emission factors were determined using the Tier 3 methodology (based model with COPERT) which follows in using typical values for driving speeds, ambient, temperatures, highway-rural-urban mode mix, trip length.

The NOx emissions resulting from electricity consumption of the driving training simulator, are estimated by means of implied emission factors, expressed in tons of NOx per GWh of electricity consumed, and are based on country data given by the Portuguese Environment Agency (Portuguese National Inventory Report on Greenhouse Gases).

Results from vehicle-kilometres coming from SMTUC records . The data reliability is maximised due to an objective data collection among SMTUC records on performed and scheduled trips, which in turn are recorded following reliable procedures.

- **Indicator 9** (PM *Emissions*) – Average PM emissions per vehicle-km of driving training sessions (g/vehicle-km).

A = B / C, where:

[2] http://eea.europa.eu/emep-eea guidebook

- ✓ A = Average PM emissions per vehicle-km (g/vkm)
- ✓ B = Total PM emissions resulting from driving training sessions, namely electricity/fuel consumption associated to vehicles and driving training simulator, (g)
- ✓ C = Total vehicle-km performed in driving training sessions (vkm)

For driving training vehicles, the PM emissions calculation is based on average European emission factors, for pollutant and type of vehicle technology (e.g. Conventional, Euro 1, ...), according to the EMEP/European Environment Agency (EEA) emission inventory guidebook 2009, updated May 2012, on exhaust emissions from road transport[3]. These average European emission factors were determined using the Tier 3 methodology (based model with COPERT) which follows in using typical values for driving speeds, ambient, temperatures, highway-rural-urban mode mix, trip length.

The PM emissions resulting from electricity consumption of the driving training simulator, are estimated by means of implied emission factors, expressed in tons of PM per GWh of electricity consumed, and are based on country data given by the Portuguese Environment Agency (Portuguese National Inventory Report on Greenhouse Gases).

Results from vehicle-kilometres coming from SMTUC records . The data reliability is maximised due to an objective data collection among SMTUC records on performed and scheduled trips, which in turn are recorded following reliable procedures.

- **Indicator 10** (*Awareness level*) – Percentage of the users with knowledge of the measure on account of provided information (%).

  A = B / C × 100, where:

  - ✓ A = Percentage of users with knowledge of the measure (%)
  - ✓ B = Total number of respondents with knowledge of the measure
  - ✓ C = Total number of respondents

  The Awareness level of the measure will be measured by carrying out specific questionnaires to SMTUC drivers including questions relative to the knowledge of the respondent about the measure (see Annex).

  The so called driver's survey is composed of specific questions related to the driving training sessions and methods used. The drivers interviewed express a judgement on several various items choosing between very satisfied – satisfied – indifferent – unsatisfied – very unsatisfied.

- **Indicator 11** (*Acceptance level*) – Percentage of the users who favourably receive the measure (%).

  A = B / C × 100, where:

  - ✓ A = Percentage of users who favourably receive the measure (%)
  - ✓ B = Total number of respondents who favourably receive the measure
  - ✓ C = Total number of respondents

  The acceptance level of the measure will be measured by carrying out specific questionnaires to SMTUC drivers including questions relative to the respondent's attitude towards the measure (see Annex).

[3] http://eea.europa.eu/emep-eea guidebook

The so called driver's survey is composed of specific questions related to the driving training sessions and methods used. The drivers interviewed express a judgement on several various items choosing between very satisfied – satisfied – unsatisfied – very unsatisfied.

C1.2 Establishing a Baseline

Indicator 1: Average Operating Costs

The average operating costs of the baseline, Table C1.2.1, are based on the costs of running driving training sessions in real operational conditions, using buses. The data is based on SMTUC records.

Table C1.2.1: Average Operating Costs (€/vkm), Ex-Ante.

Indicator and Data Used	Ex-Ante Oct 2010-Sep 2011
Fuel Costs (€)	913,53
Maintenance personnel costs (€)	72,18
Hardware maintenance costs (€)	175,67
Personnel costs (€)	4.669,46
Total Costs (€)	**5.830,84**
Total vehicle-km (vkm)	1.710,73
Average operating costs (€/vkm)	**3,41**

Indicator 2: Capital Costs

This indicator takes into account the total capital costs, such as equipement and software, necessary to implement the measure, in other words, expenditures associated with the purchase and installation of the necessary equipment and software for SMTUC driving training simulator system. Considering that in the baseline, the measure had not yet been implemented, the capital costs are considered to be null.

Indicator 3: Vehicle Fuel Efficiency – Training Effect

The baseline takes into account the energy that is consumed in driving training sessions in real operational conditions, using buses. The data is based on SMTUC records, Table C1.2.2.

Table C1.2.2: Vehicle Fuel Efficiency (MJ/vkm), Ex-Ante.

Indicator and Data Used	Ex-Ante Oct 2010-Sep 2011
Total fuel consumed in the drive training sessions (MJ)	31.550,45
Total vehicle-km (vkm)	1.710,73
Average Fuel Efficiency (MJ/vkm)	**18,44**

Indicator 4: Vehicle Fuel Efficiency – Ecodriving Effect

The vehicle fuel efficiency in the baseline takes into account the results achieved on the first session of driving training activities of the reference group using the driving simulator, conducted in July 2012. It`s considered that at this stage the measure effects are negligible. Table C1.2.3, shows the results for the baseline.

For fuel efficiency purposes, the driving training sessions were performed in a mixed circuit, with negligible traffic in order to promote the adaptation of the 25 PT drivers to the driving simulator and to the first concepts of eco-driving.

Table C1.2.3: Average Fuel Efficiency (MJ/vkm), Ex-Ante.

Indicator and Data Used	Ex-Ante July 2012
Total fuel consumed in the first drive training session using the simulator (l)	34,87
Total fuel consumed in the first drive training session using the simulator (MJ)	1.250,37
Total vehicle-km (vkm)	57,50
Average Fuel Efficiency (MJ/vkm)	**21,75**

Note: 1litre of diesel=35,86 MJ

Indicator 4: Quality of Driving Service

The quality of driving service is measured as the average rating given by the driving training instructor to the 25 drivers of the reference group, in each training session. The rating is based on the average of five different parameters:

1. Signalling the change of direction manoeuvre;
2. Reckless invasion of another route;
3. Traffic signals compliance;
4. Driving sudden;
5. Use of mirrors.

For the baseline it will be considered the ratings achieved on the first session of driving training activities using the driving simulator, conducted in July 2012. In Table C1.2.4 are presented the baseline results.

