Measure title: **New Ticketing System in Coimbra**

City: **Coimbra** *Project:* **MODERN** *Measure number:* **02.05**

Executive summary

Coimbra intended to increase the effectiveness of the system of inter relation among Public Transport (PT) operators and extend it to the municipalities around Coimbra, by using both single and combined fares, as well as to develop new products in terms of inter modality, since this has always been a priority strategy to the Municipality of Coimbra throughout the years.

For these reasons Coimbra implemented a new e-ticketing system in the Urban PT Service owned by the Municipality (SMTUC). The system has been based on technologies allowing "contact less" validations for all kinds of transport e-cards and e-tickets, the creation of a wider range of products and a greater reliability of the systems performance. Also fraud control has been facilitated. A more complete on demand database has been provided, enabling monitoring and benchmarking as well as dynamic network and supply planning and the adaptation of the transport network to the real needs of the populations' mobility.

The major advantage of the new e-ticketing system has been the great increase in the interopearability between systems and PT operators and in the intermodality. In this field took special highlight the creation of new e-tickets for the Park&Ride system, the establishment of a partnership with an association of PT operators and the complete integration with the Automatic Vehicle Management system of SMTUC.

Despite some delays in the measure implementation resulting from financial and bureaucratic issues, the less time for the demonstration period didn't affected the achievements of some key results, namely:

- An increase of the average operating revenues (+0,02 €/v-km) due to a shift from private cars to public transport (+ 1,2% PT users) and a decrease of the average operating costs (- 0,0095 €/v-km). Adding the effects of the operating revenues and costs it can be concluded that the measure has a positive impact from an economic view point. This fact has been confirmed by the Cost-Benefit Analysis showing that the measure can generate a positive NPV of 1,82 M € over a 15 year period with a payback of the investment expected to be between the 5th and 6th year of implementation.
- Significant energy savings due to the assessed reduction of the energy consumption per passenger (-0,24 MJ/pkm) and generates a positive impact on CO2, NOx, and PM emissions with a decrease of 17,081 g/pkm, -0,698 g/pkm, and 0,03 g/pkm, respectively. The CO emissions remained constant.
- An increase of the Park & Ride system usage with a growth of 10% of the e-tickets sold.

In the future the e-ticketing system will continue functioning, as well as the development of the on-line payment system. Once the legal issues relating to national legislation and the financial crisis will be overcome, the payment and reload of the e-cards through ATM machines will also be implemented. The contacts created for the establishment of an inter-municipal pass will continue, namely by searching for new ways to avoid financial barriers and involve both the surrounding Municipalities and PT operators in a common project.

A Introduction

A1 Objectives

The measure objectives are:

(A) High level / longer term:

- To combat the social exclusion and guarantee good life quality, with special attention to populations in the surrounding towns and municipalities.
- To promote intermodality and interoperability in the regional / urban mobility systems, including integration of services, such as parking.

(B) Strategic level:

- To increase the importance of the social role of PT in the region.
- Increase the use of PT in the city.
- To decrease city traffic levels.

(C) Measure level:

(1) To install a new e-ticketing system on board of 125 PT vehicles.

(2) To create products, including the improvement of the integration of services (such as those linked to parking), that will also contribute to increase by 1% the passengers in the municipality PT service and 3% the usage of Park & Ride.

(3) Expansion of public transport in the metropolitan area.

A2 Description

Coimbra intended to increase the effectiveness of the system of inter relation among PT operators and extend it to municipalities around Coimbra, by using both single and combined fares, as well as to develop new products in terms of inter modality, including the multimodal "railway – bus" pass and a service related to private vehicles, since this has always been a priority strategy to the Municipality of Coimbra throughout the years.

One of the main aims was in fact to facilitate the access to PT, to make it faster and more comfortable, in order to attract new users.

For these reasons Coimbra implemented a new e-ticketing system based on technologies allowing "contact less" validations for all kinds of transport e-cards and e-tickets, the creation of a wider range of products and a greater reliability in the systems performance. Also fraud control has been facilitated. A more complete on demand database has been provided, enabling monitoring and benchmarking as well as dynamic network and supply planning and the adaptation of the transport network to the real needs of the populations mobility.

Taking into consideration the great importance of the project at regional level and the interest showed by the National Authority of Inland Transportation[1] for the support of measures that could increase the integration of several PT operators and other modes of transportation in the metropolitan areas, the Municipality of Coimbra, through its municipal public transport service (SMTUC), began the contacts for the national funding of the e-ticketing system purchase before the CIVITAS application.

Despite this anticipation, a large amount of the time for implementation of this measure has been spent on solving administrative and bureaucratic problems:

- First the governmental decision for the co-financing of the system purchase only occurred on 29th December 2009, 7 months after the technical conclusion of the tender process (with the proposal for adjudication on 11th May 2009) – SMTUC carried out recovery actions, launching a loan contract for the purchase of the e-ticketing system, taking into consideration that in Portugal the final adjudication only could be authorized after all funds are designated. But the loan contract procedure was equally time consuming, due in large part to the financial crisis in Portugal that obliged more rigorous procedures during the contract validation by the National Court of Accounting;

- A contention on the final results and hierarchical appeals to several instances occurred during the procedure of the international public tender for the e-ticketing system was carried out by one of the tender contestants. Despite no reasons being attributed to the contestant, these appeals led to the suspension of the procedure until the final decision, allowing the final adjudication to happen only on 30th August 2010.

- Finally, the loan contract validation by the National Court of Accounting occurred in December 2010, the signature of the contract for the e-ticketing system took place on 23rd December 2010 and the new validation by the National Court of Accounting (now for the system purchase) was released on 17th February 2011.

To recover the time lost, several planned activities have been anticipated or ran in parallel with these administrative procedures:

- Accordingly, for the technical specifications of the new system, while solving the financial and administrative issues, SMTUC carried out a market analyse through the available online information or using the information provided by the manufacturers during presentations of their products. SMTUC took also advantage of the visits made to other existing systems and of the experience of the staff of OTLIS (the association of the public transport operators of the Lisbon region). These activities included a partnership with OTLIS aiming at the establishment of a national standard of e-ticketing systems – the partnership allowed for a common data base model and the same application programming interface (API) and the same security access module (SAM). These solutions benefited the interoperability and intermodality on the national level and allowed for economically more favourable tender proposals due the fact that a great amount of the work needed for the development of the system for Coimbra region has been already made by the major part of the manufacturers when they supplied Lisbon region in the past.

- Moreover, the period between the contract signature and the validation by the Court (almost 2 months) has been used for the planning of the system installation with the supplier, allowing the shortening the implementation time (that was 1 year by contract).

[1] General Directorate of Inland Transportation (DGTT) and National Institute of Mobility and Inland Transportation (IMTT) since November 2007

- Finally, in parallel, SMTUC created the concept of "Coimbra ConVIDA" for e-cards and "Viagem ConVIDA" for e-tickets and carried out procedures for the purchase of 50.000 e-cards and 220.000 e-tickets.

Thus, until December 2011 the equipment was installed in the central office for the system management, the on line data collection and data processing, and also on board of 150 vehicles (SMTUC assisted and supervised the installation of the equipment on board of all the fleet). The on board equipment consist in one console adjacent to the driver for the on board system management, for on board tickets sale (supported on thermal paper), and for the "contact less" reading and reloading of the pre-paid e-tickets and the fares supported on e-cards, as well as one validator for the main task of reading the e-tickets and e-cards (Fig. A2.1).

Fig. A2.1 – The on-board equipment of the new e-ticketing system

The other equipment that was purchased and installed is the following:

- 8 "Contactless" Reader Terminals for Controllers
- 9 Vending, Card Load and Personalization Machines
- 28 Vending and Card Load Portable Terminals
- 2 Transaction / Accounting Posts
- 4 Automatic Machines for Driver Accounting Transactions
- 1 Central Server
- 1 Middleware Platform

The launch of the system in test mode was carried out in September 2011 for specific fares and public transport lines considering that up to this date the major part of the system was already installed.

The vending equipment and the 4 automatic machines for PT drivers account activities related with on board tickets sales have also been installed by the end of 2011.

Training has been provided to the SMTUC maintenance and accounting personnel, supervisors and to all other users of the new system, including the drivers.

During the last week of December 2011 an info mail about the new e-ticketing was delivered to all the Coimbra residents (to 84.007 mail boxes).

On 1st January 2012 the new e-ticketing system started in the entire SMTUC PT network and fleet for the on board thermal tickets and the e-tickets (pre-paid) – The system allowed in this phase the sale on board by the driver of thermal tickets for the occasional passengers that didn't have pre-paid e-tickets and the vending and on board validation of "contact-less" pre-paid e-tickets.

In February 2012 the remaining fares (supported in the e-cards "Coimbra ConVIDA) was launched for the whole SMTUC public transport network, despite the existence of a transition period running up to the end of May 2012 in which the 2 systems functioned in parallel for the e-card passes.

The new e-ticketing system is an "open" system that will not depend on the actual system integrator for it expansion in the future, and in which all kinds of card technologies can be read (facilitating the integration of other PT operators and more mobility products in the future – car sharing, bike sharing).

In any case, the new system has already allowed for the creation of an intermodal new product – The Park & Ride e-ticket that provides 1 day free parking in the parks of the system and 2 or 4 displacements, now in all PT lines during 1 hour each displacement. The existing combined fare between SMTUC and the other PT operators involving all inhabitants of the Municipality of Coimbra also benefited from the improvements of the new system, namely with the new channels for purchasing and reloading the new SMTUC e-card.

The system was initially developed to allow for the future integration of multiple PT operators (public and/or private), namely in view of the creation of an inter-municipal pass. However, the financial crisis has led many of the municipalities involved to reconsider their investment priorities. Accordingly, urban mobility issues have many times taken a back seat to other considerations, namely those associated with social themes and economic recovery.

On the other hand, the automatic accounting system for the PT drivers is experiencing good results and allowed for savings in human resources. The personnel dedicated in the past to these operations has now been liberated for other activities. Also the development by OTLIS of the application that will allow for the on-line payment and reloading of the passes is on-going. The situation is the same for the possibility of providing this activity through ATM machines (in this case already developed by OTLIS and in functioning in Lisbon, but waiting for a decision in the case of Coimbra– due to some legal impositions caused by the new legislation provided by the national government to combat the financial crisis in Portugal).

The new e-ticketing system was also integrated with SMTUC's automatic vehicle management (AVM) system – a GPS/GPRS technology based system. This has allowed for the new on-board consoles to manage the AVM system and avoid the need for drivers to repeat operations on other devices. This integration has also permitted the georeferencing of passenger entries.

In the near future, the new information e-panels at the buses stops will provide real time information on bus arrivals and will have also the capability to read the e-tickets (informing the number of remaining trips) and reload the e-cards.

The implementation of the new e-ticketing system also had organisational and economical impacts.

First a great improvement in the reliability of this system was verified in comparison with the previous system, mainly due to the change in the validation of the tickets from magnetic technology (involving

mechanisms and material wear) to "contact less" technology (without mechanical wear). This fact allowed for important savings in maintenance, both in material and personnel – for example, the technician responsible for the coordination and monitoring of the system installation delayed the retirement until its conclusion and has been not replaced, allowing for the decrease of 1 individual of the maintenance personnel dedicated to the IT systems in SMTUC.

Also the automatic accounting system for the PT drivers is experiencing good results and allowed for savings in human resources. The personnel dedicated in the past to these operations have now been shifted to other activities. Namely 2 employees have been transferred to the ticket sales and have been supported the maintenance of the Infomobility Centre in functioning after the end of the CIVITAS MODERN co-financing period.

In any case, the implementation of the automatic accounting machines hasn't been pacific, namely because these machines only have a ATM module for the settlement of accounts (machines that allow coins and notes for the transfers were twice as expensive and continue needing manual services to collect and count the money, as well as have more risks concerning fraud and safety). Before the installation of the new e-ticketing system drivers had to request tickets (paper support with magnetic band) for the on-board sale at SMTUC the accounting office. They would then carry the tickets with them in each of their driving services. Afterwards, drivers had to return to the accounting office in the following 2 days after tickets sale for the settling of accounts (the entire process was manual). They also could use a safe-deposit box placed in the city but this procedure didn't avoided the need to confirm the reckoning with the accounting office in a latter date. With the new system, drivers do not need to order and to bring tickets with them. The on-board sale is now being made through the driver console (that dispenses tickets supported in thermal paper) and the vending values are automatically transferred to the 4 automatic machines located in strategic locales in the city and SMTUC site. With the start-up of the new e-ticketing system ATM bank cards have been distributed to all SMTUC drivers with an initial financial advancement. This bank card (or the driver personal bank card) is used for the settlement of accounts trough the automatic machines that have an ATM module. These procedures created some strong contestation from the drivers, with support of the trade unions, during the beginning of the system operation. Initially, they claimed that they didn't want to use their personal bank card, reason for which SMTUC distributed the already mentioned dedicated ATM cards. But the major concern has been the fact that they didn't want to carry the coins received from the users, taking into consideration that before they had the safe-deposit box and now they need to go to a bank to deposit them. Despite this situation has not been a major problem to the measure implementation, required some special attention to it resolution and was solved while drivers had the perception that there are more advantages then disadvantages.

Finally it is important to summarise the major advantages and disadvantages of the 2 systems. In fact the main differences between the new system and the old (magnetic) system is being the major reliability of the system (the magnetic system required mechanical operations that produce material wear) and the new and enhanced functionalities, since in terms of investments the costs should be similar.

The first advantage implied the reduction of the maintenance costs (so more economic advantages) and the second allowed the creation of new mobility products, the personnel saves in the organisational field, the quickest access to better and major quantity of operational and financial data, as well as more comfortable and fastest access to the public transport. In this last filed (and contrary to the ancient system), the new system allowed the reload of the tickets and it fastest validation on board buses (contact less validation in spite magnetic validation). Also the new system provides more channels for the e-cards reload and the integration of several products simultaneously in the same card (the e-cards of the ancient system only supported public transport fares of an unique kind in each moment).

The unique disadvantage assessed in the new system is related to the fact that the system doesn't allow the display of the users' remaining trips in the pre-paid e-tickets (the remaining trips is displayed in the console or validator screen). While the ancient system, with magnetic validation for the pre-paid tickets, write the remaining trips in the ticket. This contrariety obliged more users' attention, mainly for the elders.

It is important to highlight that despite all the bureaucratic problems that have been very time consuming, the implementation of this measure has been crucial to the quality of the services provided by SMTUC, contributing to an improved urban mobility. It has also been indispensable for the ticketing activity, because during the last months of 2011 it had been very difficult to maintain the previous ticketing system functioning.

B Measure implementation

B1 Innovative aspects

The innovative aspects of the measure were:

- **Use of new technology/ITS, nationally**
    - The e-ticketing system has been developed to allow the on-line payment of the e-cards and reloading at home (through the eventual acquisition of a portable loading device) or through the validators on board the buses, allowing people to make this action at home and then travel without passing through point of sales. The same for the reload of the e-cards through ATM machines, because in Portugal only Lisbon and Oporto are implementing this system.
    - The e-ticketing system has been integrated with other SMTUC systems, more specifically the System of Exploitation's Information Treatment, GPS – Operation Support System and the Integral Transport System Management. In particularly this will provide geo-referenced information about passengers entry for the support of studies about the demand and real time monitoring of on board validation and vending.
    - The electronic panels at bus stops with the real time information about buses arriving, provided by the GPS/GPRS – Operation Support System (integrated in measure 08.03), has been equipped with another module closer to the users with a second display and equipment that allows the loading of the transport e-tickets and the verification of its balance, (in addition to the duplication of the information provided in the main display).

Figure B1.1 – Real time information panel at bus stops powered by solar energy (left) and detail of the secondary module with second information screen and "contact less" reader (right)

- **New policy and economic instrument, regionally**
    - The e-ticketing system uses "Calypso" technology and the same data model and security and protocol technology used in OTLIS (Lisbon Metropolitan Area Entity of Public Transport Operators) facilitating and giving more credibility and security for the intermodality and interoperability, allowing, namely, the creation of an inter municipal pass through which the resident population of the municipalities around Coimbra, transported by private operators, will be able to use SMTUC lines with discounts and the same card. The partnership with OTLIS allowed SMTUC to benefit from discounts in the purchase of cards from the manufacturer due the major quantity of cards involved (summing Coimbra users with Lisbon Metropolitan Area users).

- **New economic instrument, nationally**
    - The SMTUC bus drivers are providing automatically in machines the provision of accounts for the on board sales, reducing the staff previously needed for this activity.

B2 Research and Technology Development

The Research and Technology Development consisted mainly by the Model's Conception and Definition of Technical Specifications, namely the definition of the needs and design of the new integrated system that included:

- Specification of the Validation's Model (contact less type);
- Specification of transport fares structure, types and of its integration with other PT operators and other means of transportation, as well as with parking and Park & Ride. Special attention was given to the activities and studies to support the creation of an inter-municipal pass (with the partnership of surrounding municipalities and operators) through which the resident population of the municipalities around Coimbra, transported by private operators, will be able to use SMTUC lines with discounts;
- How and where to install the system on board of the PT vehicles and personnel necessary;
- Which information the system shall produce;
- Integration with other SMTUC systems, more specifically the System of Exploitation's Information Treatment, GPS – Operation Support System and the Integral Transport System Management;
- Coordinate the ending of the old service and the beginning of the new system;
- Planning the maintenance, who assures it and type of the equipment necessary;

In order to prepare the technical specifications of the new system, while solving the financial and administrative issues, SMTUC carried out a market analysis through the available online information or using the information provided by the manufacturers. SMTUC also took advantage of the visits made to other existing systems and of the experience of the staff of OTLIS (the association of the public transport operators of the Lisbon region). These activities included a partnership with OTLIS aiming at establishing a national standard for e-ticketing systems. This partnership allowed for SMTUC to adopt a common data base model, standard application programming interface (API), and security access module (SAM). These solutions not only benefited the interoperability and

intermodality at the national level, but also allowed financial savings due the fact that a great amount of the work needed for the development of the Coimbra system has been already implemented by the major part of the manufacturers operating in Portugal.

Special attention was also given to the system specifications in order to avoid the dependency from the e-ticketing suppliers for the interoperability, for the expansion of the system / purchase of new equipment, and for the creation of new fares and products. Today there are 2 standards for the e-tickets and validators technology (the A type and the B type or Calypso) and the option for equipment that could support this kind of technologies could be a good approach for the interoperability but might not be enough – the systems must have a compatible data model for the products, mainly the fares, as well as for the API (responsible for the communication protocol between systems), and the SAM (Protocol of security between systems, avoiding that a ticket from a not allowed operator can't be used in the system).

The technology with the standard "Calypso" (B type) was chosen to permit greater security in the validation and load processes (avoiding the falsification of e-tickets and e-cards), as well as more "chip" memory than the e-cards based on A type technology - and consequently more capacity to support a large variety of contracts (fares, services, products). But all the equipment installed has the capability to interpret both A type or B type standards, facilitating future integration of other PT operators or systems supported in A type technology.

The e-ticketing system was specified to be an "open" system with the possibility of customising features so as to avoid the dependency on system suppliers in future developments. This part has been the most difficult to achieve. However, SMTUC had good results, mainly in the integration with the Automatic Vehicle Management (AVM) system and achieving independence in the creation and update of new fares or the purchase of new equipment such as validators.

The new e-ticketing system was also integrated with SMTUC's automatic vehicle management (AVM) system – a GPS/GPRS technology based system. As already mentioned, this has allowed for the new on-board consoles to manage the AVM system and avoid the need for drivers to repeat operations on other devices. This integration has also permitted the georeferencing of passengers' boarding and the 2 system has a common communication device (wifi) to transfer the data recorded on buses to the respective servers based on SMTUC site (back-office and control centre of each system). The automatic data transfer besides allowed a quicker and secure process for this activity, also avoided the manual work carried out by SMTUC personnel to discharge the data recorded on the ancient validators (directly bus by bus).

Specifically for the new e-ticketing system, SMTUC created the concept "Coimbra ConVIDA" for the e-cards and "Viagem ConVIDA" for the e-tickets, including the design of dedicated layouts (Fig. B2.1).

Fig. B2.1 - The layout for the e-cards of the "Coimbra ConVIDA" system (left) and "Viagem ConVIDA" system (right)

The e-card (ISO 14443B) is oriented for regular users and can support up to 4 different contracts in simultaneous. Accordingly, it is the support per excellence for the intermodal products. The e-ticket CTS512B (ISO 14443B) is defined for less frequent users, despite that the model chosen by SMTUC allows for reloading and has enough memory for the creation of some more simple intermodal products. Also the studies for the implementation of car sharing and bike sharing services in the city point to the importance of having a common e-card to access these services, to the public transport services, and to other products or services linked to the mobility area. So the new e-ticketing system has been designed and developed to permit these functionalities.