Table C1.2.4: Quality of Driving Service Index, Ex-Ante.

Indicator and Data Used	Ex-Ante July 2012
Quality of Service	8

Note: Scale 1-10

Indicator 5: Accident Risk

The transport safety is measured by taking into account the number of recorded transport injury accidents and causalities, more precisely the number of times that the driving training system registers kerbs rises and trampling during the driving training session period of the reference group of 25 SMTUC public transportation drivers.

The baseline considers the numbers of occurrences registered on the first session of driving training activities using the driving training simulator, conducted in July 2012. In Table C1.2.5, are presented the baseline results.

For transport safety purposes, the driving training sessions were performed in an urban circuit with traffic, with the main objective of introduction the drivers to defensive driving principles.

Table C1.2.5: Transport safety/vkm, Ex-Ante.

Indicator and Data Used	Ex-Ante July 2012
Number of Kerb Rises and Trampling	53+5=58
Total vehicle-km (vkm)	122,50
Accident Risk (number of incidents /vkm)	**0,473**

Indicator 6: CO emissions

The baseline CO emissions were estimated by taking into account the total number of km performed on the driving training sessions in real operational conditions using buses.

The CO emission factor is based on average European emission factors, for pollutant and type of vehicle technology, in this case Euro 3, according to the EMEP/European Environment Agency (EEA) emission inventory guidebook 2009, updated May 2012, on exhaust emissions from road transport[4], Table C1.2.6.

The results of the measure, will be assessed by comparing the average emissions of conducting driving training sessions in buses versus driving training sessions in the simulator (considering electricity consumption of driving training simulator and associated emissions).

Table C1.2.6:CO emissions, Ex-Ante.

Indicator and Data Used	Ex-Ante Oct 2010-Sep 2011
Total vehicle-km (vkm)	1.710,73
Total CO emissions (gCO)	4.567,65
Average CO emissions per vehicle-km (gCO/vkm)	**2,67**

Indicator 7: CO_2 emissions

The baseline CO_2 emissions were estimated by taking into account the total number of km performed on the driving trainning sessions in real operational conditions using buses, Table C1.2.7.

The results of the measure, will be assessed by comparing the average emissions of conducting driving training sessions in buses versus driving training sessions in the simulator (considering electricity consumption of driving training simulator and associated emissions).

Table C1.2.7:CO_2 emissions, Ex-Ante.

Indicator and Data Used	Ex-Ante Oct 2010-Sep 2011
Total vehicle-km (vkm)	1.710,73
Total CO_2 emissions (gCO_2)	1.356.999,62
Average CO_2 emissions per vehicle-km (gCO_2/vkm)	**793,23**

Indicator 8: NOx emissions

The baseline NOx emissions were estimated by taking into account the total number of km performed on the driving training sessions in real operational conditions using buses.

The NOx emission factor is based on average European emission factors, for pollutant and type of vehicle technology, in this case Euro 3, according to the EMEP/European Environment Agency (EEA) emission inventory guidebook 2009, updated May 2012, on exhaust emissions from road transport[5], Table C1.2.8.

The results of the measure, will be assessed by comparing the average emissions of conducting driving training sessions in buses versus driving training sessions in the simulator (considering electricity consumption of driving training simulator and associated emissions).

[4] http://eea.europa.eu/emep-eea guidebook

[5] http://eea.europa.eu/emep-eea guidebook

Table C1.2.8:NOx emissions, Ex-Ante.

Indicator and Data Used	Ex-Ante Oct 2010-Sep 2011
Total vehicle-km (vkm)	1.710,73
Total NOx emissions (g NOx)	16.046,65
Average NOx emissions per vehicle-km: (g NOx/vkm)	**9,38**

Indicator 9: PM emissions

The baseline PM emissions were estimated by taking into account the total number of km performed on the driving training sessions in real operational conditions using buses.

The PM emission factor is based on average European emission factors, for pollutant and type of vehicle technology, in this case Euro 3, according to the EMEP/European Environment Agency (EEA) emission inventory guidebook 2009, updated May 2012, on exhaust emissions from road transport[6], Table C1.2.9.

The results of the measure, will be assessed by comparing the average emissions of conducting driving training sessions in buses versus driving training sessions in the simulator (considering electricity consumption of driving training simulator and associated emissions).

Table C1.2.9: **PM emissions, Ex-Ante.**

Indicator and Data Used	Ex-Ante Oct 2010-Sep 2011
Total vehicle-km (vkm)	1.710,73
Total PM emissions (g PM)	354,12
Average PM emissions per vehicle-km: (g PM/vkm)	**0,21**

Indicator 10: Awareness Level

To get a qualitative assessment of knowledge and attitude towards changes, 193 surveys (see Annex) to SMTUC drivers chose to attend driving training activities were conducted between the months of January and February 2012.

The representativeness of the sample is presented in Table C1.2.10.

Table C1.2.10: Awareness: representativeness of the sample.

Statistical Universe (SMTUC drivers chose to attend driving training activities)	193 (2012-01-23 to 2012-02-02)
Surveys	193
Statistical confidence interval	95%
	% error p = 0,5 % error p = 0,25

The baseline results are presented in Table C1.2.11.

[6] http://eea.europa.eu/emep-eea guidebook

Table C1.2.11: Awareness level, Ex-Ante.

Indicator and Data Used	Time Period	Ex-Ante
Number of positive answers	2012-01-23 to 2012-02-02	164
Total Number of respondents		193
Awareness level of the drivers (%)		**84,97**

Indicator 11: Acceptance Level

The acceptance level of the measure was measured by carrying out specific questionnaires (see Annex) to SMTUC drivers including questions relative to the respondent's attitude towards the measure. In total, 183 questionnaires were made, Table C1.2.12.

Table C1.2.12: Acceptance level, Ex-Ante.

Indicator and Data Used	Time Period	Ex-Ante Values
Number of positive answers	2012-01-23 to 2012-02-02	167
Total Number of respondents		193
Acceptance level of the drivers (%)		**86,52**

C1.3 Building the Business-as-Usual scenario

As mentioned in the Final Evaluation Plan document, the business as usual (BAU) scenario should consider the possible autonomous city development if a certain measure is not going to be implemented.

In general the change in the measure indicators due to the to the training activities making use of the driving simulator is obtained after implementing the measure. Therefore, if the measure wasn't implemented, it`s considered that the indicators results would be similar to those registered for the baseline scenario. It is considered that there are no effects of other factors that have any influence in the indicators. For this specific measure, the business as usual (BAU) scenario is considered to be similar to the baseline situation.

Indicator 1: Average Operating Costs

Table C1.3.1: Average Operating Costs (€/vkm), BAU.

Indicator	BAU=Ex-ante
Average operating costs (€/vkm)	3,41

Indicator 2: Capital Costs

The change in the Capital Costs due to the to the training activities making use of the driving simulator is obtained after setting up the measure. Therefore, if this measure wasn't implemented, the capital costs would be null.

Indicator 3: Vehicle Fuel Efficiency – Training Effect

Table C1.3.2: Vehicle Fuel Efficiency (MJ/vkm), BAU.

Indicator	BAU=Ex-Ante
Average Fuel Efficiency (MJ/vkm)	18,44

Indicator 4: Vehicle Fuel Efficiency – Eco-driving Effect

Table C1.3.3: Vehicle Fuel Efficiency (MJ/vkm), BAU.

Indicator	BAU=Ex-Ante
Average Fuel Efficiency (MJ/vkm)	21,75

Indicator 5: Quality of Driving Service

Table C1.3.3: Quality of Service, BAU.

Indicator	BAU=Ex-Ante
Quality of Service	8

Note: Scale 1-10

Indicator 6: Accident Risk

Table C1.3.4: Accident risk/vkm, BAU.

Indicator and Data Used	BAU=Ex-Ante
Accident Risk (number of incidents /vkm)	0,473

Indicator 6 to 9 (Emissions)

Table C1.3.5: Average emissions/vkm, BAU.

Indicator and Data Used	BAU=Ex-Ante
Average CO emissions per vehicle-km (gCO/vkm)	2,67
Average CO_2 emissions per vehicle-km (gCO_2/vkm)	793,23
Average NOx emissions per vehicle-km: (g NOx/vkm)	9,38
Average PM emissions per vehicle-km: (g PM/vkm)	0,21

Indicator 10: Awareness Level

Table C1.3.6: Awareness level, BAU.

Indicator	BAU=Ex-Ante
Awareness level of the drivers (%)	84,97

Indicator 11: Acceptance Level

Table C1.3.7: Acceptance level, BAU.

Indicator and Data Used	BAU=Ex-Ante
Acceptance level of the drivers (%)	86,52

C2 Measure results

The results are presented under sub headings corresponding to the areas used for indicators – economy, energy, environment, society and transport.

C2.1 Economy

Indicator 1: Average Operating Costs

For the ex-post period, the average operating costs are in fact, the costs of running the driving training simulator system along the training sessions. In total personnel costs, maintenance costs and electricity consumption costs, costs are considered, Table C2.1.1.

Table C2.1.1: Average Operating Costs (€/vkm), Ex-Post.

Indicator and Data Used	Ex-Post September 2012
Energy Costs (€)[7]	83,14
Maintenance personnel costs (€)	4,72
Hardware maintenance costs (€)	2,84
Personnel costs (€)	1.303,35
Total Costs (€)	**1.394,05**
Total vehicle-km (vkm)	480
Average operating costs (€/vkm)	**2,90**

In Table C2.1.2, the measure results for this indicator are presented, resulting from the comparison between the average operating costs of the driving training simulator system (Ex-post) with the average operating costs of a driving training session in real operational conditions, using a vehicle (Ex-ante).

Table C2.1.2: Economy: Indicator 1, Average Operating Costs.

Indicator	Ex-Ante Baseline Oct 2010-Sep 2011	BAU	Ex-Post September 2012	Difference Ex Post – Ex Ante	Difference: Ex Post – BAU
Average operating costs (€/vkm)	3,41	3,41	2,90	-0,51	

According to this results, after the measure implementation, the average operating costs of SMTUC driving training activities, decreased about 15%, from 3,41 €/vkm to 2,90 €/vkm, essentially due to lower energy and personnel costs.

Indicator 2: Capital Costs

The capital costs are all considered in the Ex-post period, Table C2.1.3.

Table C2.1.3: Economy: Indicator 2, Capital Costs.

Indicator	Ex-Ante Baseline Oct 2010-Sep 2011	BAU	Ex-Post September 2012	Difference Ex Post – Ex Ante	Difference: Ex Post – BAU
Capital Costs (€)	0	0	500.913,24	500.913,24	

[7] Electricity consumed in the driving training simulator.

C2.2 Energy

Indicator 3: Vehicle Fuel Efficiency – Training Effect

The results of the ex-post period, corresponding to the tests in the driving training simulator, are presented in Table C2.2.1.

Table C2.2.1: Average Fuel Efficiency (MJ/vkm), Ex-Post.

Indicator and Data Used	Ex-Post September 2012
Total Electricity Consumption (kWh)	196,64
Total energy consumed in the drive training activities: (MJ)	707,89
Total vehicle-km (vkm)	115
Average Fuel Efficiency (MJ/vkm)	**6,16**

In Table C2.2.2, the measure results for this indicator are presented, resulting from the comparison between the average fuel efficiency of the driving training simulator system (Ex-post) with the average operating costs of a driving training session in real operational conditions, using a vehicle (Ex-ante).

Table C2.2.2: Energy: Indicator 3, Vehicle Fuel Efficiency.

Indicator	Ex-Ante Baseline Oct 2010-Sep 2011	BAU	Ex-Post September 2012	Difference Ex Post – Ex Ante	Difference: Ex Post – BAU
Average Fuel Efficiency (MJ/vkm)	18,44	18,44	6,16	-12,29	

Compared to the BAU scenario, the average fuel efficiency in the ex-post period has improved significantly, a reduction of about 66% in terms of energy consumption per vkm, in result of switching from diesel to electricity.

Indicator 4: Vehicle Fuel Efficiency – Eco-driving Effect

Table C2.2.3: Average Fuel Efficiency (MJ/vkm), Ex-Post.

Indicator and Data Used	Ex-Ante July 2012
Total fuel consumed in the first drive training session using the simulator (l)	29,49
Total fuel consumed in the first drive training session using the simulator (MJ)	1.057,37
Total vehicle-km (vkm)	57,50
Average Fuel Efficiency (MJ/vkm)	**18,39**

Note: 1litre of diesel=35,86 MJ

Comparing the results achieved in the two driving sessions using the simulator in same conditions (bus, routes, distance, …), it`s possible to conclude that the drivers achieved an increase of about 15% in terms of average fuel efficiency, probably as a result of eco driving principles assimilation.

Table C2.2.4: Energy: Indicator 3, Vehicle Fuel Efficiency.