During the implementation of the measure some additional results that were not foreseen in the workplan have been considered. The development by OTLIS of the application that will allow for the on-line payment and reloading of the passes is on-going, as far as the possibility of providing this activity through ATM machines (Fig. B2.2).

Fig. B2.2 – Integration of systems

The system will permit users to pay the pass by internet and make the reload by “contact less” devices (at home, for example, but also in the driver console of the buses simultaneously with the validation, because this equipment has the capability to read and write in the e-cards). Also the e-cards used in the “Coimbra ConVIDA” system are “Dual card” standard (i.e. each card has 2 chips, 1 hidden chip with antenna – for the “contact less” communication with other similar interfaces – and 1 standard chip similar to the ATM cards for the use in ATM machines, allowing for the reload of the passes and charge of other products based in the e-card). The development of the ATM payment system has already been concluded by OTLIS.

B3 Situation before CIVITAS

Coimbra has already a wide range of products concerning public transports and their inter-relation with other means of transport, namely through SMTUC:

- Combined pass with private bus operators since 1988 (free travel in SMTUC lines) and multimodal pass railway – bus;
- Park & Ride system integrated with PT fares, since 1997 (first Portuguese city);
- Door-to-door mini buses for reduced mobility, since 1985;

- Lift / funicular since 2001 to connect lower and upper city centre;
- Sightseeing tours since 2004;
- Management of parking spaces since 1988;
- Historic centre line with blue line operation concept (boarding and enlightening on demand), with electric mini buses, since 2003 (first Portuguese city).

In 1997, SMTUC introduced a new ticketing system with the magnetic validation of tickets and in 2000 Coimbra expanded the system to "contact less" pass validation. Before the beginning of the CIVITAS project the system was not very reliable in terms of its maintenance, especially in its magnetic validation component. Due to technological evolution, the system presented certain limitations on the types and diversity of transport titles allowed.

The inter-modal level was lagging – namely because the multimodal pass "railway-bus" was not integrated in the ticketing system for technical reasons. The multimodal pass "railway-bus" was not used very often due to its weak economic attractiveness to the user (26 passes /month). There was also the need to expand combined titles (with free rides on SMTUC lines) to municipalities around Coimbra.

The systems of information anciently in use were outdated in relation to the new IT (Information Technologies) and machines for this ticketing system are no longer available on the market which can provide for the demand of SMTUCs growing fleet, as well as with the eventual extension of the system to other operators.

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 new e-ticketing system** *(October 2008 – November 2008) – The major part of the studies started before the beginning of the CIVITAS MODERN project and have been used by the measure, namely the study of the creation of an Inter-municipal pass demanded by Municipality to SMTUC in December 2005 (Fig. B4.1). It took place several meetings and contacts with Municipalities Mayor or Councillors, as well as with PT operators responsible for the Inter-municipal pass specifications and the agreement conditions.*

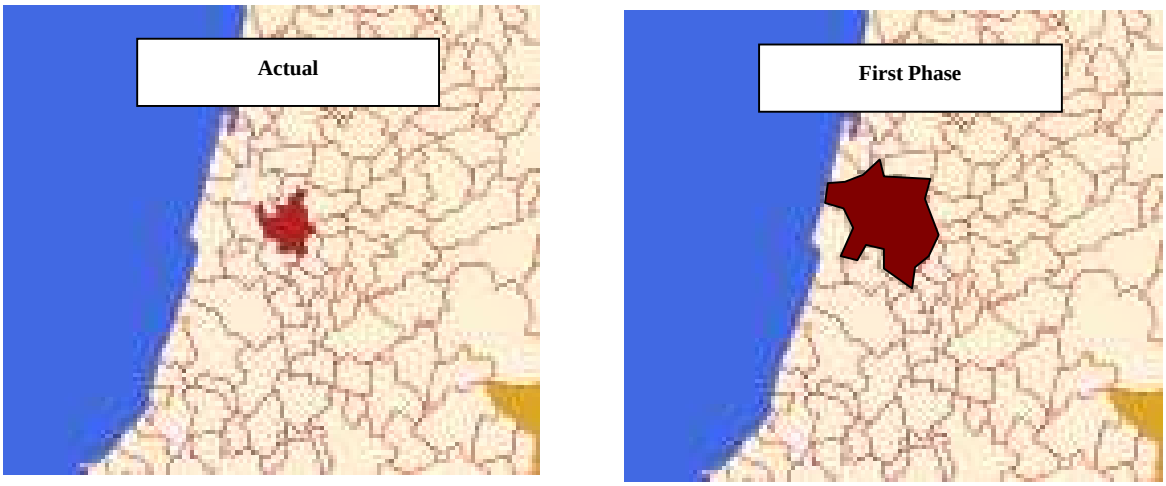


Figure B4.1-Limits of the inter-municipal pass

Also the decision to purchase a new ticketing system that will have as a priority the intermodality and interoperability capabilities occurred in July 2007, after the end of the call for CIVITAS plus funding.

At the same time SMTUC began the procedures to claim for national funding, namely:

- *Delivery of documents to IMTT (Portuguese Mobility and Transport Institute) with ticketing system definitions and claim for co-financing (July 2007).*
- *Answers to IMTT questions (December 2007 and November 2008, the last one already after CIVITAS measure began).*

Between October 2007 and November 2008 the technical specifications of the new e-ticketing system and definitions of new fares and other products or services to integrate in the ticketing system took place, namely:

- *Contacts, meetings and demonstrations with all interested suppliers of ticketing systems and related software developers to improve SMTUC's know-how about this matter;*
- *Specification of the Validation Model (contact less type);*
- *Specification of transport fares structure, types, its integration with other PT bus and rail operators as well as with the future tram train system, and other means of transportation and mobility services, such as parking and Park & Ride;*
- *Specification of vending / accounting processes and automatic transactions, including for PT Drivers;*
- *Specification of new concepts for tickets acquisition / cards load (Internet, ATM, Pay shop, Mobile Phones);*
- *Planning the installation of the system on board of the PT vehicles and means necessary for this activity;*
- *Planning the information that the system shall produce;*
- *Specification of the Integration with other SMTUC systems, more specifically the Supply Data Treatment System, GPS / GPRS – Operation Support System and the Integral Transport System Management;*
- *Coordination of actions to allow the end of the old service and the beginning of the new one without problems at users comfort level and ticketing continuance level;*
- *Planning of the maintenance, including equipment and personnel necessary.*

Release of the technical specifications for the tender procedure in July 2008 and the working document "Operation concept report and terms of references of equipment acquisitions" in November 2008.

Stage 2: Purchase and installation of the new e-ticketing system *(October 2008 – December 2011) – The launch of the purchase and installation procedure occurred in July 2008, before the start of the CIVITAS MODERN project. During CIVITAS procedures*

concerning the claim for national funding and the loan contract to grant self financing by municipality / SMTUC were carried out. The procedures of the tender, the claim for national funding and the loan contract had the following steps:

- *Opening ceremony of the tender proposals for the purchase and installation of the e-ticketing system in October 2008;*
- *In December 2008 the claim for national funding process was authorized by IMTT with transition to the Deputy Secretary of Transportation for final decision;*
- *Analysis of tender proposals for the purchase and installation of the e-ticketing system and jury final report with proposal for adjudication until May 2009;*
- *several More contacts with IMTT officials and meeting with its President to press national government to send to SMTUC the official communication of the authorization of co-financing took place between April and December 2009, taking in attention that, legally in Portugal, the adjudication of a purchase can only be done after all funds are defined;*
- *National funding for the purchase and installation of a new e-ticketing system was authorized by the Government on 29th December 2009. Only after this confirmation was it possible for the Municipality to begin the authorization process of the loan contract concerning the remaining funds. SMTUC made the process for this loan contract that was integrated with the loan needed for the measure 05.07;*
- *Final adjudication of the e-ticketing purchase in 17th March 2010 because the process was delayed due to a tender applicant contention of the final results, despite the prompt analysis and reply made by SMTUC. On 30th April the same initial contestant interposed a hierarchical appeal to the Municipality which had suspensive effects on the process and oblige a new and complicated process of analysis and reply;*
- *Analysis of proposals and final adjudication concerning the loan contract for co-financing the purchase of the e-ticketing system on 14th June and its validation by the Municipal Assembly on 29th June 2010;*
- *Reply of Municipality to the hierarchical appeal concerning the process of e-ticketing system purchase on 12th July 2010 (the Municipality asked the jury of the tender process to better substantiate the decision, causing the repositioning of the process in a new adjudication phase). New provisional adjudication for the purchase of the e-ticketing system on 29th July 2010 after the jury (SMTUC) delivered a new substantiation report, maintaining the same scores and classification;*
- *The loan contract was signed on 9th August 2010 and sent to the National Court of Accounting for validation;*
- *Concerning the purchase procedure, a new contestation occurred on 12th August 2010 with the same arguments, but the Municipality, being in accordance with the jury and seeking to hasten the process, called back the right to make the final adjudication, occurring on 30th August. On 7th October 2010 the period for the contestant appeals to the Court, asking for a preliminary injunction, ended without any appeal;*
- *Only in December 2010 the loan contract was authorized by the National Court of Accounting, allowing the celebration of the purchase contract;*

- *The contract concerning the purchase and installation of the new e-ticketing system was signed on 23rd December 2010 and sent to the National Court of Accounting on 28th December;*

Taking into consideration that the system installation can only begin after the court validation, some preliminary tasks were done, such:

- *Definition of the entire installation plan, including the place and method of the installation on board of the buses and the issues due to the period of transition between the actual and the new system that will have different types of fares.*

- *Contacts for the establishment of a partnership with OTLIS (Organization of public transportation operators of Lisbon and national railway company) with the objective of achieving common specifications, allowing better interoperability of e-ticketing systems.*

- *Visits to CARRIS site (urban public transportation company of Lisbon) to verify equipments and functionalities of a system similar to the system that SMTUC has purchased.*

- *Selection of the model data base, Security Protocol (SAM) for the "contact less" cards and the Application Programming Interface (API) for the bus-validators and driver console.*

- *Definition of the relationship between the e-ticketing system and the SMTUC accounting system as well as the specification of the new procedures in this area that the system will need.*

On 17th February 2011 the National Court of Accounting authorized the purchase and installation of the new e-ticketing system. The installation process began at this time with the commitment of the supplier to ensure a short time for the installation process, namely with the advancement of the organization and definition of the tasks. It eas also assured the organization of the supply in an incremental and modular way to allow early start of test and validation stage (for example, shifting to the end the modules that don' have relationship with the public, such as automatic accountability process for drivers or the middleware for interoperability of SMTUC systems). With this commitment it was possible to end the installation of the main equipment until the end of August 2011.

During this stage new contacts and meetings with Municipalities and regional operators took place to highlight the importance of the creation of the inter-municipal pass, in order to avoid problems with its implementation in the future.

Also the preparatory phase of the system installation included:

- *Specification of the security protocol for de SAM (Secure Application Modules) and its production;*

- *Final layout for the cards and tickets physical supports with the creation of the brand "Viagem ConVIDA[2]" (trip with life / inviting trip) for the tickets and "Coimbra*

[2] ConVIDA spelling could have 2 meanings in Portuguese. *Com Vida* that means with life or *Convida* that means invites / inviting.

ConVIDA" (Coimbra with life / Coimbra invites you) for the cards and other intermodal products.

- *Establishment of a partnership with OTLIS (Organization of public transportation operators of Lisbon and national railway company) with the objective of achieving common specifications as a national standard, allowing for better interoperability of e-ticketing systems, technical support for the mobility products and economies of scale resulting for large-scale demands of tickets and cards in tenders together the Lisbon Metropolitan area.*

- *Final definition of the relationship between the e-ticketing system and the SMTUC accounting system as well as the final adjustments concerning the specification of the new procedures in this area induced by the new system requirements.*

The on board equipment that has been purchased consists in:

- *one console next to the driver for the on-board management of the system, for the on-board sales of tickets on thermal paper support, and for the "contact less" reading and reloading of the e-cards and reading of the pre-paid e-tickets;*

- *one validator for the main task of reading the e-tickets and e-cards.*

  These 2 equipments with validation capabilities allowed for quicker passenger entry and for the extra equipments which are useful in case of equipments damages. The console also allows for the command of the Automatic Vehicle Management system, avoiding drivers to repeat operations that are similar between the 2 systems. This fact also allowed the redundancy of equipments between these 2 systems.

The other equipment that was purchased and installed is the following:

- *8 "Contactless" Reader Terminals for Controllers (these terminals are being used in fraud control but also have vending and e-card load capabilities – namely for events)*

- *9 Vending, Card Load and Personalization Machines (this equipment has been designed for the SMTUC point of sales, allowing the vending and personalization of the new e-cards and the reload of the e-tickets and e-cards).*

- *28 Vending and Card Load Portable Terminals (the terminals has been designed for the vending and reload of e-tickets and e-cards, namely for sales points in agencies, but also for the tickets sale in the Park&Ride system and events)*

- *2 Transaction / Accounting Posts (Equipment installed in the SMTUC settlement of accounts office designed for drivers and tickets sellers make the reckoning with the support of SMTUC personnel)*

- *4 Automatic Machines for Driver Accounting Transactions (Equipment designed for the drivers making the settlement of accounts autonomously)*

- *1 Central Server (Equipment for the management and monitoring of the e-ticketing system and provided of connections with other systems, sale points and equipments)*

- *1 Middleware Platform (sub-system used for the interoperability between the e-ticketing system and other systems, with emphasis with the Automatic Vehicle Management System).*

The installation process has been carried out until the end of August 2011 to allow for the launching of the system functioning in test mode since September 2011, but some remaining equipment has been installed until the end of December 2011. The installation process consisted namely of:

- *Installation of the equipment on board 150 buses (namely the new console for tickets sales and validation and the infrastructure for the new validator – the validators stocked in SMTUC will be placed during the period of transition between the new and old system taking in account the period of coexistence of the new system during which the validation will be assured by the new console).*
- *Installation of the system for the sale and loading of fares and its connection to the accounting system.*
- *Installation of 4 automatic machines for PT drivers account activities resulting from the tickets sales on board buses (Fig. B4.2).*

Figure B4.2 - The automatic machines for PT drivers account activities is allowing the payment by ATM of the results of the tickets sales on board buses with economies of resources on the accounting office

- *Installation of the e-ticketing system laboratory for equipment and system tests and for the functioning of the training sessions (Fig. B4.3).*

Figure B4.3 - Training session on the new SMTUC e-ticketing laboratory

- *Launch of 2 procedures to purchase the physical supports for the "contact less" tickets and cards. Despite that initially it was foreseen that these physical supports for the fares could be available through the protocol of partnership signed with OTLIS, like another PT operators in the Lisbon region, since in June legal opinions didn't allow that the tickets and cards could be provided directly by this entity, it was decided to launch the procedures for:*
  - *Purchase of 220 000 "Contact less" tickets CTS512B (ISO 14443B) for "Viagem ConVIDA" system:*
    - *Launch of the procedure by SMTUC on 22nd July 2011 (Direct Agreement procedure taking in attention that only 1 manufacturer produce this kind of tickets)*
    - *It was expected to be an easy and quick process but important delays of the supplier to provide the legal and mandatory documentation for the contract signature occurred. This fact pushed the contract signature into the end of November 2011. According to the supplier, taking in attention the small quantity of tickets, the SMTUC order has less priority on the manufacturing chain, so the usual delivery time for these cases was 8 weeks after contract signature. SMTUC demanded the supplier to shorten this gap, to allow the launch of the system for the public on 12th December 2011. Due to some additional problems with the e-tickets delivery the launch of the system for the e-tickets took place on 1st January 2012.*
  - *Purchase of 50 000 "Contact less" cards (ISO 14443B) for "Coimbra ConVIDA" system:*
    - *Launch of the procedure by SMTUC on 29th June 2011 (Public Tender).*
    - *Proposal opening ceremony on 17th August 2011 and beginning of the proposals analysis.*
    - *Procedure for the tests of the card samples with final adjudication on 19th September 2011. Card tests in the OTLIS laboratory until 4th October 2011 (the tests also included cards physical resistance and the cards to be used in the new system passed the tests).*
    - *Conclusion of the analysis of the proposals for the cards supply tender with the preliminary report of the jury and provisional adjudication on 18th October 2011. The final adjudication took place on 31st October 2011. The delivery time was 40 days after contract signature, but some recover actions*

allowed that the e-cards were delivered in time to allow the complete e-ticketing system start-up on 1st February 2012.

Stage 3: Training of the maintenance personnel and System operational users *(June 2011 – December 2011) – The training sessions occurred mainly in June and July 2011 for the maintenance personnel and in November 2011 for the SMTUC drivers and consisted mainly by:*

- *Training of the maintenance personnel for expertise in the coordination and accomplishment of the system installation and for the tasks of equipment maintenance and small repairs.*
- *Training of the SMTUC operational users of the system, namely for the accounting and vending staff on the management of the system and on the sales, load and personalisation of the e-tickets and e-cards, as well as of the bus drivers on the on-board console and on the automatic accounting machine.*

Stage 4: Information to the passengers *(July 2011 – January 2012) – The activities carried out during this stage consisted in the information to the citizens about the new system and occurred mainly during November and December 2011. Information to the citizens focused on the advantages of the new system and how to travel with it, namely through several news and promotional campaigns provided.*

On the last week of December 2011 an info mail about the measure and the new e-ticketing system to all the Coimbra residents was delivered (to 84.007 mail boxes).

Stage 5: Beginning of the e-ticketing system functioning in test conditions, internal evaluation of the failures and operational management of the system *(September 2011 – February 2013) – The operational stage of the measure began with the launch of the new e-ticketing system in test conditions for the on-board tickets on 22nd September 2011 (Fig. B4.4), in the blue line operated by electric mini-buses equipped with the new console – providing the on-board tickets (thermal paper) together with the old tickets. The blue line is a specific service for the historical centre of Coimbra using electric mini-buses in restricted access areas. The route of these buses is identified by a blue line in the street and the buses stop anywhere by passengers demand. The on-board sale allowed for testing the functioning of the console– in the beginning only in the blue line to facilitate the monitoring and avoid the proliferation of any problem to a major area. With the continuation of the good results, the on board sale with the new console was extended to the entire PT network until the end of 2011. The tests were conclusive and no major problems were detected.*

Figure B4.4 - Launch of the new e-ticketing system in test conditions for the on-board tickets on 22nd September 2011 with a inaugural trip in the new trolleybus and the continuation of the functioning of the system in the blue line. Detail of the console on the right figure

On 1st January 2012 the launch of the system for the e-tickets in all SMTUC fleet and network was carried out. The sale of the on-board tickets was made using the new console as well as the validation of the new "contact less" tickets ("Viagem ConVIDA" system), while current magnetic tickets and "contact less" passes were validated in the old validator during this transition phase. In the last week of 2011 the entire system was already operational, including the part that concerns the e-cards, allowing for a verification of its functioning by IMTT (National Institute of Mobility and Inland Transportation, which co-financing the system purchase). During the technical visit the IMTT validated the system and SMTUC signed the provisional reception of the system.

With the new system a new intermodal ticket was launched on the 1st January 2012. It was designated for the employees / students of large entities that use the park&ride system. The ticket is being provided by the entity with 25% discount allowing the user to park for free during one day in any park of the system and to make 2 displacements of 1 hour each in the urban PT network (transfers allowed). The 25% discount is being assured by SMTUC in the totality. With this framework and integrated within the mobility plans of CIVITAS MODERN measure 04.05, a protocol was already signed with IPOC hospital. A similar e-ticket has been created for all the park&ride users, allowing for the transfers between lines during the displacements of 1 hour.

On 2nd February 2012 the remaining fares (supported in the e-cards "Coimbra ConVIDA) were launched for the whole SMTUC public transport network, despite the existence of a transition period running up to the end of May 2012 in which the 2 systems functioned in parallel for the e-card passes. During this period the users of the new system validated their fares in the driver console while the users of the previous system used the old validator. This transition period allowed the users to transfer to the new system gradually, avoiding queues in the card personalisation service. After the transition period the old validators were exchanged for the new validators. Also the fact that the driver console has validation capabilities allowed for the change of validators to be processed in a gradual way, avoiding the need for a flash installation that certainly would imply an over-load of work and the risk of failures or less quality in the installation.

The new e-ticketing system is an "open" system that will not depend on the actual system integrator for it expansion in the future, and in which all kinds of card technologies can be read (facilitating the integration of other PT operators and more mobility products in the future – car sharing, bike sharing).

In any case the existing combined fare between SMTUC and the other PT operators involving all inhabitants of the Municipality of Coimbra also benefited of the improvements of the new system, namely with the new channels for the purchase and reload of the new SMTUC e-card.