Indicator	Ex-Ante Baseline July 2012	BAU	Ex-Post September 2012	Difference Ex Post – Ex Ante	Difference: Ex Post – BAU
Average Fuel Efficiency (MJ/vkm)	21,75	21,75	18,39	-3,36	

C2.3 Environment

Indicator 6: CO emissions

The CO emissions in the ex-post period are associated to the electricity consumption of the driving training simulator, and were estimated using national emission factor for electricity production. The total vehicle-km are an output of the driving training simulator software report, Table C2.3.1.

Table C2.3.1:CO emissions, Ex-Post.

Indicator and Data Used	Ex-Post September 2012
Total vehicle-km (vkm)	115
Driving training system electricity consumption (kWh)	196,64
Electricity Emission Factor (t CO/GWh)	0,11
Total CO emissions (gCO)	21,26
Average CO emissions per vehicle-km (gCO/vkm)	**0,18**

The average CO emissions in the ex-post period are significantly lower in comparison with the ex-ante and BAU scenario (-93%) due to the fact that emissions result from electricity consumption of the driving training simulator instead of diesel consumption of driving training vehicles in the ex-ante and BAU scenario, Table C2.3.2.

Table C2.3.2: Environment : Indicator 6, Average CO emissions per vehicle-km (gCO/vkm).

Indicator	Ex-Ante Baseline July 2012	BAU	Ex-Post September 2012	Difference Ex Post – Ex Ante	Difference: Ex Post – BAU
Average CO emissions per vehicle-km (gCO/vkm)	2,67	2,67	0,18	-2,49	

Indicator 7: CO_2 emissions

The CO_2 emissions in the ex-post period are associated to the electricity consumption of the driving training simulator, and were estimated using national emission factor for electricity production. The total vehicle-km are an output of the driving training simulator software report, Table C2.3.3.

Table C2.3.3:CO_2 emissions, Ex-Post.

Indicator and Data Used	Ex-Post September 2012
Total vehicle-km (vkm)	115
Driving training system electricity consumption (kWh)	196,64
Electricity Emission Factor (t CO_2/GWh)	375
Total CO_2 emissions (gCO_2)	73.805,36
Average CO emissions per vehicle-km (gCO/vkm)	**641,79**

The average CO_2 emissions in the ex-post period are significantly lower in comparison with the ex-ante and BAU scenario (-19%) due to the fact that emissions result from electricity consumption of the driving training simulator instead of diesel consumption of driving training vehicles in the ex-ante and BAU scenario, Table C2.3.4.

Table C2.3.4: Environment : Indicator 7, Average CO_2 emissions per vehicle-km (gCO_2/vkm).

Indicator	Ex-Ante Baseline July 2012	BAU	Ex-Post September 2012	Difference Ex Post – Ex Ante	Difference: Ex Post – BAU
Average CO_2 emissions per vehicle-km (gCO_2/vkm)	793,23	793,23	641,79	-151,44	

Indicator 8: NOx emissions

The NOx emissions in the ex-post period are associated to the electricity consumption of the driving training simulator, and were estimated using national emission factor for electricity production. The total vehicle-km are an output of the driving training simulator software report, Table 2.3.5.

Table C2.3.5:NOx emissions, Ex-Post.

Indicator and Data Used	Ex-Post September 2012
Total vehicle-km (vkm)	115
Driving training system electricity consumption (kWh)	196,64
Electricity Emission Factor (t NO_x/GWh)	0,94
Total NOx emissions (g NOx)	185,29
Average NOx emissions per vehicle-km (gNOx/vkm)	**1,61**

The average NOx emissions in the ex-post period are significantly lower in comparison with the ex-ante and BAU scenario (-83%) due to the fact that emissions result from electricity consumption of the driving training simulator instead of diesel consumption of driving training vehicles in the ex-ante and BAU scenario, Table 2.3.6.

Table C2.3.6: Environment : Indicator 7, Average NOx emissions per vehicle-km (gNOx/vkm).

Indicator	Ex-Ante Baseline July 2012	BAU	Ex-Post September 2012	Difference Ex Post – Ex Ante	Difference: Ex Post – BAU
Average NOx emissions per vehicle-km (gNOx/vkm)	9,38	9,38	1,61	- 7,77	

Indicator 9: PM emissions

The PM emissions in the ex-post period are associated to the electricity consumption of the driving training simulator, and were estimated using national emission factor for electricity production. The total vehicle-km are an output of the driving training simulator software report, Table C2.3.7.

Table C2.3.7:PM emissions, Ex-Post.

Indicator and Data Used	Ex-Post September 2012
Total vehicle-km (vkm)	115
Driving training system electricity consumption (kWh)	196,64
Electricity Emission Factor (t PM/GWh)	0,15
Total PM emissions (g PM)	29,57

Average PM emissions per vehicle-km (g PM/vkm)	**0,26**

The average PM emissions in the ex-post period are slightly higher in comparison with the ex-ante and BAU scenario (+22%) due to the fact that emissions result from electricity consumption of the driving training simulator instead of diesel consumption of driving training vehicles in the ex-ante and BAU scenario, Table C2.3.8.

Table C2.3.8: Environment : Indicator 7, Average PM emissions per vehicle-km (g PM/vkm).

Indicator	Ex-Ante Baseline July 2012	BAU	Ex-Post September 2012	Difference Ex Post – Ex Ante	Difference: Ex Post – BAU
Average PM emissions per vehicle-km (g PM/vkm)	0,21	0,21	0,26	0,05	

C2.4 Transport

Indicator 4: Quality of Driving Service

Table C2.4.1: Quality of Driving Service, Ex-Post.

Indicator and Data Used	Ex-Post September 2012
Quality of Service	8

Table C2.4.2: Transport: Indicator 4, Quality of Driving Service Index.

Indicator	Ex-Ante Baseline July 2012	BAU	Ex-Post September 2012	Difference Ex Post – Ex Ante	Difference: Ex Post – BAU
Quality of Driving	8	8	8	0	

Based on the average rating given by the driving training instructor in each training session, it`s possible to observe the maintenance in the driving quality level.

Indicator 5: Accident Risk

Table C2.4.3 presents the number of times that the driving training system registered kerbs rises and trampling during the driving training session ex-post period. The total vehicle-km are an output of the driving training simulator software report.

Table C2.4.3: Accident risk/vkm, Ex-Post.

Indicator and Data Used	Ex-Post September 2012
Number of Kerb Rises and Trampling : (number of incidents)	39+0=39
Total vehicle-km (vkm)	122,50
Accident Risk (number of incidents /vkm)	**0,318**

The transport safety has increased, as a result of the lower number of registered occurrences in the ex post period, Table C2.4.4.