The system was initially developed to allow for the future integration of multiple PT operators (public and/or private), namely in view of the creation of an inter-municipal pass. However, the financial crisis has led many of the municipalities involved to reconsider their investment priorities. Accordingly, urban mobility issues have many times taken a back seat to other considerations, namely those associated with social themes and economic recovery.

On the other hand, the automatic accounting system for the PT drivers is experiencing good results and allowed for savings in the human resources. The personnel dedicated in the past to these operations is now used for other activities.

In the meantime OTLIS developed the system that allows the payment and reloading of the e-cards through ATM machines,(already in functioning in Lisbon, but waiting for a decision in

the case of Coimbra due to some legal impositions caused by the new legislation provided by the national government to combat the financial crisis in Portugal).

Also the development by OTLIS of an application that will allow the on-line payment of the passes and it reloading at home or on board buses is on-going.

Another advantage of the new e-ticketing system has been its integration with the SMTUC automatic vehicle management (AVM) system – A GPS/GPRS technology based system. So the new on-board console can also command the AVM system to avoid repeating operations by the drivers related to the common data to the 2 systems. The communication channel to transfer data between the buses and the central is also common to the 2 systems and the AVM system provide in each moment the localisation of the buses, allowing the automatic information about the geo-referenced entry of the passengers. In the future the new e-panels already installed at the buses stops to provide real time information about the time remaining for the buses passage will have also the capability to read the e-tickets (informing the remaining trips loaded) and read and reload the e-cards.

Taking into consideration the delays in the measure implementation an extension has been requested allowing for more time to evaluate the measures impacts, namely in the modal shift to the SMTUC public transport and related indicators, that were assessed through a survey carried out to the SMTUC passengers at the end of October 2012.

B5 Inter-relationships with other measures

The measures **02.05, 04.02, 04.05 and 08.03** were identified as a group of measures because each one of them has potential to generate impacts on modal split. These measures also have potential to generate impacts on emissions. However, those impacts derive from modal split changes. Measure 04.05 will be applied only to a health cluster that involves 3 hospitals and modal split impacts will be measured with specific surveys on these hospitals, making possible to determine separated impacts on modal split due to measure 04.05. For this reason, only measures 02.05, 04.02 and 08.03 are included in the modal shift bundle of measures.

In particular, the measure is related to other measures as follows:

- **Measure no. 04.02 – Infomobility Centre and Mobility Marketing in Coimbra** – The Infomobility Centre in Coimbra will have also impacts in the modal shift and at functional aspect the Centre will be also a point of tickets and cards sale / load;

- **Measure no. 04.05 – Mobility Management Actions in Coimbra** – The Mobility Management in Coimbra will have also impacts in the modal shift, but in a controlled area, and at functional aspect it is foreseen to use the system to provide new ticketing products for the entities involved in the mobility plans;

- **Measure no. 08.03 – Infomobility Tools for Traffic Data Management in Coimbra** – The infomobility tools for traffic data management in Coimbra will have also impacts in the modal shift and at functional aspect the e-panels of the GPS/GPSR – Operation Support System will have capabilities linked to the e-ticketing system, namely the read of cards and tickets.

But the fact that these measures have begun their implementation in completely different periods contributed to the possibility evaluating the impacts separately.

C Evaluation – methodology and results

C1 Measurement methodology

C1.1 Impacts and Indicators

Table C1.1.1: Indicators. *Impacts and Indicators for the measure*

No.	Impact	Indicator	Data used	Comments
1	Operating Revenues	Average Operating Revenues	Total operating revenues; Total vehicle-km	Operating revenues and vehicles-km are provided by SMTUC and by the modal shift survey.
2	Operating Costs	Average Operating Costs	Operating costs spent with the measure operation; Total vehicle-km	Operating costs and vehicles-km are provided by SMTUC and by the modal shift survey
3	Costs	Capital Costs	Total capital costs expended in setting up the measure	Capital costs are provided by SMTUC
4	Fuel consumption	Vehicle fuel efficiency	Total energy consumed by the passengers that transferred from private car to PT; Total passenger-km	Fuel consumption results of the displacements assessed by survey. Bibliographic sources "Study on internal and external costs from transport in Portugal, issued by University of Aveiro, March 2011"; the average consumption of each type of vehicles and passenger-km is computed by the data obtained by the survey
5	Emissions	CO Emissions	Fuel type; average consumption, Type and passenger-km	Emissions factors of each type of fuel – "European Energy Agency, "the Emission Inventory Guidebook"
6	Emissions	CO2 Emissions	Fuel type; average consumption; Type and passenger-km	Emissions factors of each type of fuel – "European Energy Agency, "the Emission Inventory Guidebook"
7	Emissions	NOx Emissions	Fuel type; average consumption; Type and passenger-km	Emissions factors of each type of fuel – "European Energy Agency, "the Emission Inventory Guidebook"
8	Emissions	Small Particulate Emissions	Fuel type; average consumption; Type and passenger-km	Emissions factors of each type of fuel – "European Energy Agency, "the Emission Inventory Guidebook"
9	Quality of Service	Quality of PT Service	Index of the "perception" of service quality"	Data provided by the SMTUC passengers satisfaction survey
10	Modal Shift	Average modal shift passengers	Total passenger km for the transport mode considered; Total passenger km	Data provided by the SMTUC services and the satisfaction survey
11	Modal Split	Park & Ride Usage	Total number of Park & Ride usage	Data provided by the SMTUC services
12	Acceptance	Acceptance level – users	Total number of users who favourably receive the measure; Total number of respondents	Acceptance level is provided by the SMTUC satisfaction survey

The selection of the indicators took into consideration that it is expected that this measure should contribute for the improvement of the quality of Public Transport service, materialised by a better accessibility (user friendly) to the PT service, as well as for the launch of new mobility products and services. These facts should have effects on **the modal shift from private car to Public Transport**.

For these reason the indicator Average Modal Shift has been selected together with the related indicators – the Vehicle Fuel Efficiency and Emissions, due the savings in fuel consumption per passenger, and the Average Operating Revenues, due the increase in the tickets sales, all resulting of the transfer from private car to Public Transport. The impacts in the modal shift and related indicators also supported to evaluate the achievement of the objectives of the measure, namely concerning the strategic level: To increase the importance of the social role of PT in the region, to increase the use of PT in the city and to decrease city traffic levels.

The new ticketing system also allows better reliability of the equipment, more automatisms in several operations and improvements at organizational level. These facts have impacts in the maintenance costs (personnel and material) and in the costs with personnel appointed for the tickets sale and accounting operations. For these reasons the impact in the economy has been assessed and consequently the indicators Average Operating Costs and Capital Costs have been selected together with the already mentioned Average Operating Revenues.

The creation of new products for the Park&Ride system, resulting of one of the measure objectives, implied the selection of the indicator Park&Ride Usage that evaluated the number of tickets sold in the parks of this system.

Finally the indicators Quality of the PT Service and Acceptance level have been selected to evaluate the impact of the measure implementation in the passengers opinion.

Concerning the methodology, also the assessment to the modal shift to public transport has been the main concern (Coimbra hadn't values updated of modal split and the assessment to this indicator was impracticable due the great costs involved).

Since it was not possible to measure the impacts of the measure directly, a different methodological assessment was carried out. The methodology to assess the indicators was based on the modal shift from private cars to public transport (PT) associated to the CIVITAS measure – implementation of a new ticketing system. **The source of information was based on the findings of the SMTUC Modal Shift focused survey (new ticketing system) that was performed in September 2012** (9 months after the beginning of the measure operation in January 2012) in a universe of 750 passengers (68% Female and 31% male – details of the survey in the annex 6). **The same survey has been used to assess the baseline scenario (situation before measure implementation) and the Businees-as-usual scenario (situation expected if the measure willl be not implemented), using for the effect specific questions**.

The sample has been selected on the basis of the lines used by passengers, i.e., the number of interviewees chosen in each line has been defined according to the demand of the line relative to the overall SMTUC demand. Then it was distributed by gender and age in similar proportions of the SMTUC global passengers. The survey used the same methodology and sample that has been used yearly in the custom satisfaction survey carried out in the scope of the Quality Management System of SMTUC (certificated by several audits).

Taking into account the previous year (before measure implementation), the survey asked the passengers about the reason for changing their travel mode. As a result, 9,1% (67 responses) of the respondents replied that they changed to PT. Focusing the analysis on respondents who changed their pattern of mobility to PT, it was noted that 77,6% of respondents shifted from private car. By these statements it has been possible to realize that 7,1% (9,1%×77,6%) had changed for PT and the source was the private car.

In the same survey the passengers were asked about the reasons for changing the mode of travel. For this question 1,2% of the respondents stressed that the change was due to CIVITAS measure and all these answers concerned people moving from private car to PT.

The analysis started by introducing in the total 2011 SMTUC passengers (number of trips) the results deriving from the survey questions illustrated above. The next figure shows a diagram with the methodology and evidences for constructing the analysis scenario.

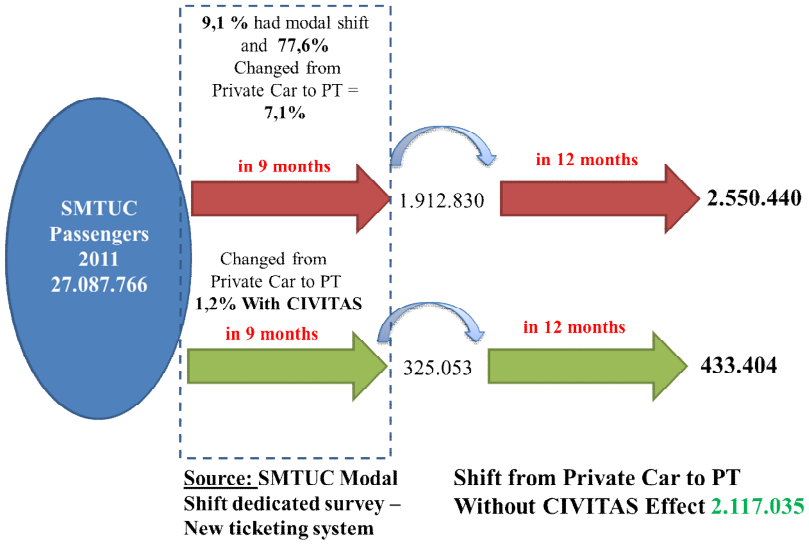


Figure C1.1.1 – Inputs for measure assessment (n.º passengers)

According to the above figure it is possible to observe that, in a 12 month period, a total of 2.550.440 passengers had changed to PT and they originated in private car and included 433.404 passengers that had changed due to the CIVITAS measure. The difference between them is the passengers that shift from private car to PT without the CIVITAS measure influence (Business-as-usual scenario).

The next figure shows the flux of passengers that are in each scenario.

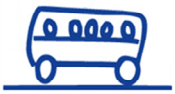
SCENARIO	EX-ANTE	BAU	EX-POST
		(A)-(B) 2.117.035	2.550.440
	2.550.440	(B) 433.404	
		(A)	
TOTAL	2.550.440	2.550.440	2.550.440

Figure C1.1.2 – Assessment methodology - Private Car / Public Transport

As demonstrated in the survey, the passengers transferred to PT due to the CIVITAS measure (433.404) were at a first stage using private car and due the financial crisis it is considered that the passengers that uses at the moment PT do not transfer to private car. By this reason in the BAU scenario for 2012 (without influence of the measure) these 433.404 passengers are using private car. The number of PT users (BAU) are computed by the difference between the ex-post (the 2.550.440 passengers that changed to PT with origin of private car) and the referred 433,404 passengers that shift due CIVITAS measure, i.e., 2.117.035 passengers in SMTUC PT for the 2012 BAU scenario.

By analysing the modal shift of passengers between the scenarios it is possible to evaluate the influence in terms of operational revenues (indicator 1), fuel consumption (indicator 4) and emissions (indicator 5-8). In any case for indicator 1 (Average operating revenues) have been used the overall SMTUC average operating revenues, while for indicators 4 to 8 have been used only the consumptions and emissions related to the passengers that transferred from private car to SMTUC public transport service

For indicators 2 and 3 the analysis was based on the operational and management data of SMTUC.

For indicators 9 the analysis was carried out with the information assessed by the SMTUC customer satisfaction survey. This survey is carried out yearly (details of the survey in the Annex 7).

In relation to indicator 11, the Park&Ride Usage was assessed by the SMTUC operation records.

Indicator 12, Acceptance level, was assessed in the same above mentioned survey that has been carried out to evaluate the modal shift (details of the survey in the Annex 6).

Another assumption was considering a unidirectional way of modal change. In Portugal, due to the economic crisis it is not assumed that there will be modal changes between the public transport to the private car, the modal changes that could occurred will be to more sustainable transport mode than to the private car.

It is important to stress that for indicator 4, the results from energy consumption from private car and from PT bus vehicles are based on data about the total vehicle-kilometres performed on those vehicles. The average vehicle consumption (l/100km) is based on both bibliographic data and from real SMTUC fleet for private car and bus, respectively. For private car the source of data is the "study on internal and external costs from transport in Portugal, issued by University of Aveiro, March 2011" (9,2 l/100km). For public transport the source is the real data of the average fleet consumption (50,1 l/100km). A load factor for both private car and public transport was considered. The load factor for private car is 1,3 passenger per vehicle (Source: IMTT – Portuguese Institute for Mobility and Inland Transportation) and for public transport is given by the SMTUC operational data from company management report (16,4 passengers per bus).

For private cars, the average energy consumption in litres of Diesel per 100 km, is converted into energy (MJ) by a factor of 34,80 MJ/litre that is calculated by mixing 2 fuel types (Diesel -35,86 MJ/litre and Gasoline – 32,18 MJ/litre) with the Portuguese 2011 fleet fuel mix 77,7% for Diesel and 21,8% gasoline. For public transport the average energy consumption (litres) is converted by a factor of 35,86 MJ/litre.

All the other data shown in the next table were directly obtained from the modal shift survey (B, C) and from the SMTUC management report (A, F, G, K, M). The load factor for private car (J) is given by the IMTT – Portuguese Institute for Mobility and Inland Transportation and for public transport (k) is given by the SMTUC operational data taken from the company management report. The other items in bold are computed as shown in Table C1.1.2.

Table C1.1.2 – Survey Analysis

Note	Survey Analysis	
A	N.º Passengers SMTUC 2011	27.087.766
B	% that changed for PT	9,1%
C	% of Private Car that changed to PT (9,1%x77,6%)	7,1%
D	N.º Passengers of Private Car to PT (9 months)	1.912.830
E=D/9x12	Δ N.º Passengers of Private Car that changed to PT (12 months)	2.550.440
F	Passenger.kilometre - pkm PT 2011	96.639.509
G	Vehicle.kilometre - vkm PT 2011	5.886.329
H=F/A	**Average distance per passenger (km/passenger)**	**3,57**
I=E×H	**Δ N.º Passengers.km of Private Car that changed to PT (12 months)**	**9.099.061**
J	Load factor – Private Car	1,3
k	Load factor – PT	16,4
L=I/J	**N.º vehicles.km in Private Car made by the passengers that changed to PT (12 months)**	**6.999.278**
M	Annual Revenue 2011 (€)	7.704.515

With the assumptions expressed above and using Table C.1.2.1 it is possible to compute the indicators 1, 4, 5, 6, 7 and 8.

Detailed description of the indicator methodologies:

- **Indicator 1** (*Average Operating Revenues*) – Ratio of total income generated from fares and tickets of the SMTUC PT users divided by the vehicle-km per year (€/vehicle-km)

  A = B / C

  where: A = Average operating revenues (€/vehicle -km)

  B = Total operating revenues, including revenues coming from tickets/fare sales supported by the ticketing system (€)

  C = Total vehicles –km

  All data are related to the overall SMTUC services

- **Indicator 2** (*Average Operating Costs*) – Ratio of total operating costs incurred in the operation of the ticketing system divided by the total vehicle-km per year (€/vehicle-km).

  A = B / C

where: A = Average operating costs for the service (€/vehicle-km)

B = Total operational costs incurred in the operation of the ticketing system, including expenditures with personnel, material –stock, material - purchase for the operation and maintenance of the ticketing system (€)

C = Total vehicle-km

Operating costs are related to the operation with the ticketing system. Vehicle-km are related to the overall SMTUC services.

- **Indicator 3** (*Capital Costs*) – Total capital costs expended in setting up the measure (€).

  Expenditures with the purchase and installation of the ticketing system (€)

- **Indicator 4** (*Vehicle fuel efficiency*) – Ratio between the total energy consumption, divided by the total passenger-km performed per year (MJ/passenger-km).

  A = B / C

  where: A = Average vehicle fuel efficiency (MJ/passenger-km)

  B = Total energy consumption (MJ)

  C = Total passenger-km performed by SMTUC PT passengers

  All data is related to the private car and public transport passengers used in trips carried out among the new ticketing system action.

- **Indicator 5** (*CO Emissions*) – Average CO emissions per passenger -km (g/ passenger -km)

  A = B / C

  where: A = Average CO emissions per passenger -km (g/ passenger -km)

  B = Total CO emissions of the private car and public transport (g)

  C = Total passenger-km performed by SMTUC PT passengers

  The data about the Total CO emissions per vehicle-km by private car vehicles is based on emission factors (g/kg fuel), year 2005 for Portugal, given by European Energy Agency, "the Emission Inventory Guidebook", dated on 23rd August 2007.

- **Indicator 6** (*CO2 Emissions*) – Average CO2 emissions per passenger -km (g/ passenger -km)

  A = B / C

  where: A = Average CO2 emissions per passenger -km (g/ passenger -km)

  B = Total CO2 emissions of the private car and public transport (g)

C = Total passenger-km performed by SMTUC PT passengers

The data about the Total CO emissions per vehicle-km by private car vehicles is based on emission factors (g/kg fuel), year 2005 for Portugal, given by European Energy Agency, "the Emission Inventory Guidebook", dated on 23rd August 2007.

- **Indicator 7** (*NOx Emissions*) – Average NOx emissions per passenger-km (g/ passenger-km)

  A = B / C

  where: A = Average NOx emissions per passenger-km (g/passenger-km)

  B = Total NOx emissions of the private car and public transport (g)

  C = Total passenger-km performed by SMTUC PT passengers

  The data about the Total CO emissions per vehicle-km by private car vehicles is based on emission factors (g/kg fuel), year 2005 for Portugal, given by European Energy Agency, "the Emission Inventory Guidebook", dated on 23rd August 2007

- **Indicator 8** (*Small Particulate Emissions*) – Average Small Particulate emissions per passenger-km (g/ passenger-km)

  A = B / C

  where: A = Average Small Particulate emissions per passenger-km (g/passenger-km)

  B = Total Small Particulate emissions of the private car and public transport (g)

  C = Total passenger-km performed by SMTUC PT passengers

  The data about the Total CO emissions per vehicle-km by private car vehicles is based on emission factors (g/kg fuel), year 2005 for Portugal, given by European Energy Agency, "the Emission Inventory Guidebook", dated on 23rd August 2007.

- **Indicator 9** (*Quality of PT Service*) – User's perspective of the quality of the service provided by the ticketing system.

  Quality of service is already measured by means of customer satisfaction survey periodically carried out by SMTUC: this survey is composed of 38 specific questions related to various items and a specific global customer satisfaction question that resume quality of service. In each question the people interviewed express a judgement choosing between very satisfied – satisfied – unsatisfied – very unsatisfied and about the importance of each of the 38 items choosing between very important – important – low importance. The survey is repeated 1 time a year (March) and is carried out to 750 SMTUC customers with face to face interviews on buses. The sample has been drowned on the basis of the lines used by the passengers.

This indicator responds to 2 specific questions that summarise quality of service related to the ticketing system.

- **Indicator 10** (*Average modal shift passengers*)

  A specific survey to new PT users is carried out to assess changes in their travel behaviour, such as the modes formerly used by the new PT users and the passengers.km made by the new PT users, before and after the measure implementation.

- **Indicator 11** (*Park & Ride Usage*) – number of tickets sold in the Park&Ride

  Number of transport titles sold in the parks, per year before and after the implementation of the measure.

  All data is related to the overall SMTUC services and results from the total number of Park & Ride usage by year based on ticket validation data taken from SMTUC database about ticket validations on the ticketing system.

- **Indicator 12** (*Acceptance level – users*) –

Percentage of the users who favourably receive the measure (%).

A = B / C

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 during customer satisfaction surveys introducing specific questions relative to the respondent's attitude towards the measure.

C1.2 Establishing a Baseline

The year 2011 is considered as the baseline, before the beginning of the measure in January 2012, excepted for the capital costs. In this case the baseline has been the year 2010, before the beginning of the system installation in February 2011.

All the data used for the analysis is related to the SMUTC services and to the information collected in the survey.