Table C2.4.4: Transport: Indicator 5, Accident Risk.

Indicator	Ex-Ante Baseline July 2012	BAU	Ex-Post September 2012	Difference Ex Post – Ex Ante	Difference: Ex Post – BAU
Transport safety (number of incidents /vkm)	0,473	0,473	0,318	-0,155	

Based on these results it`s possible to conclude that between the two driving training sessions, the accident risk as decreased 33%. The results are explained by a lower number of incidents registered in the second session (39) in comparison with the ones registered in the first session (58), both for the same travelled distance of 122,50 km. This is an important added value of the driving training system.

C2.5 Society

Indicator 10: Awareness Level

Table C2.5.1: Awareness level, Ex-post.

Indicator and Data Used	Time Period	Ex-Ante
Number of positive answers	2012-10-26 to 2012-11-20	174
Total Number of respondents		187
Awareness level of the drivers (%)		**93,05**

The awareness level of the drivers have increased about 8% in comparison with the ex-ante period, Table C2.5.2.

Table C2.5.2: Society: Indicator 10, Awareness level.

Indicator	Ex-Ante Baseline Jan-Feb 2012	BAU	Ex-Post September 2012	Difference Ex Post – Ex Ante	Difference: Ex Post – BAU
Awareness level of the drivers (%)	84,97	84,97	93,05	8,07	

Indicator 11: Acceptance Level

Table C2.5.3: Acceptance level, Ex-Post.

Indicator and Data Used	Time Period	Ex-Ante Values
Number of positive answers	2012-10-26 to 2012-11-20	168
Total Number of respondents		187
Acceptance level of the drivers (%)		**89,84**

The acceptance level of the drivers have increased about 3% in comparison with the ex-ante period, Table C2.5.4.

Table C2.5.4: Society: Indicator 11, Acceptance level.

Indicator	Ex-Ante Baseline Jan-Feb 2012	BAU	Ex-Post September 2012	Difference Ex Post – Ex Ante	Difference: Ex Post – BAU
Acceptance level of the drivers (%)	86,52	86,52	89,84	3,32	

C3 Achievement of quantifiable targets and objectives

No.	Target	Rating
1	To implement a training centre for heavy duty vehicles drivers, equipped with a dynamic driving simulator, that could allow both the reduction of accident rates (at least 5% in SMTUC drivers), and fuel expenditures (at least 3% in the SMTUC fleet). The driving simulator has been purchased and installed in a new pavilion built for the creation of the driving centre in SMTUC site. The accident risk assessed in simulation conditions decreased 33% with the driving training in the simulator, indicating that the objectives concerning the accident rates will be exceeded in real situation. The same for the fuel consumption, taking into consideration the 15% decrease with the driver training.	***
2	To improve 10% the driving training sessions. During a year of driving simulator training (November 2011 – October 2012) 259 driving training sessions on simulator and 17 on real buses and trolleybuses have been carried out. In the 1 year period prior to the measure implementation (2010) only 85 driving training sessions occurred (on real buses). This represents an increase of 225% with the measure implementation.	***
3	To perform at least 500 training actions during CIVITAS. During CIVITAS, considering only the period after the implementation of the new Driving Centre, 518 training sessions have been carried out, 262 on the driving simulator.	**
4	To improve the cooperation between SMTUC and others fleet operators (PT operators, Municipality, Driving Schools, etc.) Technicians of the Municipality, Carristour (PT Driving School) and ANTROP (Portuguese Association of Public Transport Operators) visited the driving simulator centre and partnerships with these entities for future training actions for PT drivers of all the centre Portuguese region under consideration.	**
NA = Not Assessed O = Not Achieved * = Substantially achieved (at least 50%) ** = Achieved in full * = Exceeded**		

C4 Up-scaling of results

As described in detail in the previous points of the report, the measure was implemented in a reference group of SMTUC drivers, more precisely 25 drivers, who were involved in different training sessions, using the driver training simulator.

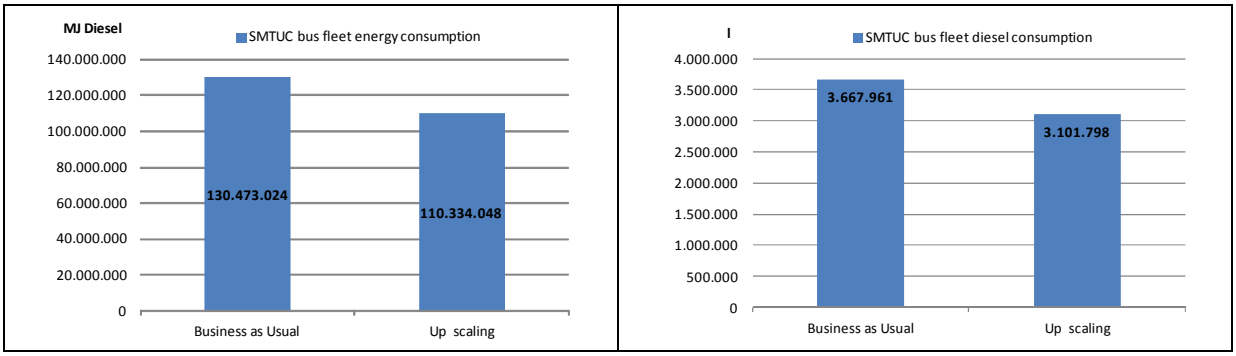
Considering that SMTUC has a global universe of about 280 drivers, it`s important to assess the potential impacts of up scaling the measure to the entire SMTUC universe, particularly in terms of the possible improvement of vehicle fuel efficiency/fuel consumption, as a result of the driving training simulator activities and eco driving principles.

Taking into consideration the indicator, average fuel efficiency on a mixed circuit, expressed in terms of energy per vehicle kilometre, it was possible to conclude that the measure resulted in a improvement of the fuel efficiency because in the ex post scenario, after the measure implementation, the 25 drivers recorded an improvement in fuel efficiency ratios, which means a lower fuel consumption for the same driving course, Table C4.1.

Table C4.1: Energy: Indicator 3, Vehicle Fuel Efficiency.

Indicator	Ex-Ante Baseline July 2012	BAU	Ex-Post September 2012	Difference Ex Post – Ex Ante	Difference: Ex Post – BAU
Average Fuel Efficiency – Driving Training Simulator Effect (MJ/vkm)	21,75	21,75	18,39	-3,36	

Assuming the extrapolation of these results to the entire SMTUC universe and considering that based on historical data, the entire SMTUC fleet has an annual value of approximately 6.000.000 vkm, it is possible to estimate the impact that the measure could have in an upscale scenario, Graph C4.1 and C4.2.

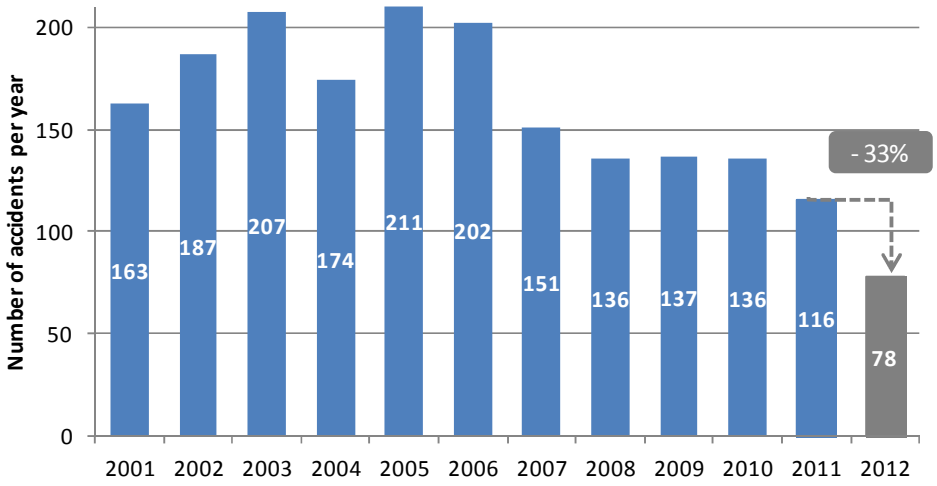


Graph C4.1and C4.2: Measure up scaling potential results in terms of possible fuel economy.

If the measure could be up scaled to all SMTUC drivers, and assuming that the 15% decrease of the average fuel efficiency achieved in the driving simulator could be maintained in real operational conditions, the total SMTUC bus fleet diesel consumption could be reduced in about 500.000 litres per year. Considering a reference price for the diesel of about 1,0395 €/l, this number could represent an annual saving of 519.750€ in terms of fuel costs.

The potential reduction of fuel consumption as a result of eco driving principles could also have an important impact in terms of emissions avoided. In fact, assuming the average CO_2 emission factor for diesel, 2,60 $kgCO_2$/l diesel (Portuguese National Inventory Report on GHG, 1990-2009. Submitted Under the UN Framework Convention in Climate Change and the Kyoto Protocol. April 2011) the potential emissions avoided will be about 1.300 tCO_2.

In terms of accident risk, it was possible to observe that the number of accidents decreased 33% between the two driving training sessions conducted in the simulator, probably as a result of the defensive driving principles acquired by the 25 drivers during the sessions. Assuming that this trend can be transposed to the whole SMTUC universe, it is possible to estimate the impact of the measure in terms of total number of accidents per year, taking into consideration the historical SMTUC data in this field, Graph C4.3. This would lead to a historically low number of accidents registered in a given year in the SMTUC universe.



Graph C4.3: Measure up scaling potential results in terms of number of accidents.

C5 Appraisal of evaluation approach

The evaluation process was based on different approaches, depending on the indicators within the areas of economy, energy, environment and society.

Initially an additional indicator was considered, more precisely "Percentage of female drivers in the universe of SMTUC drivers". However, considering the measure objectives it was decided that this indicator does not have a direct relation with the measure implementation and does not add any gain to measure evaluation. For these two motives the indicator was not considered for evaluation purposes.

In terms of emissions calculation, the approach was based on emission factors, specific for pollutant and type of vehicle technology (in this case an Euro 3 vehicle), according to the EMEP/European Environment Agency (EEA) emission inventory guidebook 2009, updated May 2012, on exhaust emissions from road transport[8]. These average European emission factors were determined using the Tier 3 methodology (based model with COPERT) which follows in using typical values for driving speeds, ambient, temperatures, highway-rural-urban mode mix, trip length.

A lack of funding from the Portuguese government for the driving simulator purchase delayed the measure implementation because a long administrative process occurred in order to assure alternative funds. As the demonstration period (4 months) didn't allow an assessment of the real behaviour of the drivers after a correct period of driving simulator training, a reference group of 25 SMTUC drivers was set up to have the time to evaluate the impacts of the driving training sessions that began on 26th June 2012. This methodology allowed for more intensive training sessions in the driving simulator and assess the drivers' behaviour modifications in a shorter time period.

So, for the indicators 3 to 10 the evaluation methodology was mostly based on the assessment of the results achieved by the reference group of 25 SMTUC drivers, as a result of the 4 driving training sessions conducted in the simulator (two different tests, conducted in July and repeated in September 2012)

[8] http://eea.europa.eu/emep-eea guidebook

Without the possibility of measuring the real impacts of the training in the drivers behaviour during an acceptable time frame, the indicator in the safety field has been the Accident risk derived from the simulator outputs in spite of the assessment to the real evolution of the number of accidents of SMTUC drivers. A similar approach has been made for the fuel consumption and the related emissions, while the driving quality has been also assessed during the driving simulator trainings, but from the trainers' perception on driver behaviour.

C6 Summary of evaluation results

The key results are as follows:

- **Reduction of the Average Operating Costs** – The measure led to a reduction in the average operating costs (€/vkm) of the driving training activities. In fact, the driving training simulator has lower energy, maintenance, and personnel costs in comparison with driving training sessions in real operational conditions, using diesel vehicles. Overall, the average operating costs decreased about 15%, from 3,41 €/vkm to 2,90 €/vkm, essentially due to much lower energy costs.
- **Improvement of Fuel Efficiency**– The measure has the potential to improve the average fuel efficiency of SMTUC services. During the driving training sessions using the simulator, a substantial improvement of the average fuel efficiency in mixed circuit was observed, corresponding to a 15% reduction in terms of energy consumption per vkm (about 500.000 litres per year of fuel savings when the training is eventually applied to all SMTUC drivers).
- **Reduction of Emissions** – Using a driving training simulator instead of diesel vehicles in real operational conditions has a significant impact on the average emissions per vkm. The replacement of the diesel consumed in the driving training vehicles for electricity consumed in the driving training system simulator, leads to reductions in the average emissions per vehicle-km between 19% and 93%, depending on the pollutant under consideration.
- **Lower Accident Risk** - The driving training simulator can help improve transport safety. Between driving training sessions in the simulator and considering the same circuit and travelling distance, a reduction of the total number of occurrences was registered, namely curb jumping and trampling in about 33%.