Indicators 1, 2 and 3 (Operating Revenues, Operating Costs and Capital Costs)

The source of the information has been the SMTUC recorded data through the normal accounting procedures.

Indicator 1 (*Average Operating Revenues*)

Table C1.2.1 – Indicator 1 – Ex-ante

Indicators and respective parameters	Ex-Ante values
Operating Revenues (2011)	7.709.515 €
Total vehicle-km	5.886.329 vkm
Average operating revenue	1,31 €/vkm

Indicator 2 (*Average Operating Costs*)

The year 2011 is considered as the baseline. The values of the operating costs are atypically lower because for the previous SMTUC ticketing system the related costs of personnel and material were not imputed to the SMTUC accounting system. The reason was that the system was in the final phase (no parts to replace). This situation still lower maintenance was more pronounced because the supplier of the new system has borrowed at this stage validators of the old system (which had also supplied). For more details please consult Annex 3.

Table C1.2.2 – Indicator 2 – Ex-ante

Indicators and respective parameters	Ex-Ante values
Total Operating Costs - 2011	154.726 €
Total vehicle -km	5.886.329 vkm
Average operating costs	0,0263 €/vkm

Indicator 3 (*Capital Costs*)

Table C1.2.3 – Indicator 3 – Ex-ante

Indicators and respective parameters	Ex-Ante values
Total capital cost (2010)	0 €

Indicator 4 (*Vehicle fuel efficiency*)

The energy consumption was related to the shift of 7,1% of passengers that occurred in 9 months extrapolated to 12 months (2.550.440 passengers) from the private car to the SMTUC public transport service.

All the steps to achieve the vehicle fuel efficiency are illustrated in the Table C1.2.4.

Table C1.2.4 – Indicator 4 – Ex-ante

Note		**Ex-ante**
E	Δ N.º Passengers of Private Car that changed to PT (12 months)	2.550.440
I	Δ N.º Passengers.km of Private Car that changed to PT (12 months)	9.099.061 p-km
L	Δ N.º vehicle.km of Private Car that changed to PT (12 months)	6.999.278 v-km
O	Average Consumption Private car (l/100km)	9,2
P=L×O/100	**Consumption Private Car**	643.933,5
Q	Total consumption private car (MJ)	22.462.791
R=Q/I	**Vehicle Fuel efficiency (MJ/pkm)**	**2,47**

Analysing the above Table C1.2.4 it can be established that in the initial stage the vehicle fuel efficiency is 2,47 MJ/pkm that use private car (2.550.440 passengers) – 100% that are willing to have a modal split change from private car to PT.

Indicators 5, 6, 7 and 8 (CO, CO2, NOx, PT)

The source of the information has been the fuel emission factors for each pollutant given by bibliographic sources, as is displayed in Annex 4. The study considered the following emission factors (g/kg.fuel) and converted to g/MJ (by Annex 2) for the ex-ante scenario (private car) (Table C1.2.5). The conversion of kg fuel to MJ as assumed a conversion factor based on the density and the gross calorific value of the fuel.

Table C1.2.5 – Indicators 5, 6, 7 & 8 – Emissions Factors

POLLUTANT	**CO**	**NOx**	**CO2**	**PT**
Diesel Passenger Car (g/kg.fuel)	3,2	11,28	3 140	0,72
Gasoline Passenger Car (g/kg.fuel)	61,56	9,18	3 180	0,03
Diesel Passenger Car (g/MJ)	0,075	0,263	73,115	0,017
Gasoline Passenger Car (g/MJ)	1,430	0,213	73,867	0,001

With the emissions factors (g/MJ) computed in the above Table C1.2.5 and weighting with the fuel mix 2011 (Annex 1) and multiplying by the average private car fuel consumption (9,15 l/100km) the overall fleet weighted emissions factors for each pollutant is obtained. Table C.1.2.6 shows the emissions for each pollutant (CO, NOx, CO2, PT).

Table C1.2.6 – Indicators 5, 6, 7 & 8 – Emissions

Pollutant	**CO**	**NOx**	**CO2**	**PT**
Emissions Private Car (g) - *weighted*	8.317.980	5.629.097	1.638.167.784	295.924

The indicators are displayed by the ratio between the emissions (g) and the passengers km travelled per year (pkm) (9.099.061pkm). The results of baseline for each indicator are indicated in the Table C1.2.7.

Table C1.2.7 – Indicators 5, 6, 7 & 8 – Ex-Ante

Indicators and respective parameters	Ex-Ante values
CO emissions	0,91 g/pkm
CO2 emissions	180,04 g/pkm
NOx emissions	0,62 g/pkm
PT emissions	0,03 g/pkm

Indicator 9 (*Quality of PT Service*)

The quality of service was assessed by the SMTUC customer survey (more details in the Annex 7). Before the measure was introduced an initial survey to 739 customers was developed in 2011. Two specific questions were asked. The first question was related with how easy it is to purchase the tickets and the second on how easy it is to validate the tickets. These questions were scored from 1 – dissatisfied - to 4 - very satisfied and the overall responses were weighted as shown in Table C 1.2.8.

Table C1.2.8 – Indicator 9 – Ex-Ante

Indicators and respective parameters	Ex-Ante values
Facility to purchase the tickets	3,18
Facility to validate the tickets	3,28

Indicator 10 (*Average modal shift - passengers)*

The modal shift was assessed through the modal shift survey (more details in the Annex 6). Before the measure implementation all the passengers (9.099.061 pkm) that are suitable to change to public transport used private car. Table C.1.2.9 shows the ex-ante situation for modal shift.

Table C1.2.9 – Indicator n.10 – ex-ante values

Indicators and respective parameters	Ex-Ante values
Private Car	9.099.061 pkm
Public Transport SMTUC Bus	-

Indicator 11(*Park & Ride Usage*)

The use of the Park &Ride system was evaluated by the sales of two trip tickets that were sold only on-site. After 2012 it was noted that the other entities that contributed for the Park &Ride (e.g. University) stopped buying the tickets. The main reason for this fact is the economic crisis and budgetary cuts. To be comparable was harmonized this usage in the period 2007 - 2012 only the tickets sold at the parks.

On the other hand in 2012 only two peripheral car parks were active. Before (2007-2011) three parks were active. Also, in order to be comparable within the entire period the usage 2007-2012 was harmonized just for the usage of two parks. The ex-ante values are related to the two parks.

Table C1.2.10 – Indicator n.11 – ex-ante values

Indicators and respective parameters	Ex-Ante values
Number of tickets (2 trips) sold - year 2011	12.117

Indicator 12 (*Acceptance level – users*)

The specific question for the acceptance level of the previous ticketing system was carried out in the SMTUC Modal Shift dedicated survey – New ticketing system - that was performed in September 2012. (more details of the survey in the Annex 6).This survey shows a high degree of satisfaction of as is shown in Table C1.2.11.

Table C1.2.11 – Indicator n.12 – ex-ante values

Indicators and respective parameters	Ex-Ante values
Acceptance- users	
Very satisfied	47,1%
Satisfied	49,1%
Dissatisfied	3,8%

C1.3 Building the Business-as-Usual scenario

The year 2012 has been considered as the starting point for the BAU. All the data used for the analysis are related to SMUTC services and to the information collected from the survey.

The BAU scenario was built by considering the shift of the number of passengers that transferred from private car to PT. As it was considered in C.1.1, the number of passengers that transferred from private car to PT without the effect of the measure is obtained by the difference between the total passengers that was capable of changing (2.550.440) and the passengers that will change to PT due to the measure (433.404). The total passengers that will change without the effect of the measure will be 2.117.035 passengers in PT.

Indicators 1, 2 and 3 (Operating Revenues, Operating Costs and Capital Costs)

The source of the information has been the modal shift survey – New ticketing system - carried out in September 2012 where it was possible to develop a methodology that allows analysing the evolution of the above indicators.

Table C1.3.1 – Indicator 1 – BAU

Indicators and respective parameters	**BAU**
Revenues from SMTUC PT users transferred from private transport	7.496.988 €
Total vehicle-km	5.886.329 vkm
Average operating revenue	1,27 €/vkm

The value of the revenues of new SMTUC PT users are computed by the product of the number of passengers (2.117.035) by the average SMTUC revenue (0,28 €/passenger) – see Table C.1.1.2. The average operating revenue for BAU scenario is 1,27 €/vkm.

Table C1.3.2 – Indicator 2 – BAU

Indicators and respective parameters	BAU
Total Operating Costs – 2012	170.848 €
Total vehicle –km	5.886.329 vkm
Average operating costs	0,0290 €/vkm

The value of the total operating costs is based on the 2011 value with a 2% decrease. This reduction is related to SMTUC expectations for continuing operating the existent ticketing system. For further details please consult Annex 3.

Indicator 3 (*Capital Costs*)

The change in the capital costs related to the operation of the new ticketing system is obtained after setting up the measure. Therefore, without the implementation of the measure, the capital costs would be as before. It was considered that there are no effects of other factors that have any influence in this indicator. In this case, the Business-as-usual is equal to the baseline situation.

Therefore, the Table C1.3.3 shows the results of BAU scenario for this case.

Table C1.3.3 – Indicator 3 – BAU

Indicators and respective parameters	BAU
Total capital cost	0 €

Indicator 4 (*Vehicle fuel efficiency*)

The energy consumption was related to the shift of the 7,1% of passengers that occurred in 9 months extrapolated to 12 months (2.550.440 passengers) from the private car to the SMTUC PT service. From these passengers it is possible to know that 433.404 uses private car and in 2.117.035 uses PT without the effect of the measure – further information consult item C.1.1.

All the steps to achieve the vehicle fuel efficiency are illustrated in the Table C1.3.4.

Table C1.3.4 – Indicator 4 – BAU

		BAU
N.º Passengers.km that changed to PT (12 months) ***[A]***		9.099.061 pkm
Private Car	N.º Passengers of Private Car (12 months) – before CIVITAS measure	433.404
	N.º vehicles.km of Private Car that changed to PT (12 months)	1.189.409 vkm
	Average Consumption (l/100km)	9,2
	Consumption (l)	109.425,7
	Total consumption (MJ) ***[B_{PC}]***	3.817.173
PT	N.º Passengers of PT (12 months) – before CIVITAS measure	2.117.035
	N.º vehicles.km of Private Car that changed to PT (12 months)	460.538 vkm
	Average Consumption (l/100km)	50,5
	Consumption (l)	232.572
	Total consumption (MJ) ***[B_{PT}]***	8.340.027
Vehicle Fuel efficiency (MJ/pkm) ***[B_{PC}+B_{PT}]/[A]***		**1,34**

Analysing the above Table C1.3.4 it can be established that in the initial stage the vehicle fuel efficiency is 1,34 MJ/pkm for all passengers that use private car (2.550.440 passengers).

Indicators 5, 6, 7 and 8 (CO, CO2, NOx, PT)

The source of the information has been the fuel emission factors for each pollutant given by bibliographic sources, as is displayed in Annex 4. The study considered the following emission factors (g/kg.fuel) and converted to g/MJ (by Annex 2) for the ex-ante scenario (private car) (Table C1.3.5). The input for computing the emissions is the energy consumption of private car (3.817.173 MJ) and PT (8.340.027 MJ) as displayed in Table C1.3.4.

Table C1.3.5 – Indicators 5, 6, 7 & 8 – Emissions Factors

POLLUTANT	CO	NOx	CO2	PT
Diesel Buses (g/kg.fuel)	11,88	40,75	3 140	1,85
Diesel Passenger Car (g/kg.fuel)	3,2	11,28	3 140	0,72
Gasoline Passenger Car (g/kg.fuel)	61,56	9,18	3 180	0,03
Diesel Buses (g/kg.fuel)	0,277	0,949	73,115	0,043
Diesel Passenger Car (g/MJ)	0,075	0,263	73,115	0,017
Gasoline Passenger Car (g/MJ)	1,430	0,213	73,867	0,001

With the emissions factors (g/MJ) computed in the above Table C1.3.5 it is possible to obtain the emissions per pollutant. This is possible by the product of the pollutant emission factor (g/MJ) with the energy consumption of private car and PT.

Table C1.3.6 – Indicators 5, 6, 7 & 8 – Emissions

Pollutant	CO	NOx	CO2	PT
Emissions Private Car (g) - *weighted*	1.413.501	956.570	278.379.028	50.287
Emissions PT (g)	2.307.066	7.913.548	609.780.151	359.265
TOTAL	**3.720.567**	**8.870.118**	**888.159.179**	**409.553**

The indicators are displayed by the ratio between the emissions (g) and the passengers km travelled per year (pkm) (9.099.061 pkm). The results of baseline for each indicator are indicated in the Table C1.3.7:

Table C1.3.7 – Indicators 5, 6, 7 & 8 – BAU

Indicators and respective parameters	BAU
CO emissions	0,41 g/pkm
CO2 emissions	97,61 g/pkm
NOx emissions	0,97 g/pkm
PT emissions	0,05 g/pkm

Indicator 9 (*Quality of PT Service*)

The change in the quality of PT Service related to the new ticketing service is obtained after setting up the measure. In this case the Business-as-usual is equal to the baseline situation.

Table C1.3.8 – Indicator 9 – BAU

Indicators and respective parameters	BAU
Facility to purchase the tickets s	3,18
Facility to validate the tickets	3,28

Indicator 10 (*Average modal shift passengers)*

The modal shift was assessed through the modal shift survey (more details of the survey in the Annex 6). A ratio of passengers km (1.546.231 pkm) change to PT without the effect of the measure. Table C.1.3.9 shows the BAU situation for modal shift.

Table C1.3.9 – Indicator n.10 – BAU

Indicators and respective parameters	BAU
Private Car	1.546.231 pkm
Public Transport SMTUC Bus	7.552.830 pkm

Indicator 11(*Park & Ride Usage*)

In the BAU scenario to evaluate the use of the Park &Ride system a projection to 2012 with the historical values for the period between 2007 and 2011 and concerning the trips tickets sold in the 3 parks were taken. Resulting from the trend, the computed value for 2012 was harmonized to 2 parks (since in 2012 only 2 parks were in functioning).

Table C1.3.10 – Evolution of the tickets sale in the Park&Ride System

Number of tickets (2 way)	2007	2008	2009	2010	2011	2012
3 Parks	32.175	26.028	22.747	20.733	18.175	13.983
2 Parks	21.450	17.352	15.165	13.822	12.117	9.322

Note: In yellow the projected value (linear). In blue the harmonized value for the already existing 2 parks

Table C1.3.11 – Indicator n.11 – BAU

Indicators and respective parameters	BAU values
Number of tickets (2 trips) - year 2012	9.322

Indicator 12 (*Acceptance level – users*)

The specific question for the acceptance level of the previous ticketing system was carried out together with the 2012 modal shift survey (more details of the survey in the Annex 6). This survey shows a high degree of satisfaction as is shown in table C1.2.12. The BAU scenario is equal to ex-ante.

Table C1.3.12 – Indicator n.11 – BAU

Indicators and respective parameters	BAU
Acceptance- users	
Very satisfied	47,1%
Satisfied	49,1%
Dissatisfied	3,8%

C2 Measure results

After the implementation of the measure a dedicated survey was carried out to assess the changes in modal shift due to the measure. This survey has 750 responses and also helped to assess the satisfaction level of the new ticketing service in comparison with the previous ticketing system. Taking into account this modal change the next sub headings present the measure results for the indicators – economy, energy, environment, transport and society.

C2.1 Economy

With the implementation of the measure, the Operating Revenues are related to the increase of the 1,2% of the users that changed to public transport (bus) due to the new ticketing system.

Therefore, the following tables shows the ex-post results for these cases.

Table C2.1.1 – Indicator n.1 – Ex-post values

Indicators and respective parameters	Ex-Post values
Revenues variance of new SMTUC PT users transferred from private transport (2012)	7.618.341 €
Total vehicle-km	5.886.329 vkm
Average operating revenue	1,29 €/vkm

The value of the revenues of new SMTUC PT users are computed by the product of the total number of passengers (2.550.440) by the average SMTUC revenue (0,28 €/passenger) – see Table C1.2.1. The average operating revenue for BAU scenario is 1,27 €/vkm, that is an increase of 0,02 €/vkm related with the BAU scenario.

Table C2.1.2 – Indicator n.2 – Ex-post values

Indicators and respective parameters	Ex-Post Values
Total Operating Costs (2012)	115.192,53 €
Total Operating Costs (2013)	117.802,71€
Total Operating Costs (2014)	132.792,94 €
Total Operating Costs (2015)	135.448,80€
Total vehicle –km	5.886.329 vkm
Average Operating cost (2012) - System under Warranty	0,0196 €/vkm
Average Operating cost (2013) - System under Warranty	0,0200 €/vkm
Average Operating cost (2014)	0,0226 €/vkm
Average Operating cost (2015)	0,0230 €/vkm

For the ex-ante scenario the values for 2012 and 2013 are lower than the real value because the system is covered by the warranty. For the period 2014 - 2015 it is expected that more realistic costs and the values are provided by new ticketing system supplier.

Table C2.1.3 – Indicator n.3 – Ex-post values

Indicators and respective parameters	Ex-Post values
Total capital cost	1.201.097€

The following Table summarise the comparison of the indicators 1, 2 and 3 after the implementation of the measure with the baseline and the BAU scenario.

Table C2.1.4 – Summary – Balance between economy indicators (after/before and after/BAU)

Indicator	Before (date)	B-a-U (date)	After (date)	Difference: After –Before	Difference: After – B-a-U
1. Average Operating Revenues	1,31 €/passenger-km (2011)	1,27 €/passenger-km	1,29 €/passenger-km (Sept 12)	-0,02 €/passenger-km	+0,02 €/passenger-km
2. Average Operating Costs	0,0263 €/passenger-km (2011)	0,0290 €/passenger-km (2012)	0,0196 €/passenger-km (2012) 0,0200 €/passenger-km (2013) 0,0226 €/passenger-km (2014) 0,0230 €/passenger-km (2015)	-0,0067€/passenger-km (2012) -0,0063 €/passenger-km (2013) - 0,0037 €/passenger-km (2014) - 0,0033 €/passenger-km (2015)	- 0,0095 €/passenger-km (2012) - 0,0090 €/passenger-km (2013) - 0,0065 €/passenger-km (2014) - 0,0060 €/passenger-km (2015)
3. Capital Costs	0,00 €	0,00 €	1.201.097 €	1.201.097 €	1.201.097 €

The following graph shows the evolution of average operating revenues (€/vkm) with CIVITAS and the evolution of this indicator according to the BAU scenario (Without CIVITAS).

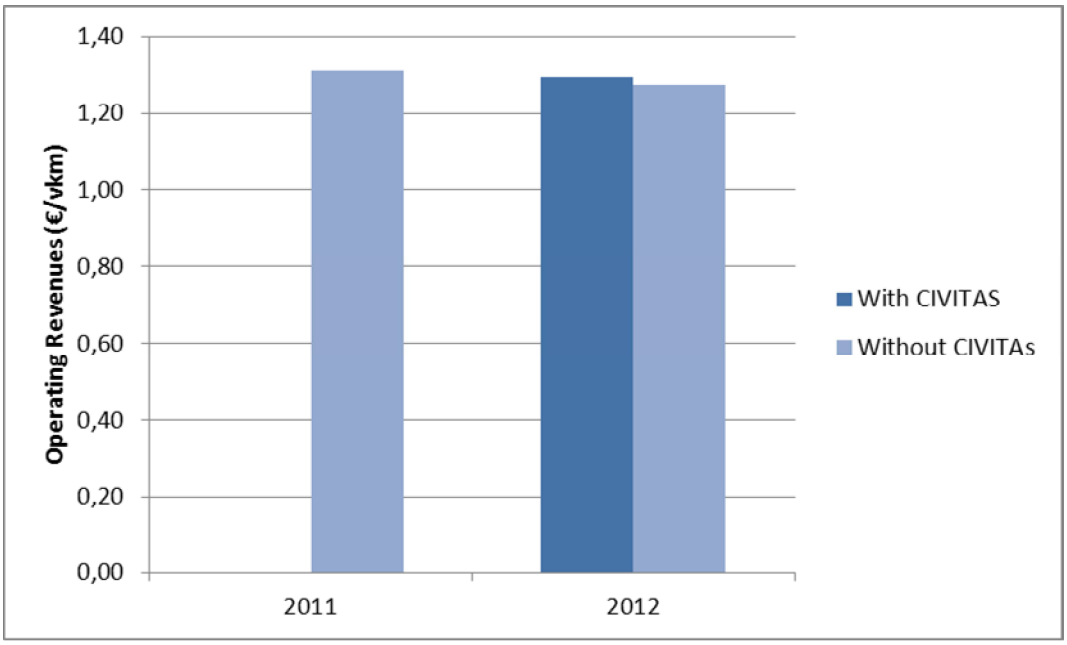


Figure 2.1.1 – Average operating revenues without/with CIVITAS

The following graph shows the evolution of average operating costs (€/vkm) with CIVITAS and the evolution of this indicator according to the BAU scenario (Without CIVITAS).

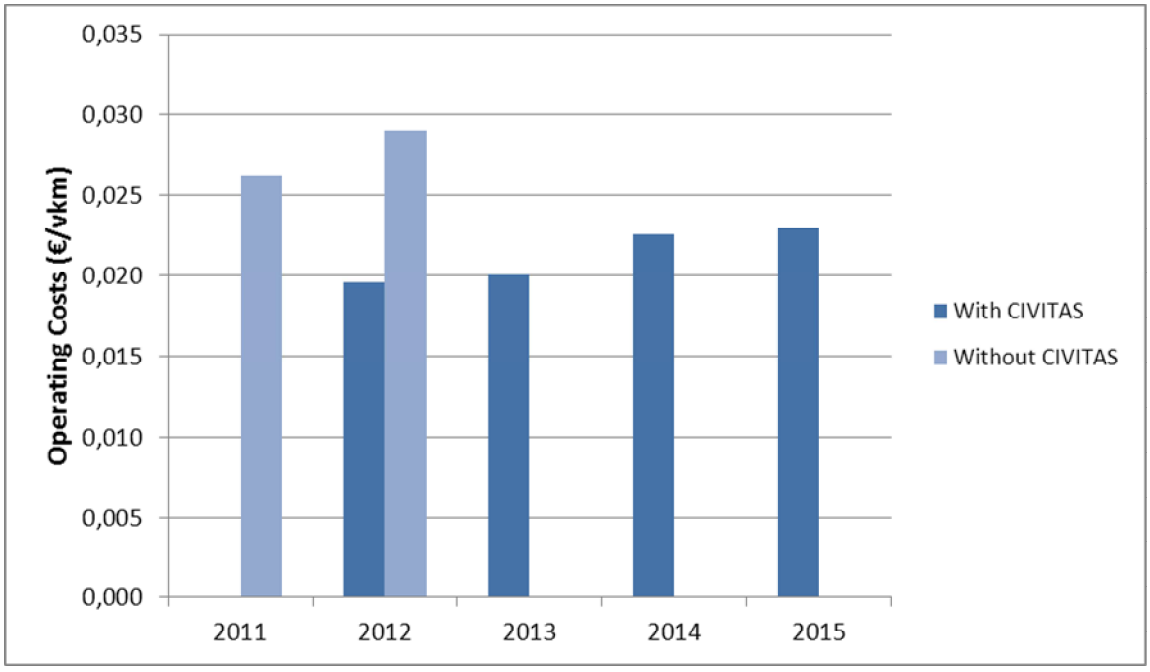


Figure 2.1.2 – Average operating costs without/with CIVITAS

The following graph shows the evolution of capital costs (€) with CIVITAS and the evolution of this indicator according to the BAU scenario (Without CIVITAS).

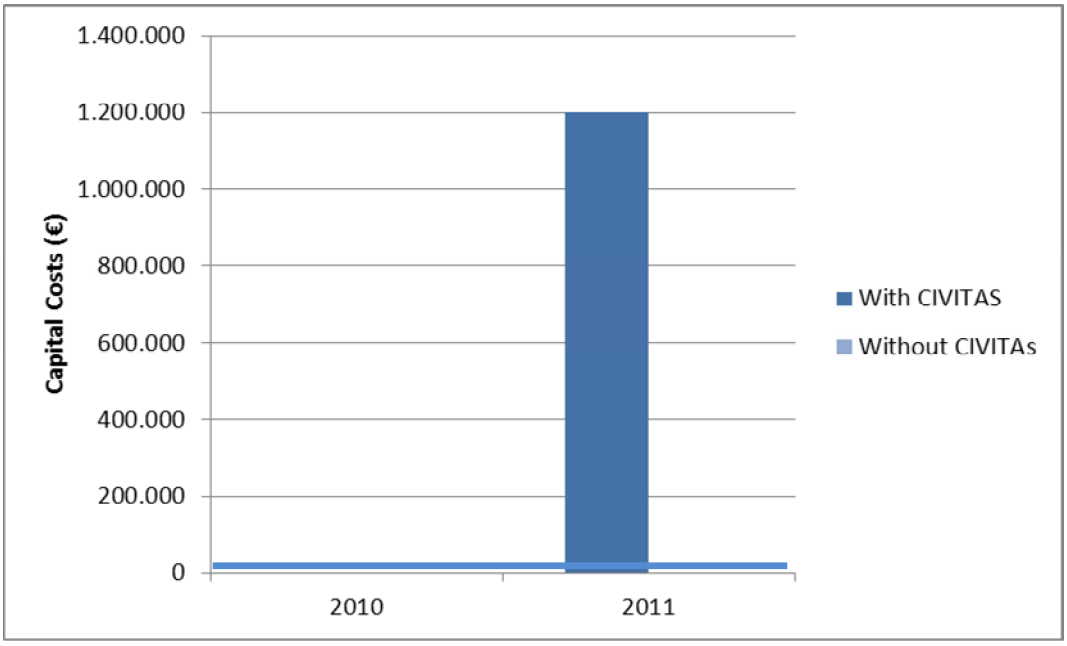


Figure 2.1.3 – Capital costs without/with CIVITAS

C2.2 Energy

The energy consumption was related to the shift of the 7,1% of passengers that occurred in 9 months extrapolated to 12 months (2.550.440 passengers) from the private car to the SMTUC public transport service.

Table C2.2.1 – Indicator 4 – Ex-Post

	Ex-Post
N.º Passengers.km of Private Car that changed to PT (12 months)	9.099.061 pkm
N.º Passengers of PT (12 months) – with CIVITAS measure	2.550.440
Δ N.º vehicles.km of PT (12 months)	554.821 vkm
Average Consumption PT (l/100km)	50,5
Consumption PT (l)	280.185
Total consumption private car (MJ)	10.047.416
Vehicle Fuel efficiency (MJ/pkm)	**1,10**

Analysing the above Table C2.2.1 it can be established that in the initial stage the vehicle fuel efficiency is1,10 MJ/pkm for the passengers that use public transport (2.550.440 passengers).

Table C2.2.2 – Summary – Balance between energy indicator (after/before and after/BAU)

Indicator	Before (date)	B-a-U (date)	After (date)	Difference: After – Before	Difference: After – B-a-U
1. Fuel efficiency	2,47 MJ/passenger-km (2011)	1,34 MJ/passenger-km (2012)	1,10 MJ/passenger-km (2012)	-1,35 MJ/passenger-km	-0,24 MJ/passenger-km

Analysing the indicator it is possible to observe an increase of energy efficiency of 1,35 MJ/pkm from ex-post and ex-ante. With the implementation of the measure the energy efficiency is 0,24 MJ/pkm (i.e. 17% energy efficiency increase).

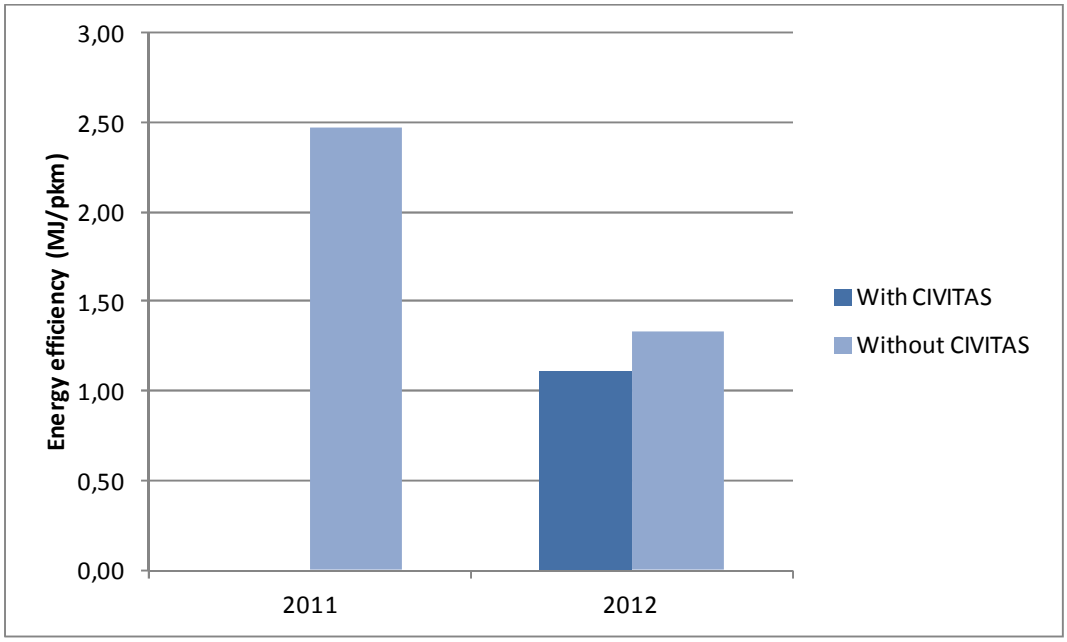


Figure 2.2.1 – Energy Efficiency without/with CIVITAS

C2.3 Environment

For the ex-post scenario it is assumed that all the passengers (2.550.440) use PT and for the ex-ante scenario all the passengers use private car for their travels. The energy consumption of these passengers in PT is converted into energy (C2.2) 10.047.416 MJ. With this amount of energy the emissions will be computed by the related emission factor (Table C1.3.5).

Table C2.3.1 – Indicators 5, 6, 7 & 8 – Emissions

Pollutant	**CO**	**NOx**	**CO2**	**PT**
Emissions Private Car (g) - *weighted*	0	0	0	0
Emissions PT (g)	3.720.562	2.517.848	732.738.563	132.364
TOTAL	**3.720.562**	**2.517.848**	**732.738.563**	**132.364**

The indicators are displayed by the ratio between the emissions (g) and the passengers km travelled per year (pkm) (9.099.061 pkm). The results of baseline for each indicator are indicated in the Table C2.3.2.

Table C2.3.2 – Indicators 5, 6, 7 & 8 – Ex-Post

Indicators and respective parameters	Ex-post
CO emissions	0,41 g/pkm
CO2 emissions	80,53 g/pkm
NOx emissions	0,28 g/pkm
PT emissions	0,01 g/pkm

Table C2.3.3 – Environmental indicators - Summary– Ex Post, BAU and Ex-ante

Indicator	Before (date)	B-a-U (date)	After (date)	Difference: After –Before	Difference: After – B-a-U
6. CO emissions	0,91 g/pkm (2011)	0,41g/pkm (2012)	0,41g/pkm (2012)	-0,50 g/pkm	0,00 g/pkm
7. CO2 emissions	180,40 g/pkm (2011))	97,61 g/pkm (2012)	80,53 g/pkm (2012)	-99,87 g/pkm	-17,08 g/pkm
8. NOx emissions	0,62 g/pkm (2011)	0,97 g/pkm (2012)	0,28 g/pkm (2012)	-0,03 g/pkm	-0,07 g/pkm
9. PT emissions	0,03 g/pkm (2011))	0,05 g/pkm (2012)	0,01 g/pkm (2012)	-0,02 g/pkm	-0,03 g/pkm

The following graph shows the evolution of CO emissions (g/pkm) With CIVITAS and the evolution of this indicator according to the BAU scenario (Without CIVITAS).

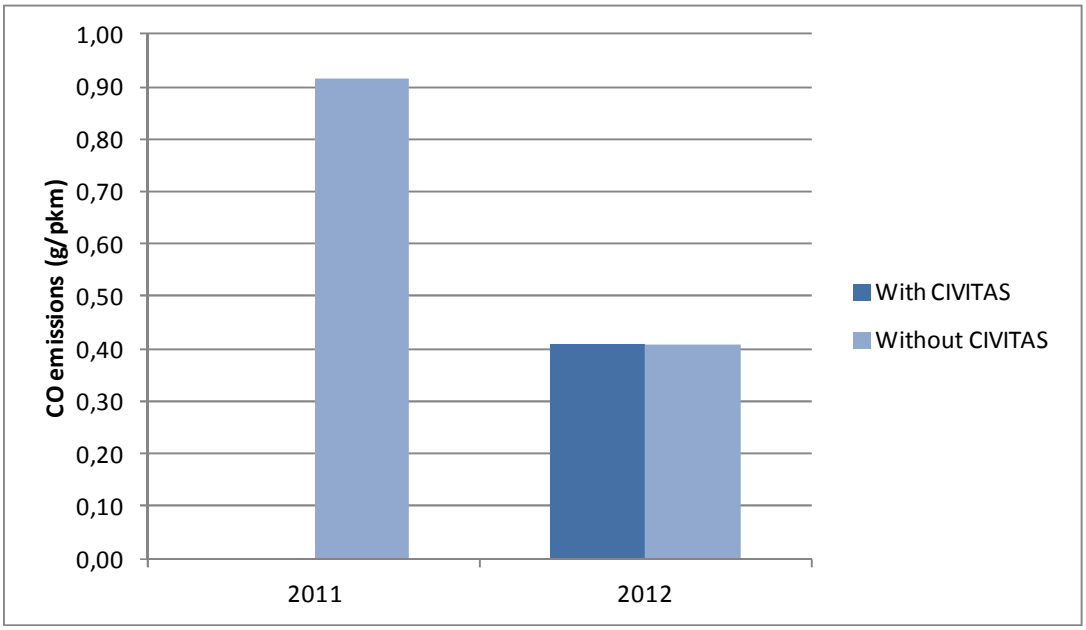


Figure C2.2.3 - CO emissions (with/without CIVITAS)

The following graph shows the evolution of CO2 emissions (g/pkm) With CIVITAS and the evolution of this indicator according to the B-a-U scenario (Without CIVITAS).

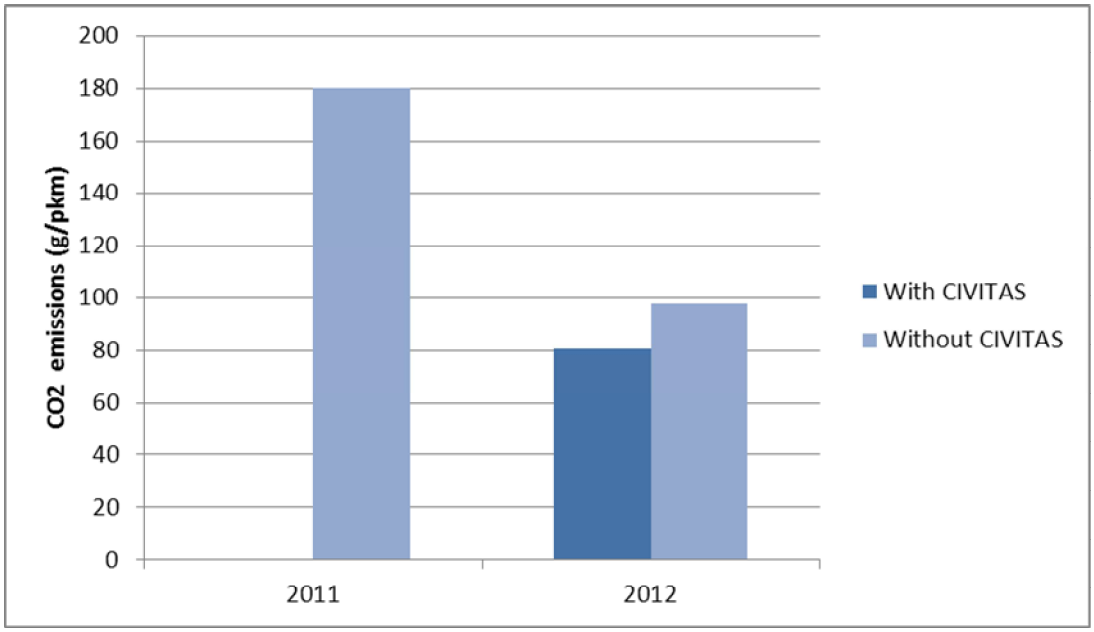


Figure C2.2.4 – CO2 emissions (with/without CIVITAS)

The following graph shows the evolution of NOx emissions (g/pkm) With CIVITAS and the evolution of this indicator according to the BAU scenario (Without CIVITAS).

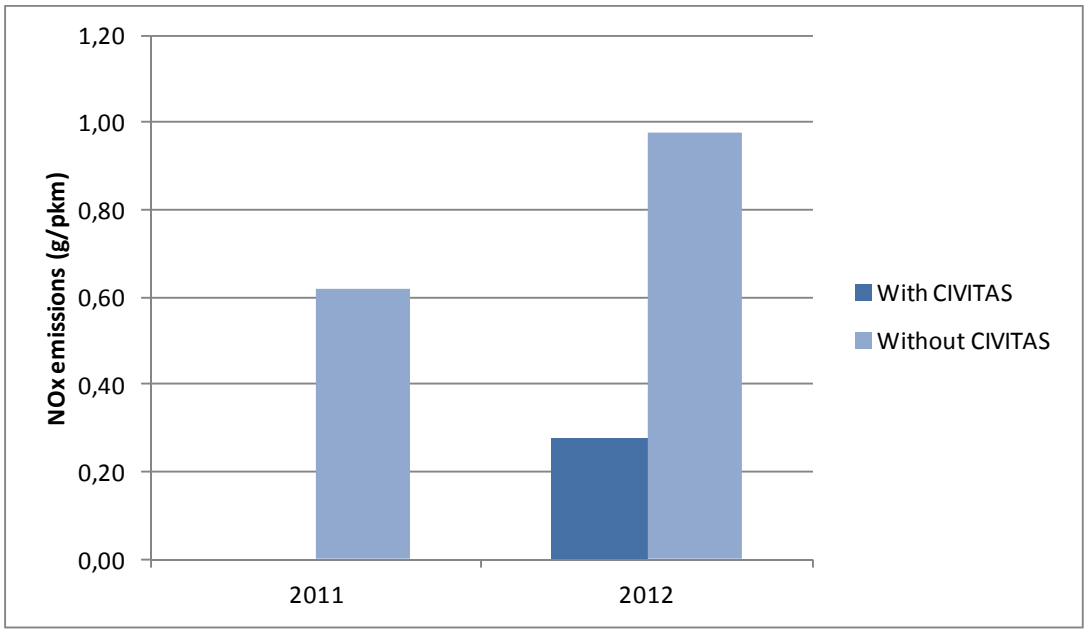


Figure C2.2.5 – NOx emissions (with/without CIVITAS)

The following graph shows the evolution of PT emissions (g/pkm) With CIVITAS and the evolution of this indicator according to the BAU scenario (Without CIVITAS).

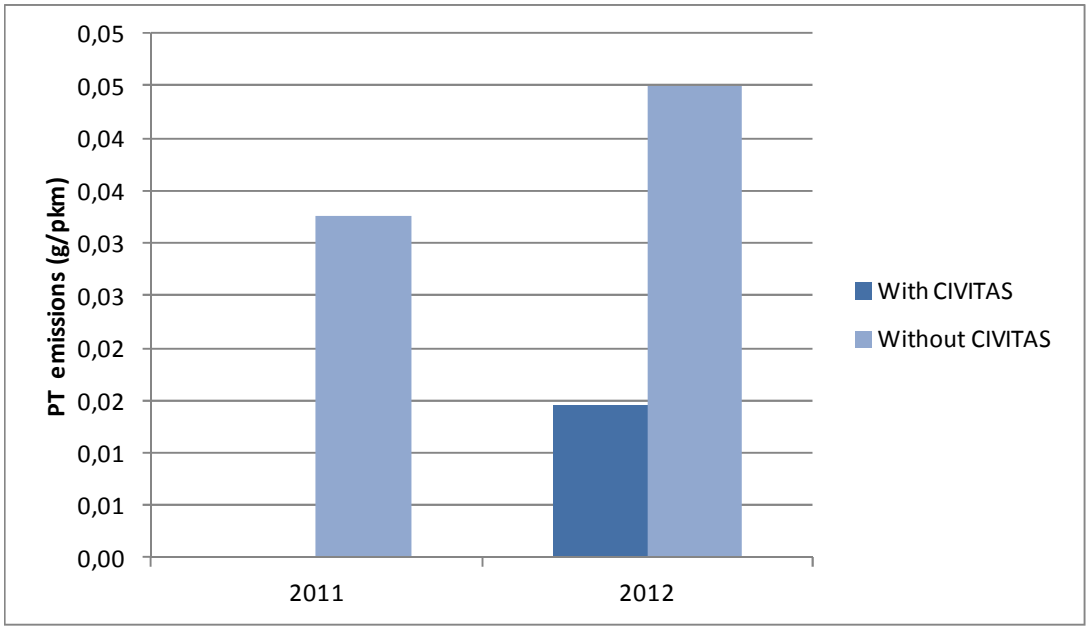


Figure C2.2.6 – PT emissions (with/without CIVITAS)

As expected, with a modal shift to public transport using 100% diesel fuel, instead of using a share of gasoline vehicles, there have been impacts on the emissions. The measure has positive impacts on the mitigation of CO2, NOx and PT and NOx.