C7 Future activities relating to the measure

The functioning of the Driving Centre will continue in the future. A process of licensing the driving centre for the training of PT drivers from other companies is in course and partnerships with some specialised organisations are presently under consideration.

Due to the lower cost that the driver training would have and the increase in available resources (buses not used for training) that the simulator allows for, a significant raise in the number of training courses and trainees is expected. There would be fuel savings, pollution reduction, increase of safety, and higher levels of diving quality which would increase passenger comfort.

D Process Evaluation Findings

D.1 Deviations from the original plan

The deviations from the original plan comprised:

- **Delay in the measure implementation due a prolonged administrative and bureaucratic process related to the lack of co-financing from the national government** – Despite the first positive informal contacts with the Portuguese Institute for Mobility and Inland Transport (IMTT) beginning in July 2007, for demanding the national co-financing for the purchase of the driving simulator, it was at the end of 2009 that several working meetings with the Chairman of the IMTT took place to point out the importance of installing this equipment in Coimbra (in the centre of the country). Due a change of opinion concerning the national financing, these initiatives and others during 2010 had no positive results, reason for which the Municipality and SMTUC[9] opted to establish a loan contract to cover the remaining part of the simulator financing not supported by CIVITAS. This resulted in a prolonged administrative and bureaucratic process, due in large part to the greater control carried out by the National Court of Accounting due the national financial crisis. The consequent delay and the need to carry out a correct evaluation obliged the extension of the measure for another 4 months despite the recovery actions undertaken.

D.2 Barriers and drivers

D.2.1 Barriers

Preparation phase

- **Barrier 1.1 – Technological Barrier** – The lack of know-how and experience about state-of-the-art on driving simulators for public transport vehicles, due the reduced number of this type of equipment installed at European level, made the work for the specifications and for the design of the driving simulator, as well as the tender procedures, more difficult.

- **Barrier 2.1 – Financial Barrier** – The lack of co-financing by the national government for the driving simulator purchase obliged SMTUC and Municipality to carry out a loan contract to assure the needed funds for the driving simulator purchase. The already prolonged time-expensive administrative and bureaucratic procedures for this effect and for the international tender have been aggravated by the financial national crisis. In fact the time lost with the process for the 2 stages of validation by the National Court of Account have been too much and added to aggravate important delays, despite the recovery actions undertaken.

Implementation phase

- **Barrier 2.1 – Technological Barrier** – SMTUC opted for the construction of new buildings for the Driving Centre and for the installation of the driving simulator because the existing facilities did not have the conditions to support the technical

[9] Urban Public Transport Operator owned by the Municipality of Coimbra

requirements that the high technology imposed. SMTUC opted for the installation of pavilions to allow a simpler and more cost-effective process, But the initial company responsible for the installation of the main pavilion abandoned the process, obliging SMTUC to carry out a new procedure for the effect. This problem caused some delays that didn't have an influence in the driving simulator installation because SMTUC carried out recovery actions.

Operation phase

- **Barrier 3.1 – Problem related Barrier** – The driving training sessions on the SMTUC driving simulator began with a great delay (26th June 2012) due to the accumulated problems referenced in the formers barriers. Despite the extension of the measure duration, the remaining time for the evaluation of the measure impacts (less than 4 months) was too short to allow a correct assessment to the change in the SMTUC drivers behaviour.

- **Barrier 3.1 – Technological Barrier** – The driving condition in this kind of simulators implied some time of adaptation, otherwise the trainees could become sick. If this phenomenon occurs all the future training activities for these drivers could be put in risk, as well as the image of the training activities with driving simulator.

D.2.2 Drivers

Preparation phase

- **Driver 1.1 – Technological Driver** – The possibility of visiting other driving simulators in this phase, namely due to the good relationship between SMTUC and the Transport Public Operator of Madrid (EMT) or the Portuguese Association of Public transport Operators (ANTROP), both owners of this kind of equipment.

- **Driver 2.1 – Financial Driver** – Despite the financial crisis in Portugal and the lack of national co-financing, SMTUC and Municipality decided to assume alone the financing of the major part of the driving simulator purchase, establishing a loan contract for this effect. The availability of CIVITAS funds and the desire of SMTUC to respect their commitments with the MODERN project also helped the decision. Also important could be the availability of income in the future coming from the training of drivers from other companies that need to comply with the European Directive 2003/59.

Implementation phase

- **Driver 2.1 – Involvement Driver** – The involvement and motivation of the SMTUC technicians and the great cooperation between SMTUC and the driving simulator supplier has been a great aid for the recovery actions needed during the implementation process.

Operation phase

- **Driver 3.1 – Organisational Driver** – Despite the difficulty of having drivers available for the training activities, in great part due the economical crisis in Portugal

that didn't allow the reinforcement of more drivers, SMTUC made all the efforts to grant some drivers to the referred activity.

- **Driver 3.2 – Technological Driver** – During the visits to the Driving Centre of EMT SMTUC technicians also had training in the planning of the training sessions in driving simulator, as well as the risks that could appear and the best way to solve them.

D.2.3 Activities

Preparation phase

- **Activities 1 – Technological Activities** – Taking into consideration the lack of knowledge of the SMTUC technicians on driving simulators technology (barrier 1.1) and the possibility of visiting other driving simulators (driver 1.1), visits were carried out to the driving simulator for heavy vehicles in Porto (ANTROP) and the driving simulators for public transport buses in the Transport Public enterprise of Madrid (EMT), helping SMTUC technicians to acquire experience in this equipment, as well as to better set-up the measure implementation and the specifications for the driving simulator.

- **Activities 2 – Financial Activities** – To combat the lack of co-financing by the national government (driver 1.2) and taking advantage of the good involvement in the measure of the Municipality and SMTUC (driver 1.2), it was decided to carry out a loan contract to grant the remaining funds that were needed for the purchase of the driving simulator. For this decision also contributed the fact that in the future this investment could be covered by income from the training of drivers of other companies that need to comply with European Directive 2003/59 (that binds the continuous driver education - 35 hours each 5 years - recommending that this should be made by state-of-the-art simulators). For this reason partnership with several stakeholders are being analysed.

Implementation phase

- **Activities 3 – Involvement Activities** – Taking advantage of the good involvement and motivation of the SMTUC technicians (driver 2.1), a rigorous planning and monitoring of the installation of the pavilions for the Driving Centre has been carried out, avoiding that some of the delays in the beginning of this process (barrier 2.1) could affect the installation of driving simulator. Also the good cooperation with INDRA, the developer of the driving simulator (driver 2.1), contributed to the success of this issue, because great part of the work of equipment assemblage has been made in the manufacturer site, instead of the final place in the SMTUC Driving Centre.

Operation phase

- **Activities 4 – Problem related Activities** – The remaining time for the evaluation of the measure impacts (less than 4 months) was too short to allow a correct assessment to the change in the SMTUC drivers behaviour (barrier 3.1). Taking advantage of the SMTUC willingness to comply with their commitments, putting available drivers for the training activities (driver 3.1), it was decided to set-up a reference group of 25 of the 280 SMTUC drivers to have the time to evaluate the impacts of the driving training sessions that began on 26th June 2012. This methodology allowed to have

more intensive training sessions in the driving simulator and assess the drivers' behaviour modifications in a shorter time span.

- **Activities 5 – Planning Activities** – Taking into consideration that the driving conditions in the simulator obliged to have some time of adaptation to avoid risks of less acceptance from the trainees (barrier 3.2), SMTUC used the experience acquired in the training activities during the visits to the Driving Centre of Madrid (driver 3.2) and made a rigorous planning of the training activities, namely by stipulating that the first session for each driver must be inferior to 3 minutes and in favourable driving conditions (without passengers, less traffic, large streets and good weather conditions).

D.3 Participation

D.3.1 Measure partners

- **Measure partner 1 - Serviços Municipalizados de Transportes Urbanos de Coimbra (SMTUC); Public transport company; Leading role**

SMTUC was responsible for the coordination of the activities of the measure, the work of research, knowledge acquisition and planning of the measure implementation. Also SMTUC conducted the setup of the measure and it implementation, namely by the purchase of the driving simulator and the accomplishment of it installation in SMTUC site.

The training activities, including the ones related to the reference group of 25 drivers, has been also carried out by SMTUC.

The data collection regarding the evaluation was also collected and provided by SMTUC.

- **Measure partner 2 – Câmara Municipal de Coimbra (CMC); City; Principle participant**

The Municipality together with SMTUC assumed a loan contract for the financing of the driving Simulator purchase.

Also the Mayor, the Councillor for Mobility, and technicians from the Municipality visited the driving simulator together with the media, helping SMTUC to promote the driving simulator.

Since October 2011 the Municipality has been also responsible for the dissemination of the CIVITAS MODERN project of Coimbra.

- **Measure partner 3 – Prodeso Ensino Profissional, Lda (PRODESO); High school; Principle participant**

PRODESO was responsible for the dissemination activities for the first three years of the MODERN project of COIMBRA.

- **Measure partner 4 – Perform Energia, Lda (PE); Private company; Principle participant**

PE was the partner responsible for the evaluation of this measure, namely analysing data and results, as well as providing the related reports.

D.3.2 Stakeholders

- **Stakeholder 1 – General Public –** The general public will benefit from more safety and economic driving behaviour of the transport public drivers after the training sessions in the driving simulator.

- **Stakeholder 2 – INDRA** – This company was the responsible for the development and installation of the driving simulator, as well as the initial training for the trainers and maintenance personnel of SMTUC **(**www.indracompany.com).

- **Stakeholder 3 – Associação Nacional dos Transportadores Rodoviários de Pesados de Passageiros (ANTROP)** – The National Association of the Road Public Transport Operators allowed SMTUC to visit their driving simulator and is analysing the possibility to establish a partnership with SMTUC with the objective of licensing and provide training in the SMTUC driving simulator (www.antrop.pt).

- **Stakeholder 4 – CarrisTur** – Carristur, that is owned by Carris, the Urban Public transport of Lisbon, is also responsible for a training service. Carristur provide to SMTUC a proposal for a partnership with the objective of licensing and provide training in the SMTUC driving simulator (www.carristur.pt).

- **Stakeholder 5 – Empresa Municipal de Transportes de Madrid (EMT)** – The Municipal Public Transport operator of Madrid allowed SMTUC to visit its Driving Centre and experienced the driving simulators, as well as provided training to the SMTUC trainers and important information to all the participants, including the measure leader. (www.emtmadrid.es).

- **Stakeholder 6 – Public Transport Operators** – The drivers of the public transport operators were a target group for the training activities in the SMTUC driving simulator.

- **Stakeholder 7 – Media** – Media has been a channel for the dissemination and promotion of the measure and all the events organized had the participation at least of the local media.

D.4 Recommendations

D.4.1 Recommendations: measure replication

- **Preparation of Drivers –** The use of the high tech simulator implies a period of physical habituation in order for drivers to take complete advantage of its potential. Accordingly, the first sessions should be limited to periods under three minutes so that the drivers can get used to the simulation environment. The length of time that drivers use the simulator can be gradually augmented as the various sessions progress.

- **Adapt the physical space to the specifications of the simulator -** The simulator is high powered equipment which generates a high amount of heat. The physical space were the simulator is located should be prepared with air conditioning systems which can contribute to creating the best possible training environment.

- **Visits to already implemented driving simulators –** Visiting already implemented driving simulators and changing experiences with training Centres equipped with this tools is recommended because many times the idea predefined about this equipment is very different of the reality and with important technological complexity.

- **Taking advantage of the European Directive 2003/59 –** The European Directive 2003/59, which establishes continuous driver education (35 hours every 5 years), recommending the use of high-tech driving simulators, could be an important driver for the profitability of the investment.

D.4.2 Recommendations: process

- **Plan and integrate potential partners at the earliest stage possible –** The creation of a training centre which envisions the participation of other companies and partners demands that contacts and negotiations begin at the earliest stage possible. In order to reap the benefits of the investment the company which owns the simulator should begin involving other companies and partners from the start-up of the simulator, otherwise it will lose valuable time afterwards.

- **Guarantee funding before beginning the acquisition process –** The high investments involved in the acquisition of a high tech simulator such as the one purchased in Coimbra demands that all the financial funding be sorted out and defined from the beginning of the decision process in order to avoid delays in securing the financial resources while the process is on-going.

Annex (Survey Form)

Driving Center | Questionnaire to SMTUC drivers

Question 1: Do you know that SMTUC has the intention to implement a Driving Training Center equipped with a high technology driving simulator (with a real and dynamic driving seat and capable of simulating passengers interaction)?

☐ Yes ☐ No

Question 2: What is your opinion about the use of high technology driving simulator for the purpose of training bus drivers?

☐ Favorable ☐ Unfavorable