In terms of emissions the CIVITAS measure has a positive impact of CO2, NOx and PT with -17,081 g/pkm, -0,698 g/pkm and 0,03 g/pkm, respectively. The CO remains emissions constant.

This assessment was performed considering a modal shift with an increase of the PT demand . But in reality this increase in demand did not affect the PT offer. Thus, a real emissions of pollutants was not verified.

C2.4 Transport

The transport indicators for the ex-post scenario are indicator 9. Quality of PT Service, indicator 10. Modal Split and indicator 11. Park&Ride usage.

The quality of the service was assessed by the SMTUC customer survey (More details of the survey in the Annex 7). Before the measure was introduced an initial survey to 719 customers was developed in 2012. Two specific questions were carried out. The first question was related with how easy it is to purchase the tickets and the second how easy it is to validate the tickets. These questions were scored from 1 - unsatisfied to 4 - very satisfied and the overall responses were weighted as shown in Table C 2.4.1.

Table C2.4.1 – Indicator 9 – Ex-Post

Indicators and respective parameters	Ex-post values
Facility to purchase the tickets s	2,99
Facility to validate the tickets	3,03

The modal shift was assessed by the modal shift survey (more detail of the survey in the Annex 6). After the measure implementation 2.550.440 passengers that used private car change to public transport (9.099.061 p-km). Table C.1.2.9 shows the ex-post situation for modal shift.

Table C2.4.2 – Indicator n.10 – ex-post values

Indicators and respective parameters	Ex-post values
Private Car	-
Public Transport SMTUC Bus	9.099.061 pkm

The Park & Ride usage is related with the tickets sold in the 2 active parks until September 2012 and inferred for the year.

Table C2.4.3 – Indicator 11 – Ex-Post

Indicators and respective parameters	Ex-post values
Number of tickets (2 trips) - year 2012	13.279

A graphical trend of the number of tickets sold harmonized for the 2 parks is shown in the next figure.

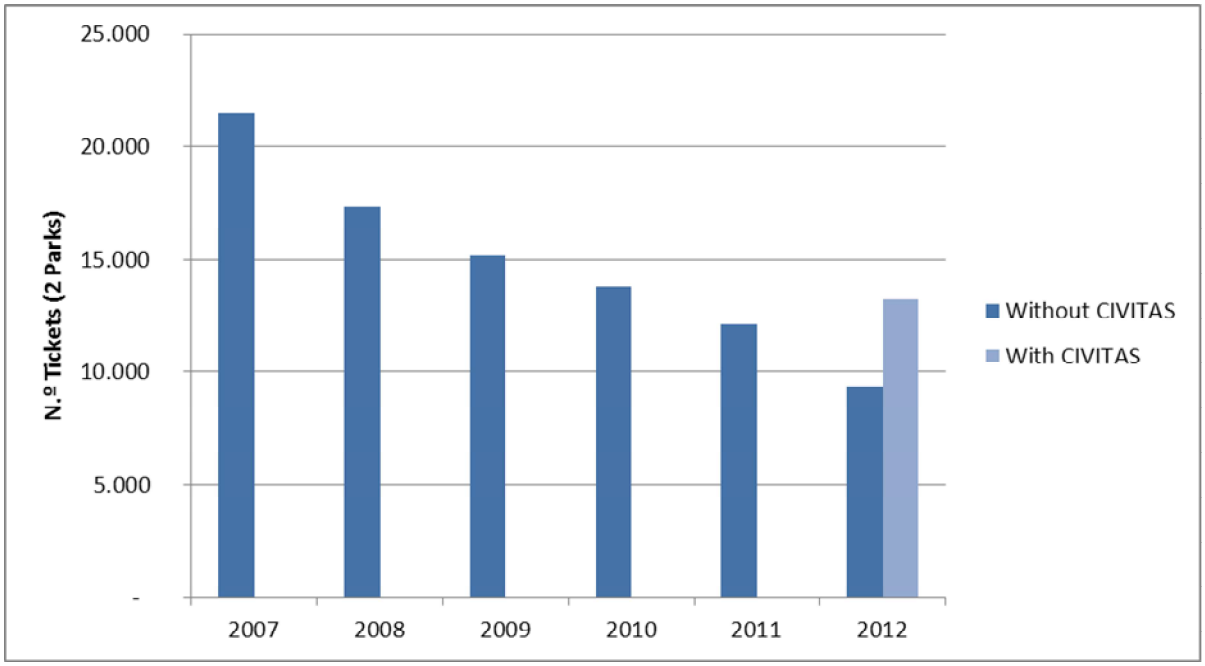


Figure C2.4.1 – Park&Ride Usage without/with CIVITAS

Table C2.4.4 – Transport indicators - Summary– Ex Post, BAU and Ex-ante

Indicator	Before (date)	B-a-U (date)	After (date)	Difference: After –Before	Difference: After – B-a-U
9. Quality of PT service					
Facility to purchase tickets	3,18 (2011)	3,18 (2012)	2,99 (2012)	-0,19	-0,19
Facility to validate tickets	3,28 (2011)	3,28 (2012)	3,03 (2012)	-0,25	-0,25
10. Modal shift					
Private Car	9.099.061 pkm (2011)	1.546.231 pkm (2012)	- (2012)	-9.099.061 pkm	-1.546.231 pkm
Public Transport	(2011)	7.552.830 pkm (2012)	9.099.061 pkm (2012)	9.099.061 pkm	1.546.231 pkm
11. Park&Ride users					
N.º Tickets (2 trips) – 2 parks	12.117 (2011)	9.322 (2012)	13.279 (2012)	1.162	3.957

The decrease in the perception of the users about the PT quality, related to the questions involving the new e-ticketing system, could be related to the recent implementation of the ticketing system. In the survey period, it was noted that the SMTUC passengers felt some difficulties in adapting to the ticket validation system. It is expectable that the passengers will get used to the new system and feel the benefits resulting from it.

In the other hand the measure implementation had a positive impact in the modal shift with an increase of 1,2% of the SMTUC passengers.

Analysing the ex-post scenario it is possible to observe that the CIVITAS measure has induced an increase of the number of tickets sold in the Park%Ride system. Comparing the ex-post with the BAU scenario an increase of the number of tickets by 42% has been encountered. When comparing the ex-post with the ex-ante scenario an increase of 10% can be observed.

C2.5 Society

The specific question of the acceptance level of the new ticketing system was carried out together with the modal shift survey (more details of the survey in the Annex 6). This survey shows a low degree of satisfaction as illustrated in Table C2.5.1 (result of the acceptance level).

Table C2.5.1 – Indicator n.12 – Ex-post

Indicators and respective parameters	Ex-post
Acceptance- users	
Very pleased	15,0 %
Pleased	46,1 %
Unsatisfied	32,0%

Table C2.5.2 – – Society indicators - Summary– Ex Post, BAU and Ex-ante

Indicator	Before (date)	B-a-U (date)	After (date)	Difference: After –Before	Difference: After – B-a-U
12. Acceptance level - users	Very satisfied 47,1% Satisfied 49,1% Dissatisfied 3,8% (2011)	Very satisfied 47,1% Satisfied 49,1% Dissatisfied 3,8% (2012)	Very satisfied 15,0% Satisfied 46,1% Dissatisfied 32,0% (2012)	- 32,1% -3,0% 28,2%	- 32,1% -3,0% 28,2%

It can be observed by analysing the acceptance level that the reduction of the satisfaction level is very low. Like for the results in the PT quality, the main reason is related to the recent implementation of the ticketing system. In the survey period, it was noted that the SMTUC passengers felt some difficulties in adapting to the ticket validation system. It is expectable that the passengers will get used to the new system and feel the benefits resulting from it.

C2.6 Cost benefit analysis

C2.6.1 Evaluation period for CBA

Cost-benefit analysis was conducted using the CBA Guideline for CIVITAS Plus Evaluation (Draft 1.0) document developed by Transportation Research Group (TRG), School of Civil Engineering and the Environment, University of Southampton, UK. The output of the CBA was the Net Present Value (NPV) of the measure, which computes the changes of economic costs and benefits, discounted over the 15 years expected lifetime of the measure, which matches the evaluation period of CBA (2012-2027).

The analysis was performed by comparing the costs and benefits of the new ticketing system (no-contact for pre-purchased tickets) (CIVITAS Case) with an old system (for magnetic pre-purchased tickets) (BAU Case).

The generated benefit of the technological change is due to the increase of:

- Revenues from the passengers (transferred from private car due to the measure);

- Time savings due the quicker validation process of the e-tickets comparatively to the ancient tickets with magnetic band technology (this approach has been chosen in alternative to the assessment of the Average PT Network speed initially foreseen, because has been considered more correct, taking in attention that has been a direct measurement, while the assessment to the commercial speed could be influenced by several other factors external to the measure implementation);
- Air Pollutant Reductions (NOx, CO2, volatile compounds (HC), particulates (PM)).

In terms of costs the main beneficiaries were the personnel and the maintenance (material stock and purchase).

The balance between costs and benefits was computed using the NPV by discounting the aggregated annual cash flow (sum of the 15 year annual cash flows). The discount rate considered is 3% per year.

C2.6.2 Method and values for monetisation

Capital cost for the year 2012 has been monetised considering the investment of the new ticketing system.

Operating costs for the years 2012-2027 have been monetised considering the value of SMTUC Operating Costs related to the measure. The enrolled costs are the (A.) Personnel and (B.) Maintenance. The costs of maintenance are related to the material stock and equipment purchase.

These costs were also updated in the analysis period by considering the following:

Table C2.6.2.1 – Explanation of source and assumptions for construction the CBA analysis

Operating Cost	BAU Case	CIVITAS Case	OBS.
A. Personnel (O&M new ticketing system + ticket sales staff)	For 2012 is a computed value obtained by the 2007-2009 annual personnel cost average. For the period 2013-2027 was considered an increase of 2% per year. For ticket sales staff was considered the wages from 24 workers	2012-2013 the personnel cost were very low due the warranty contract of the system. The 2014 value is the real value provided by the ticketing system supplier. For the period 2015-2027 was considered an increase of 2% per year. For ticket sales staff was considered the wages from 22 workers (2 less then BAU case, already transferred to other activities)	Estimated by SMTUC
B. Maintenance	For 2012 is a computed value obtained by the 2007-2009 annual personnel cost average. For the period 2013-2027 was considered 2% increase.	For 2012 was considered less 20% of the average of the last 5 years (new system and in Warranty). Thereafter (2013-2027) was considered 2% increase.	Estimated by SMTUC

On the benefits side, it is expected benefits in terms of revenue of the new passengers (433.404) that had changed from private car to PT due to the measure. This value is monetised considering an average revenue in 2012 of 0,28 €/passenger. This value is actualised by the inflation rate till 2027. A inflation rate of 3,0% is considered in 2012 (Bank of Portugal previsions) and thereafter a fixed tax of 1,5%. As been considered that the 1,2% increase rate in the passengers, assessed in the modal shift survey, will be maintained during the other years.

Table C2.6.2.2 – Determinations of the revenues in the CBA analysis

Year (€)	New Passengers	Inflation	Total Revenues Ex-post (€)	Total Revenues BAU (€)	Ex-Post - BAU (€)	Notes
2012	433.404	3,0%	7.618.341	7.496.987	121.353	Total revenues Ex-Post (2012) is previewed by SMTUC manegement. 2012 BAU value is Ex-post value minus 433.404 passengers x revenue per pessenger (0,28 €/passenger). The SMTUC passengers was admited an constant increase of 1,2% per year. All the values are corrected by the inflation rate that is 3% for 2012 and 1% in 2013 (Bank of Portugal forecast) and for the next period (2014-2027) constant (1,5%).
2013	438.605	1,0%	7.846.891	7.720.397	126.494	
2014	443.868	1,5%	7.925.360	7.796.068	129.292	
2015	449.195	1,5%	8.044.240	7.911.434	132.806	
2016	454.585	1,5%	8.164.904	8.028.488	136.415	
2017	460.040	1,5%	8.287.377	8.147.254	140.123	
2018	465.560	1,5%	8.411.688	8.267.756	143.932	
2019	471.147	1,5%	8.537.863	8.390.019	147.844	
2020	476.801	1,5%	8.665.931	8.514.069	151.862	
2021	482.522	1,5%	8.795.920	8.639.930	155.990	
2022	488.313	1,5%	8.927.859	8.767.629	160.230	
2023	494.172	1,5%	9.061.777	8.897.192	164.585	
2024	500.103	1,5%	9.197.703	9.028.645	169.058	
2025	506.104	1,5%	9.335.669	9.162.016	173.653	
2026	512.177	1,5%	9.475.704	9.297.331	178.373	
2027	518.323	1,5%	9.617.840	9.434.618	183.221	

The time savings resulting from the difference between the average time of the Old system (for magnetic pre-bought tickets – 3,1 seconds) and the average time new system (no-contact for pre-purchased tickets - 1.8 seconds). The net time savings per passenger is 1,3 seconds. Of the total passengers, there are 23,8% that use pre-bought tickets (magnetic) in 2010 and 2011. In 2012 and subsequent years are all without contact.

The time savings for BAU situation are monetised considering the value 0 and only exist for CIVITAS measure situations. Time savings from time reductions (CIVITAS Measure) are monetised considering the following expression:

$A = B \times C \times D \times E$

where,

A – Time reduction savings (€)

B – Total SMTUC passengers

C – Percentage of passengers that uses magnetic tickets (23,8%)

D – Time benefit of using the new ticketing system (s)

E – Average value of time (€/h)

The values for the times saving benefit are showed in the following Table.

Table C2.6.2.3 – Determinations of the time savings in the CBA analysis

Year	Total Passengers	Pre-bought tickets (magnetic)	Time Savings (hour)	Inflation	Time Savings (€/hour) - inflation adjusted	Time Savings (€) - inflation adjusted
2012	26.942.731	6.412.370	2.316	3,0%	12,29	**28.458**
2013	27.265.158	6.489.108	2.343	1,0%	12,41	**29.087**
2014	27.402.977	6.521.909	2.355	1,5%	12,54	**29.526**
2015	27.451.561	6.533.472	2.359	1,5%	12,73	**30.022**
2016	27.306.707	6.498.996	2.347	1,5%	12,92	**30.312**
2017	27.256.675	6.487.089	2.343	1,5%	13,11	**30.710**
2018	27.299.703	6.497.329	2.346	1,5%	13,31	**31.220**
2019	27.237.795	6.482.595	2.341	1,5%	13,51	**31.617**
2020	27.084.716	6.446.162	2.328	1,5%	13,71	**31.910**
2021	27.102.402	6.450.372	2.329	1,5%	13,91	**32.410**
2022	27.087.992	6.446.942	2.328	1,5%	14,12	**32.879**
2023	27.256.979	6.487.161	2.343	1,5%	14,33	**33.580**
2024	27.333.929	6.505.475	2.349	1,5%	14,55	**34.180**
2025	27.362.679	6.512.318	2.352	1,5%	14,77	**34.729**
2026	27.286.661	6.494.225	2.345	1,5%	14,99	**35.152**
2027	27.256.901	6.487.143	2.343	1,5%	15,21	**35.641**

References of values used - Time Savings

The pondered Average value of time (€/h) is obtained considering the following:

$$B = (H \times I + J \times K) / (H + J)$$

where,

H – Proportion of passengers travelling for work related motives (46,1%)

I – Average value of time for passengers travelling for work related motives (19,56 €/h)

J – Proportion of passengers travelling for non-work related motives (53,9%)

K – Average value of time for passengers travelling for non-work related motives (6,06 €/h)

This implies that the value of time is **12,29 €/h for 2012** (for more detail consult ANNEX 5 Cost-Benefit Analysis Data). For the period 2012-2027 value was adjusted by an inflation rate.

For emissions was considered benefits associated to the modal shift from private car to PT. the total monetisation for the emission factors are expressed in the next Table. (further details please consult annex 5).

Table C2.6.2.4 – Determinations of the emissions savings in the CBA analysis

Year	BAU CASE (A) -€				CIVITAS CASE (B) - €				BENEFIT (A-B) - €			
	NOx	HC	CO2	PT	NOx	HC	CO2	PT	NOx	HC	CO2	PT
2012	15,72	692,36	23.739,16	18,70	16,90	666,57	19.635,18	19,77	-1,18	25,79	4.103,99	-1,06
2013	15,88	699,28	23.976,55	18,89	17,06	673,23	19.831,53	19,96	-1,19	26,05	4.145,03	-1,07
2014	16,11	709,77	24.336,20	19,17	17,32	683,33	20.129,00	20,26	-1,21	26,44	4.207,20	-1,09
2015	16,36	720,42	24.701,25	19,46	17,58	693,58	20.430,94	20,57	-1,22	26,83	4.270,31	-1,11
2016	16,60	731,22	25.071,76	19,75	17,84	703,99	20.737,40	20,88	-1,24	27,24	4.334,36	-1,12
2017	16,85	742,19	25.447,84	20,05	18,11	714,55	21.048,46	21,19	-1,26	27,65	4.399,38	-1,14
2018	17,10	753,32	25.829,56	20,35	18,38	725,26	21.364,19	21,51	-1,28	28,06	4.465,37	-1,16
2019	17,36	764,62	26.217,00	20,66	18,66	736,14	21.684,65	21,83	-1,30	28,48	4.532,35	-1,17
2020	17,62	776,09	26.610,26	20,97	18,94	747,18	22.009,92	22,16	-1,32	28,91	4.600,34	-1,19
2021	17,89	787,73	27.009,41	21,28	19,22	758,39	22.340,07	22,49	-1,34	29,34	4.669,34	-1,21
2022	18,15	799,55	27.414,55	21,60	19,51	769,77	22.675,17	22,83	-1,36	29,78	4.739,38	-1,23
2023	18,43	811,54	27.825,77	21,92	19,80	781,31	23.015,30	23,17	-1,38	30,23	4.810,47	-1,25
2024	18,70	823,72	28.243,16	22,25	20,10	793,03	23.360,53	23,52	-1,40	30,68	4.882,63	-1,26
2025	18,98	836,07	28.666,80	22,59	20,40	804,93	23.710,94	23,87	-1,42	31,14	4.955,87	-1,28
2026	19,27	848,61	29.096,81	22,92	20,71	817,00	24.066,60	24,23	-1,44	31,61	5.030,21	-1,30
2027	19,56	861,34	29.533,26	23,27	21,02	829,26	24.427,60	24,59	-1,46	32,08	5.105,66	-1,32

C2.6.3 Life time cost and benefit

Tables C2.6.3.1 to C2.6.3.4 shows the economic data used for the Cost Benefit Analyses.

The new ticketing system was acquired and installed during 2011 (installation all concluded only in December 2011). For these reason it was assumed in the CBA analysis the capital costs in 2012 to allow a easy understanding of the measure effects..

Table C2.6.3.1 – Capital cost in the evaluation period (not discounted)

Year	CIVITAS measure	BAU
2012	1.201.097	0,00
2013-2027	0,00	0,00

The capital costs it is broken down as the following:

Table C2.6.3.2 – Specification of capital costs

NAME	COST (€)
Board Equipment	511.310,30
Inspection of Terminals	23.528,80
Data Collection Station and Surveillance Terminal	8.631,14
Sales and Load Stations	114.807,80
Sale Terminals	36.386,80
Equipment for Settlement of Accounts	17.238,20
Automatic Machines for the Settlement of Accounts	51.586,00
Server	153.743,00
Integration Platform of Computer Applications - Middleware	42.978,00
Wireless Communication Infrastructure	8.953,53
Installation, Testing and Commissioning	150.000,00
SUB-TOTAL	**1.119.163,57**
Agents Sale Terminals	81.934,00
TOTAL	**1.201.097,57**

Table C2.6.3.3 –Costs in the evaluation period (not discounted)

		0 2012	1 2013	2 2014	3 2015	4 2016	5 2017	6 2018	7 2019	8 2020	9 2021	10 2022	11 2023	12 2024	13 2025	14 2026	15 2027
A. Personnel	CIVITAS Case	115.192	115.192	128.139	130.701	133.315	135.982	138.701	141.475	144.305	147.191	150.135	153.138	156.200	159.324	162.511	165.761
	BAU Case	163.958	167.237	170.581	173.993	177.473	181.022	184.643	188.336	192.102	195.944	199.863	203.861	207.938	212.097	216.338	220.665
B. Maintenance	CIVITAS Case	300	306	312	319	325	332	338	345	352	359	366	373	381	388	396	404
	BAU Case	530	540	551	562	574	585	597	609	621	633	646	659	672	685	699	713
TOTAL (€)	CIVITAS Case	115.492	115.498	128.451	131.020	133.641	136.313	139.040	141.820	144.657	147.550	150.501	153.511	156.581	159.713	162.907	166.165
	BAU Case	164.487	167.777	171.133	174.555	178.046	181.607	185.239	188.944	192.723	196.578	200.509	204.519	208.610	212.782	217.038	221.378
Changes (€)		**-48.995**	**-52.279**	**-42.682**	**-43.535**	**-44.406**	**-45.294**	**-46.200**	**-47.124**	**-48.066**	**-49.028**	**-50.008**	**-51.008**	**-52.029**	**-53.069**	**-54.131**	**-55.213**

Note: The decrease in personnel costs with the new system was due to its better reliability, more automatisms on several operations and improvements at organizational level that implied in a consequent reduction of personnel allocated to the maintenance and accounting services..

Table C2.6.3.4 - Savings for the evaluation period (not discounted)

		0 2012	1 2013	2 2014	3 2015	4 2016	5 2017	6 2018	7 2019	8 2020	9 2021	10 2022	11 2023	12 2024	13 2025	14 2026	15 2027
Renevues - New users	CIVITAS Case	7.618.341	7.846.891	7.925.360	8.044.240	8.164.904	8.287.377	8.411.688	8.537.863	8.665.931	8.795.920	8.927.859	9.061.777	9.197.703	9.335.669	9.475.704	9.617.840
	BAU Case	7.496.987	7.720.397	7.796.068	7.911.434	8.028.488	8.147.254	8.267.756	8.390.019	8.514.069	8.639.930	8.767.629	8.897.192	9.028.645	9.162.016	9.297.331	9.434.618
Time Savings	CIVITAS Case	28.458	29.087	29.526	30.022	30.312	30.710	31.220	31.617	31.910	32.410	32.879	33.580	34.180	34.729	35.152	35.641
	BAU Case	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Air Pollutant Reductions NOx	CIVITAS Case	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
	BAU Case	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Air Pollutant Reductions HC	CIVITAS Case	26	26	26	27	27	28	28	28	29	29	30	30	31	31	32	32
	BAU Case	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Air Pollutant Reductions CO2	CIVITAS Case	4.104	4.145	4.207	4.270	4.334	4.399	4.465	4.532	4.600	4.669	4.739	4.810	4.883	4.956	5.030	5.106
	BAU Case	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Air Pollutant Reductions PM	CIVITAS Case	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
	BAU Case	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL (€)	CIVITAS Case	7.650.927	7.880.147	7.959.117	8.078.557	8.199.575	8.322.512	8.447.399	8.574.038	8.702.468	8.833.027	8.965.504	9.100.195	9.236.794	9.375.383	9.515.916	9.658.615
	BAU Case	7.496.987	7.720.397	7.796.068	7.911.434	8.028.488	8.147.254	8.267.756	8.390.019	8.514.069	8.639.930	8.767.629	8.897.192	9.028.645	9.162.016	9.297.331	9.434.618
Changes (€)		**153.939**	**159.749**	**163.049**	**167.123**	**171.087**	**175.258**	**179.643**	**184.019**	**188.399**	**193.096**	**197.875**	**203.003**	**208.149**	**213.367**	**218.585**	**223.997**

Table C2.6.3.5 – Balance between costs and benefits due to measure (lifetime period)

	0 2012	1 2013	2 2014	3 2015	4 2016	5 2017	6 2018	7 2019	8 2020	9 2021	10 2022	11 2023	12 2024	13 2025	14 2026	15 2027
Undiscounted Cash Flow (€)																
Changes in total costs	1.201.097	-52.279	-42.682	-43.535	-44.406	-45.294	-46.200	-47.124	-48.066	-49.028	-50.008	-51.008	-52.029	-53.069	-54.131	-55.213
Changes in total benefits	153.939	159.749	163.049	167.123	171.087	175.258	179.643	184.019	188.399	193.096	197.875	203.003	208.149	213.367	218.585	223.997
Net Cash Flow	-1.047.158	212.028	205.731	210.658	215.493	220.552	225.843	231.143	236.466	242.124	247.883	254.012	260.178	266.436	272.715	279.210
Discounted Cash Flow (€)																
Changes in total costs	1.152.102	-50.756	-40.231	-39.841	-39.454	-39.071	-38.692	-38.316	-37.944	-37.576	-37.211	-36.850	-36.492	-36.138	-35.787	-35.439
Changes in total benefits	153.939	155.097	153.690	152.941	152.008	151.179	150.448	149.624	148.724	147.992	147.238	146.654	145.992	145.292	144.510	143.775
Net Cash Flow	-998.163	205.853	193.921	192.782	191.462	190.250	189.140	187.940	186.668	185.568	184.449	183.503	182.483	181.430	180.297	179.214
Cumulative cash flow	-998.163	-792.310	-598.389	-405.607	-214.144	-23.894	165.246	353.186	539.854	725.422	909.871	1.093.374	1.275.857	1.457.287	1.637.584	1.816.798
Changes in NPV (€)	**1.816.798**															

C2.6.5 Summary of CBA results

The results of CBA demonstrate that the measure could produce a NPV of 1,82 M € over a 15 year period analysis, based on the updated balance of costs and benefits of the new ticketing system.

In order to evaluate the sensitivity due to the discount rate an analysis has been carried out (Table C2.6.5.1). A 3% rate per year was assumed and 2 scenarios have been consider to analyse a high discount rate with 5,5% and a low discount rate (2,5%).

Table C2.6.5.1 – Sensitivity analysis (low and high scenario)

Analysis	NPV (M€)
Low (discount rate 2,5%)	1,93
Current (discount rate 3%)	1,82
High (discount rate 5%)	1,43

The analysis demonstrated that the discount rate has a small impact in the NPV and it always remains positive.

C3 Achievement of quantifiable targets and objectives

No.	Target	Rating
1	To install a new e-ticketing system on board of 125 PT vehicles. The e-ticketing has been installed on board of 139 PT vehicles, in the lift and in the park&ride service, totalizing 150 on board sets. Each set has 2 equipment that allow the validation function in duplicate (Duple function Console near the driver and passengers entry + the Validator at passengers passage)	★★★
2	To create fare products, including for the improvement of the integration of services (such as those linked to the parking), that will also contribute to increase by 1% the passengers in the municipality PT service and 3% the Park & Ride usage. New fare products have been created, including for the park&ride system. During the first 9 months of the new e-ticketing functioning the passengers increased 1,2 % due the system implementation and the tickets sale in the 2 remaining parks of the park&ride system increased 9,6% when compared 2012 with 2011.	★★★
3	Expansion of public transport in the metropolitan area. During CIVITAS MODERN project 2 new PT lines for the surroundings has been created, as well as the expansion of 1 line to one hospital involved in the scope of the mobility management actions of the CIVITAS MODERN measure 04.05. All these inhabitants served by these lines is benefiting of the new e-ticketing system and SMTUC fares.	★★

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

C4 Up-scaling of results

Since the new ticketing system was implemented in all of the SMTUC vehicles there are no up-scaling.

C5 Appraisal of evaluation approach

The evaluation strategy of this measure sought to focus on a number of indicators across the areas of economy, transport, energy, environment, and society, which were to be measured in different ways.

This strategy that was based on the Local Evaluation Plan (LEP) was defined a long time before the final definition of the measure and during the LEP elaboration the hypothesis considered in relation to the foreseen evaluation approach of the measure was very different from the approach that was actually taken.

An extension of the measure has been required to allow for a longer evaluation period and better assessment of the impacts, taking into consideration that the new e-ticketing system started the full operation for all types of passes in February 2012 and until the end of May 2012 a transition period was applied with the 2 systems working together. Additionally, in this period the summer holidays contributed to a drop in passengers. Due to the time available for evaluation, it was not possible to measure directly the impacts of the measure in the behaviour of the citizens.

Accordingly the methodology to assess the indicators was based on the modal shift from private car to public transport associated to the New Ticketing System (due to the financial crisis in Portugal it was considered that a shift from PT to the private cars was not likely).

For this effect in September 2012 a survey was carried out amongst 750 SMTUC passengers, inquiring about their modal behaviour and changes since the beginning of the operation of the new e-ticketing system (9 months earlier).

With the data provided by the surveys an assessment was carried out in terms of average operating revenues, fuel energy, and environmental indicators. For the remaining economic indicators, transport, and society indicators the source of the information was based on SMTUC operational data and the customer satisfaction survey carried out in the scope of SMTUCs normal procedures of the Quality Management System.

Also the impact of the measure in the Average PT Network Speed has been abandoned to be evaluated in this measure because it was difficult to assess the direct influence of the measure in the indicator and there are other CIVITAS MODERN measures that had a major impact in the Average PT Network Speed, like the measure 08.03, in which the indicator has been assessed.

C6 Summary of evaluation results

The key results are as follows:

- **Increase of the average operating revenues -** The measure induced an increase of the average operating revenues related to the passengers that transferred to public transport (+0,02 €/v-km).

- **Decrease of the average operating costs -** The measure induced a decrease of the average operating costs (- 0,0095 €/v-km). Adding the effects of the operating revenues and costs it can be concluded that the measure has a positive impact in the economic indicators.
- **Positive NPV and attractive pay-back period -** The Cost-Benefit Analysis (CBA) of the measure demonstrates that it generates a positive NPV of 1,82 M € over a 15 year period and a payback of the investment is expected between the 5th and 6th year of implementation. A sensitivity analysis of the discount rate impact into the NPV demonstrated that it generates a small influence between the factors.
- **Positive impacts on the attractiveness of the new system - 15% of users are** very satisfied and about 46% consider the measure satisfactory. The percentage of not satisfied compared to the previous system can be justified by the fact that the system was recently implemented and the users are not sufficiently familiar with its use, mainly the elders.
- **Contribution to energy efficiency in the city** – The implementation of the measure would result in significant savings in energy due to the assessed reduction of the energy consumption per passenger (-0,24 MJ/pkm).
- **Positive impact on emissions mitigation –** The measure generates a positive impact on CO2, NOx, and PT emissions with a decrease of -17,081 g/pkm, -0,698 g/pkm, and 0,03 g/pkm, respectively. The CO emissions remain constant.
- **Increase of the usage of the Park & Ride system –** Comparing the ex-post with the BAU scenario an increase 42% of the number of tickets sold can be foreseen. When comparing the ex-post with the ex-ante scenario an increase of 10% can be observed. All the comparisons indicate that the measure generate an increase of the Park & Ride usage.

C7 Future activities relating to the measure

The e-ticketing system will continue functioning, as well as the development of the on-line system for the payment of the fares.

The payment and reload of the e-cards through ATM machines will be also implemented when the legal issues relating to national legislation (provided for the combat of the financial crisis) are surpassed.

The contacts carried out for the creation of an inter-municipal pass will continue, namely by searching for new ways to avoid the financial barriers and involve the surrounding Municipalities and PT operators in the project.

In any case, the launch of new fares and the development of new features for the improvement of intermodality and interoperability will be a priority.

D Lessons learned

D0 Measure / focussed measure

1	The measure fits into the EU policy towards clean urban transport (five pillars of the EU Green Paper)
2	The measure fits into the city policy towards sustainable urban transport and / or towards sustainability in general
3	The expected impact on the transport system, environment, economy and/ or society / people is very high
4	The high level of innovativeness of the measure with respect to technique, consortium, process, learning etc
5	The measure is typical for a group of measures or a specific context
6	The possibility of carrying out a good Cost Benefit Analysis
7	Participation of a range of different actors
8	The high degree of complexity of managing the measure
9	The measure is regarded as an example measure
10	Other, *please describe*

Which are the three most important reasons for selecting this measure as a focused measure?

1 The measure fits into the EU policy towards clean urban transport (five pillars of the EU Green Paper)	1	Most important reason
6 The possibility of carrying out a good Cost Benefit Analysis	2	Second most important reason
2 The measure fits into the city policy towards sustainable urban transport and sustainability in general	3	Third most important reason

D1 Deviations from the original plan

The deviations from the original plan comprised:

- **Extended administrative and bureaucratic procedures delayed the implementation of the measure**– Taking into consideration the importance of the project at the regional level and the interest manifested by the National Authority of Inland Transportation (IMTT) for supporting of measures which can increase the integration of several PT operators and other modes of transportation in the metropolitan areas, the Municipality of Coimbra, through its municipal public transport service (SMTUC), began contacts for national funding of the e-ticketing system before the CIVITAS candidature. Despite this anticipation, a large part of the time for the measure implementation has been spent in solving administrative and bureaucratic problems. First the governmental decision for the co-financing of the system purchase only occurred on 29th December 2009, more than 1 year after the expected and 7 months after the technical conclusion of the tender process. To recover the time lost, the tender process began before the authorization of the national co-financing, but national legislation established that the final adjudication only could be authorized after all funds were identified. For this reason Municipality and SMTUC launched a loan contract procedure. This procedure has also been time consuming, in part due the financial crisis in Portugal which obliged even more rigorous procedures during the contract validation by the National Court of Accounting. Also a contention to the final results and hierarchical appeals to several judicial instances occurred during the procedure of the international public tender for the e-ticketing system. Despite the contestants' lack of reasons, these appeals obliged a suspension of the procedure until the final decision, allowing that the final adjudication could only be concluded on 30th August 2010. Finally, the loan contract validation by the National Court of Accounting occurred in December 2010, the signature of the contract for the e-ticketing system took place on 23rd December 2010, and the new validation by the National Court of Accounting (now for the system purchase) was released on 17th February 2011. Despite the fact that the contract stipulated 1 year for the development and installation of the e-ticketing system, recovery actions allowed the start-up of the new system on 1st January 2012 (for the tickets). On 2nd February 2012 the system was fully

operational for all kind of passes. Due to this delay the measure duration has been extended 4 months in order to allow for a longer evaluation period and a better assessment of the impacts.

- **The objective related to the increase of the passengers in the municipal public transport operator has been changed from the 2% initially foreseen to the actual 1%** – The objectives of the measure have been reformulated due to the above mentioned delay in the implementation of the e-ticketing system. Taking into consideration that during CIVITAS the time available for the e-ticketing system to have any impact was reduced and did not allow a change in citizens behaviour, the expected increase in the SMTUC passengers has been fixed in 1%, instead of the 2% initially foreseen.

- **The initial objective leading to the creation of an Inter-municipal pass during CIVITAS has been suspended** – To offer better interoperability to the inhabitants of the surrounding municipalities that need to travel to Coimbra through private PT operators and to use SMTUC in the city, the Municipality of Coimbra and SMTUC envisioned the creation of an inter-municipal pass during CIVITAS.. This product would imply discounts to the passengers from the municipalities, SMTUC, and the other PT operators, as well as some costs with the adaptation of the e-ticketing systems (despite in SMTUCs case the new system is already interoperable and open to other e-card technologies). But the financial crisis in Portugal made many of these Municipalities and PT operators to reconsider their priorities, delaying their decision to join Coimbra in this initiative, subsequently forcing an adaptation in this objective. Accordingly, the Municipality of Coimbra and SMTUC opted to plan (and carried out) some extensions of their PT network during CIVITAS and abandoned the creation of the Inter-municipal pass (despite during CIVITAS several meetings and contacts continued with the surrounding municipalities and PT operators to achieve this objective as soon as possible). The already existing multimodal railway – bus pass was also involved in this process. This pass already had an insignificant demand due any discount was being applied for this fare and the old system didn't allow the integration of systems, obliging the user to have cards of the 2 operators. So the pass wasn't appealing, but with the new e-ticketing system using the same data base model of the railway operator, has been expected that during CIVITAS this situation could change with it integration in the inter-municipal pass. The suspension of the launch of this pass also implied that didn't make any sense to maintain the initial objective to increase 100% the multimodal railway – bus pass,

D2 Barriers and drivers

D2.1 Barriers

Preparation phase

- **Barrier 1.1** – **Financial Barrier:** Despite SMTUCs early request (before CIVITAS) for national co-financing of the e-ticketing system, only on 29th December 2009 did the government approve for the co-financing (over 1 year after the expected). This fact delayed the beginning of the measure implementation. Also the financial crisis in Portugal influenced the process of creation of an inter-municipal pass involving the surrounding municipalities of Coimbra Municipality. To turn the product more attractive to customers, discounts for the purchasing the passes were foreseen. However, the crisis implied a reconsideration of the priorities for the municipalities and the PT operators.

- **Barrier 1.2** – **Technological Barrier:** Before the CIVITAS MODERN project SMTUC already possessed a ticketing system that provided "contact less" technology (but only for the passes). This system was based in a technology dependent on the integrators that caused many problems in the past. Accordingly, SMTUC wanted to apply "open" technology in the new system. Thus comprehensive knowledge of such systems was required for the definition of the correct specifications for the tender procedure of the system purchase. This process revealed to be very complicated and time consuming, carrying the risk of delays if recovery actions had not been put in practice.

Implementation phase

- **Barrier 2.1** – **Institutional Barrier:** In Portugal the final adjudication, related to a purchase procedure, could only be authorized after all funds are identified. The above mentioned delay in the definition of the national funds for the e-ticketing system purchase obliged the Municipality of Coimbra and SMTUC to carry out a loan contract procedure to grant all funds for the system purchase. But this process has very time consuming due to the long administrative and bureaucratic procedures existing in Portugal,, namely in the National Court of Accounting. For this reason the major part of the implementation time was spent in the resolution of legal and financial problems, as well as in the planning and implementation of recovery actions. Also, significant work and time were spent answering a contestation to the tender results carried out by a contestant to the tender procedure. Despite the contestant's lack of legal reasons, the contestation and subsequent hierarchical appeals obliged the suspension of the procedures until reaching a final decision, contributing to a greater delay in the implementation process.
- **Barrier 2.2** – **Institutional Barrier:** It was initially foreseen that the supply of the new e-tickets and e-cards (physical supports for the fares) could be available trough the partnership protocol signed with OTLIS (Organization of public transportation operators of Lisbon and national railway company) as a national standard and taking advantage of the economies of scale resulting from large-scale demands of tickets and cards resulting from tender processes organised with the Lisbon Metropolitan area (SMTUC has the same data base model, application programming interface – API – and Security Protocol – SAM – as the OTLIS PT operators). Since in June 2011 legal interpretations did not allow for the tickets and cards to be supplied directly by this entity, it was decided to launch a procedure for the purchase of the e-tickets and e-cards. But this tardy unexpected decision, associated with the delays caused by the bureaucratic procedures, as well as some problems with errors in the e-cards, caused new delays that hindered the success of the recovery actions undertaken for the combat to the other delays.

Operation phase

- **Barrier 3.1** – **Problem related Barrier:** The accumulated delays, due to the problems mentioned above, also caused a significant delay in the beginning of the operation phase, implying and extension of the duration of this phase in order to have time to assess the impacts of the measure implementation and to revise some methodologies (to carry out these assessments and the values of some quantifiable objectives).

D2.2 Drivers

Preparation phase

- **Driver 1.1 – Involvement Driver:** The Municipality (with emphasis on the decision makers), and SMTUC staff were very motivated for the measure implementation and were aware of the commitments assumed with the citizens and the CIVITAS MODERN project. This involvement and responsibility was crucial for the recovery actions undertaken during the preparation phase .

- **Driver 1.2 – Technological Driver:** OTLIS has a large experience in ticketing issues and some months before the beginning of the CIVITAS MODERN project it launched an international public tender for the implementation of e-ticketing system in several PT operators in the Lisbon region. This experience and knowledge were available to SMTUC staff.

Implementation phase

- **Driver 2.1 – Organisational Driver:** SMTUC dedicated a large part of it organizations in the implementation of the e-ticketing system to recover more quickly the time lost and to achieve better quality and results with the new system.

Operation phase

- **Driver 3.1 – Involvement Driver:** The participation in the CIVITAS MODERN project served as a driver per se for the quick resolution of problems, using the motivated SMTUC staff which was aware of their responsibilities Equally significant, SMTUC counted on the advice and experience of other MODERN partners and technical managers.

D2.3. Activities

Preparation phase

- **Activities 1 – Involvement Activities:** Municipality of Coimbra and SMTUC were very motivated and aware of their responsibilities for the task of implement the e-ticketing system in Coimbra and the remaining actions in the scope of the CIVITAS MODERN measure (Drive 1.1). To mitigate the effects of the delay in the authorization by the national government of the co-financing for the e-ticketing system purchase and to allow for the anticipation of the definition of all the funds for this investment (Barrier 1.1), the Municipality and SMTUC decided to carry out a loan contract for the e-ticketing purchase and anticipated and developed in parallel several other tasks – e.g., specifications of the system and the update of the implementation planning; meetings and other contacts with decision makers of IMTT demanding a quicker reply on national co-financing; meetings with several surrounding municipalities and all the PT operators for the launch of the inter-municipal pass.

- **Activities 2 – Technological Activities:** Taking into consideration the technical complexity of the implementation of the e-ticketing system, and the need to avoid

future dependency on suppliers for upgrades (Barrier 1.2), SMTUC took advantage of the exchange of experience and knowledge by several stakeholders, with emphasis on OTLIS. Therefore, for the technical specifications of the new system, while solving the financial and administrative issues, SMTUC carried out a market analysis through the available online information and the information provided by the manufacturers. SMTUC also took advantage of the visits to other existing systems and of the experience of the OTLIS staff. These activities included a partnership with OTLIS aiming at the establishment of a national standard for e-ticketing systems – the partnership allowed for a common data base model and the same application programming interface (API) and the same security access module (SAM). These resolutions benefited the interoperability and intermodality at a national scale and allowed for economically more favourable tender proposals due to the fact that a great part of the work needed for the development of the system for Coimbra region was already developed by the major part of the manufacturers which supplied the Lisbon region in the past.

Implementation phase

- **Activities 1 – Organisational Activities:** The major part of the implementation time was spent in the resolution of legal and financial problems (Barriers 2.1 and 2.2). Taking advantage of the important allocation of SMTUC resources in the support of the measure implementation (Driver 2.1), it was possible to carry out several activities in parallel and in less time. These organisational and planning activities avoided the accumulation of delays, directed available experienced technicians to the resolution of technical problems, and allowed to reply correctly, promptly, and quickly to legal solicitations, including those from the National Court of Accounting.

Operation phase

- **Activities 1 – Problem related Activities:** Despite the recovery actions, the accumulation of delays, due to the multiple problems that happened during the preparation and implementation phase, caused an inevitable delay of the beginning of the operation phase and, subsequently, less time for the assessment of the measure impacts (Barrier 3.1). The importance of the measure for the citizens and the awareness of the staff involved about their responsibilities concerning the obligations with the CIVITAS MODERN project (Driver 3.1), contributed to the decision of carrying out a systematic monitoring and accomplishment of the measure demonstration – with focus on the correct functioning of the e-ticketing system and the data collection, but also working for the creation of new mobility products. Also it was decided to carry out a survey to SMTUC passengers, allowing fort the assessment of the modal shift.

D3 Participation of stakeholders

D3.1 Measure partners

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

SMTUC was responsible for the specification, purchase, and installation process of the new e-ticketing system, as well as the training of the system users (drivers, controllers, and maintenance staff). Also, SMTUC carried out the management of operational and monitoring activities, as well as some dissemination activities.

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

CMC was responsible for carrying out with SMTUC the loan contract for the e-ticketing system purchase and for the approval of the fares.

Since October 2011, CMC assumed the responsibility for the dissemination of the MODERN project of Coimbra.

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

While responsible for the dissemination activities for the first three years of the MODERN project of COIMBRA, PRODESO gave some support in the promotion of this measure.

- **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.

D3.2 Stakeholders

- **Stakeholder 1 – Public transport users**

SMTUC passengers are the main beneficiaries of this measure since it has allowed for an enhancement of the quality and feasibility of the ticketing system.

- **Stakeholder 2 – Public in general**

The public in general also benefit of the new e-ticketing system purchase because this system allowed for the establishment of a standard of interoperability and intermodality that is allowing for the creation of new mobility products.

- **Stakeholder 3 – Supplier of the new e-ticketing system**

The group NOVA BASE / BCCM was the supplier of the new e-ticketing system and has also been responsible for it installation and integration with other systems, with emphasis for the Automatic Vehicle Management System (AVM) – namely allowing for a single console to command both systems and to receive information on the coordinates of the bus stops for the geo-referencing of passenger entrances.

- **Stakeholder 4 – Instituto da Mobilidade e Transportes Terrestres (IMTT)**

IMTT is the National Institute of Mobility and Inland Transportation and co-financed the purchase new e-ticketing system in 50%.

- **Stakeholder 5 – Associação de operadores de transportes públicos da região de Lisboa (OTLIS)**

  The Organization of public transportation operators of Lisbon region and national railway company (OTLIS) supported SMTUC in the specifications of the e-ticketing system and established a partnership for a common data base model and the same application programming interface (API) and security access module (SAM). These resolutions benefit the interoperability and intermodality in a national range.

- **Stakeholder 6 – Surrounding municipalities.**

  Some surrounding municipalities of Coimbra metropolitan area have been involved in meetings and other contacts with the objective of the creation of an inter-municipal pass.

- **Stakeholder 7 – PT operators of Coimbra region**

  The regional PT operators and the national railway operator have been involved in meetings and other contacts with the objective of the creation of an inter-municipal pass and for the integration of its systems with SMTUCs e-ticketing system.

- **Stakeholder 8 – Media**

  The media has been a channel for the dissemination and promotion of the measure.

D4 Recommendations

D4.1 Recommendations: measure replication

- **Special attention must be given to the specification of e-ticketing systems, mainly concerning the interoperability of systems and the independence from suppliers for future upgrades –** The e-ticketing systems are technologically complex and have technological requirements that hinder the interoperability between ticketing systems from different PT operators or between systems specific to each operator (such as AVM systems). For this reason special attention must be given to the system specifications in order to facilitate the future integrations of systems and to avoid the dependency from the e-ticketing suppliers for this task. Today there are 2 standards for the e-tickets and validators technology (the A type and the B type or Calypso) and the option for equipment that could support this kind of technologies could be a good approach for the interoperability but could not be enough – the systems must have a compatible data model for the products, mainly the fares, and the same for the Application Programming Interface (API – responsible for the communication protocol between systems) and the Security Access Module (SAM – Protocol of security between systems, avoiding that a ticket from a not allowed operator can't be used in the system). For this reason the establishment of a common standard for a city or a region could be very useful – SMTUC already uses a common standard with the Lisbon region and the national railway company envisioning the creation of a national standard. In any case, the e-ticketing system must be an "open" system with the possibility of customising features so as to avoid the dependency on system suppliers in future developments. This part is the most difficult to achieve. However, SMTUC had good results, mainly in the integration with the AVM

system and achieving independence in the creation and update of new fares or the purchase of new equipment such as validators.

- **It is recommended involving technicians of several areas during the implementation of the measure and to give importance to the monitoring process during the start-up of the e-ticketing system –** The e-ticketing systems normally have impacts in many areas of a PT operator –operation of the PT network, maintenance, accounting, data processing, etc. For this reason, it is recommended involving these areas since the beginning of the process to provide correct specifications and to make the technicians aware of all these issues. They were also important in the phase of the system monitoring, allowing for prompt detection and resolution of the problems. Accordingly the more contact and experience they had with the system, the better the results achieved in this phase.

D4.2 Recommendations: process

- **The procedure for the purchase of the physical supports for the e-tickets or e-cards could be time consuming and with less favourable prices for medium or small size cities –** Medium or small size cities do not have the advantage as larger cities in negotiating the purchase of e-tickets (or e-cards) with the suppliers due to the quantity factor. Also the production of great quantities is a priority and pushes the production of small quantities to the dates that they have available between the other productions – so it is also expected that smaller quantities will imply greater delivery times. To mitigate these problems some actions could be undertaken: In the tender procedure some advantages for the supplier which shorten delivery time could be considered (but this methodology may not be enough – mainly if some kind of "Calypso" e-tickets are used that are manufactured by an unique enterprise that could "impose" the delivery conditions; if economically advantageous, it is recommended to plan the needs of tickets for some years, to allow more quantities in the purchase process); another possibility is trying to establish partnerships with other cities or PT operators to have common specification for the e-tickets or e-cards and acquire the tickets through common purchase procedures – but this methodology have several barriers to its application, namely because in a great part of the cases the layout of the e-tickets (or e-cards).

- **The financial crisis could change priorities in the cities objectives from the mobility worries to the resolution of other issues –** With the financial and economic crisis in Portugal, the social role of the national government (or of the municipalities) in the support of some activities is being discussed. Some decisions that implied the allocation of public funds for the financing of some mobility measures could be delayed and other issues can be given priority, such as health care, education, or unemployment. In Coimbra, mobility issues continue to be one of the Municipality priorities, considering that the support to this activity could aid the social and economic recovery (as was demonstrated by the maintenance during 2013 of the same fares price practiced during 2012 and the continuation of the process for the creation of an inter-municipal pass with some surrounding municipalities that involves some discounts for the passengers granted for all the parts. But on the other hand these municipalities and the respective PT operators have not been interested in the measure after the beginning of the referred crisis, despite their citizens / passengers continue to be the most benefited if the measure is implemented).

ANNEX 1 Fuel Mix Data

The next table shows the data obtained in relation to the evolution of the Share of different fuels (diesel, gasoline) in the Fuel consumption in Portugal since 2004:

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
% Diesel	n.a.	n.a.	n.a.	n.a.	71,1%	72,2%	73,0%	74,5%	75,4%	75,9%	76,9%	77,7%
% Gasoline	n.a.	n.a.	n.a.	n.a.	28,6%	27,4%	26,6%	25,2%	24,2%	23,6%	22,7%	21,8%
% GPL	n.a.	n.a.	n.a.	n.a.	0,3%	0,3%	0,3%	0,4%	0,4%	0,5%	0,4%	0,5%

Source: DGEG - General Directorate for Energy and Geology, Statistics

ANNEX 2 Energy Density and Conversion Factors

Energy Density				
1 litre Diesel	35,86 MJ	1 litre Diesel	0,835	kg
1 litre Gasoline	32,18 MJ	1 litre Gasoline	0,7475	kg

ANNEX 3 Operating costs

Year	Personnel (€)	Personnel Ticket Shops (€)	Material - stock (€)	Material - purchase (€)	Total (€)
2007	26.429,98	143.041,38	591,74	2.392,25	172.455,35
2008	19.234,40	143.041,38	720,38	2.997,71	165.993,87
2009	17.085,20	143.041,38	277,40	13.690,21	174.094,19
2010 (Atypical year)	6.937,30	143.041,38	31,63	4.411,39	154.421,70
2011 (Atypical year)	7.199,70	143.041,38	255,85	4.229,10	154.726,03
2012 (System under Warranty)	0,00	115.192,53	300,32 [3]	0,00	115.192,53
2013 (System under Warranty)	0,00	117.496,38	306,33	0,00	117.802,71
2014 [1]	12.634,18	119.846,31	312,45	0,00	132.792,94
2015 [2]	12.886,86	122.243,23	318,70	0,00	135.448,80
Baseline (2011)	7.199,70	143.041,38	255,85	4.229,10	**154.726,03**
BAU 2012 [3]	20.916,52	143.041,38	529,84	6.360,05	170.847,79
BAU 2013	21.334,86	145.902,21	540,44	6.487,26	174.264,76
BAU 2014	21.761,55	148.820,25	551,25	6.617,00	177.750,05
BAU 2015	22.196,79	151.796,66	562,27	6.749,34	181.305,06

OBS.:
1 - Value provided by the supplier in the tender
2 - 2% increase on the previous year
3 - Less 20% from the 2007-2011 average
4 - 2007, 2008 and 2009 average - further years it is considered an increase of 2%

Actual values recorded in SMTUC (Without CIVITAS measure)
With CIVITAS extrapolation
Without CIVITAS extrapolation

	2007	2008	2009	2010	2011	2012	2013	2014	2015
Without CIVITAS	172.455,35	165.993,87	174.094,19	154.421,70	154.726,03	170.847,79	174.264,76	177.750,05	181.305,06
With CIVITAS								132.792,94	135.448,80
Without CIVITAS - Atypical year									
With CIVITAS - Atypical year						115.192,53	117.802,71		

ANNEX 4 Emission Factors

Table 4-18: Bulk emission factors (g/kg fuel) for Portugal, year 2005.

Category	Portugal					
	CO	NO_x	NMVOC	CH_4	PM	CO_2 [kg/kg fuel]
Gasoline PC	61.56	9.18	8.50	0.71	0.03	3.18
Diesel PC	3.20	11.28	0.57	0.04	0.72	3.14
Gasoline LDV						
Diesel LDV	9.39	17.91	1.72	0.11	2.05	3.14
Diesel HDV	7.14	34.09	1.14	0.24	1.04	3.14
Buses	11.88	40.75	4.18	0.31	1.85	3.14
Mopeds	403.89	3.62	360.25	6.55	6.32	3.18
Motorcycles	590.71	5.89	128.94	4.57	2.80	3.18

ANNEX 5 Cost-Benefit Analysis Data

The next table shows the values obtained for travel time savings:

Year: 2002	Time savings (€/h)
Work related trips (Bus, Portugal)	15,52
Non-work related trips (Bus, Portugal)	4,81

Source: HEATCO Project. Deliverable D5 Proposal for Harmonised Guidelines (2006) (URL: http://heatco.ier.uni-stuttgart.de/), taken from J. Piao and J. Preston, CBA Recommendations for CIVITAS Evaluation, Transportation Research Group, Southampton University, UK

The following table shows the evolution of inflation rates from 2002-2027:

Year	2002	2003	2004	2005	2006	2007
Inflation Rate (%)	3,6%	3,3%	2,4%	2,3%	3,1%	2,5%

Source: Bank of Portugal, National institute of Statistics

Year	2008	2009	2010	2011	2012	2013
Inflation Rate (%)	2,6%	-0,8%	1,4%	3,8%	3,0%	1,0%

Source: Bank of Portugal, National institute of Statistics

2012 - 2013Government and Bank of Portugal Previsions

Year	2013-2027
Inflation Rate (%)	1,5%

Analysis Prevision

The following table shows the estimated values of travel time savings:

Year: 2012	Time savings (€/h)
Work related trips (Bus, Portugal)	19,56
Non-work related trips (Bus, Portugal)	6,06
AVERAGE	**12,29**

The estimation of these values is based on the values of travel time savings obtained from POINTER and on the evolution of inflation rates from 2002-2012.

The projection for the period 2012-2027 was adjusted by the expected inflation rate.

Year	**Total Passengers**	**Pre-bought tickets (magnetic)**	**Time Savings (hour)**	**Inflation**	**Time Savings (€/hour) - inflation adjusted**	**Time Savings (€) - inflation adjusted**
2012	26.942.731	6.412.370	2.316	3,0%	12,29	**28.458**
2013	27.265.158	6.489.108	2.343	1,0%	12,41	**29.087**
2014	27.402.977	6.521.909	2.355	1,5%	12,54	**29.526**
2015	27.451.561	6.533.472	2.359	1,5%	12,73	**30.022**
2016	27.306.707	6.498.996	2.347	1,5%	12,92	**30.312**
2017	27.256.675	6.487.089	2.343	1,5%	13,11	**30.710**
2018	27.299.703	6.497.329	2.346	1,5%	13,31	**31.220**
2019	27.237.795	6.482.595	2.341	1,5%	13,51	**31.617**
2020	27.084.716	6.446.162	2.328	1,5%	13,71	**31.910**
2021	27.102.402	6.450.372	2.329	1,5%	13,91	**32.410**
2022	27.087.992	6.446.942	2.328	1,5%	14,12	**32.879**
2023	27.256.979	6.487.161	2.343	1,5%	14,33	**33.580**
2024	27.333.929	6.505.475	2.349	1,5%	14,55	**34.180**
2025	27.362.679	6.512.318	2.352	1,5%	14,77	**34.729**
2026	27.286.661	6.494.225	2.345	1,5%	14,99	**35.152**
2027	27.256.901	6.487.143	2.343	1,5%	15,21	**35.641**

The next table shows the age of SMTUC passengers:

Age (%)	2009	2010	2011	2012
<18	12,6	12,5	6,1	9,9
19-25	28,3	32,4	41,2	35
26-45	23,9	19,6	23,6	17,6
46-55	15,2	13,5	15,2	15,1
56-65	13,2	10,3	7,9	13,2
>62	6,8	11,7	6	9,2

Source: SMTUC – Customer satisfaction Surveys (2009-2012)

The following table shows the motive of the trips of SMTUC passengers

Motive (%)	2009	2010	2011	2012
Home-Work/School	66,8	63,9	70,2	59,5
Shopping/Leisure	29,6	31,4	25,5	35,4
Work trip	3,6	4,7	4,3	5,1

Source: SMTUC – Customer satisfaction Surveys (2009-2012)

The following table shows the percentage of work related trips and non-work related trips among SMUTC passengers:

Motive (%)	2009	2010	2011	2012	**Average**
Work related trips	47,8	45,1	48,5	48,5	**46,1**
Non-work related trips	52,2	54,9	51,5	51,5	**53,9**

The assumption in this table is that Home-Work/School trips among passengers <18 are 100% Non-work related trips, that Home-Work/School trips among passengers 19-25 are 75% Non-work related trips and that Home-Work/School performed by each age group is proportional to the percentage of SMTUC passengers belonging to that group.

The next table shows the values obtained for emissions savings:

Year	Inflation Rate	NOx (€/ton.)	HC (€/ton.)	CO2(€/ton.)	PM (€/ton.)
2000	-	1,3	500,0	-	33,5
2001	4,40%	1,4	522,0	-	35,0
2002	3,6%	1,4	540,9	-	36,2
2003	3,3%	1,5	558,7	-	37,4
2004	2,4%	1,5	571,9	-	38,3
2005	2,3%	1,5	584,9	-	39,2
2006	3,1%	1,6	603,0	-	40,4
2007	2,5%	1,6	617,8	-	41,4
2008	2,6%	1,6	633,8	-	42,5
2009	-0,8%	1,6	628,7	-	42,1
2010	1,4%	1,7	637,5	25,0	42,7
2011	3,8%	1,7	661,8	26,0	44,3
2012	3,0%	1,8	681,6	26,7	45,7
2013	1,0%	1,8	688,4	27,0	46,1
2014	1,5%	1,8	698,8	27,4	46,8
2015	1,5%	1,8	709,2	27,8	47,5
2016	1,5%	1,9	719,9	28,2	48,2
2017	1,5%	1,9	730,7	28,7	49,0
2018	1,5%	1,9	741,6	29,1	49,7
2019	1,5%	2,0	752,8	29,5	50,4
2020	1,5%	2,0	764,0	30,0	51,2
2021	1,5%	2,0	775,5	30,4	52,0
2022	1,5%	2,0	787,1	30,9	52,7
2023	1,5%	2,1	798,9	31,3	53,5
2024	1,5%	2,1	810,9	31,8	54,3
2025	1,5%	2,1	823,1	32,3	55,1
2026	1,5%	2,2	835,4	32,8	56,0
2027	1,5%	2,2	848,0	33,3	56,8

Source:

INE - National Statistic Institute

BP - Bank of Portugal

Source: CBA Guideline for CIVITAS Plus Evaluation (Draft 1.0), Transportation Research Group (TRG), School of Civil Engineering and the Environment, University of Southampton, UKIMPACT 2008, pg 13

The estimation of these values is based on the energy savings (MJ) and the bulk emissions factor (Annex 4). These energy savings per mode of transports is converted in g of pollutant by the density and the gross calorific factor of the fuel, weighted by the percentage of the fuel consumption in Portugal (annex 1). With these conversion is possible to have the emission factor per pollutant in g/MJ.

Emissions	CO	NOx	HC	CO2	PT
Diesel Buses (g/kgfuel)	11,88	40,75	4,18	3140	1,85
Diesel Passenger Car (g/kgfuel)	3,2	11,28	0,57	3140	0,72
Gasoline Passenger Car (g/kgfuel)	61,56	9,18	8,5	3180	0,03
Diesel Buses (g/MJ)	**0,277**	**0,949**	**0,097**	**73,115**	**0,043**
Diesel Passenger Car (g/MJ)	0,075	0,263	0,013	73,115	0,017
Gasoline Passenger Car (g/MJ)	1,430	0,213	0,197	73,867	0,001
Private Car - *weighted*	**0,370**	**0,251**	**0,053**	**72,928**	**0,013**

The total emissions per pollutant are:

- **BAU**

Energy Consumption	**BAU**
Energy Consumption (MJ) Private Car	**3.817.173**
Energy Consumption (MJ) PT	**8.340.027**
Passengers.km	**9.099.061**

	CO	**NOx**	**HC**	**CO2**	**PT**
Emissions Private Car (g)	1.413.501	956.570	204.019	278.379.028	50.287
Emissions PT (g)	2.307.066	7.913.548	811.746	609.780.151	359.265
TOTAL	**3.720.567**	**8.870.118**	**1.015.764**	**888.159.179**	**409.553**
TOTAL (ton.)	**3,72**	**8,87**	**1,02**	**888,16**	**0,41**

- **EX POST**

Energy Consumption	**EX POST**
Energy Consumption (MJ) PT	**10.047.416**
Passengers.km	**9.099.061**

	CO	**NOx**	**HC**	**CO2**	**PT**
Emissions Private Car (g)					
Emissions PT (g)	2.779.374	9.533.628	977.928	734.615.722	432.815
TOTAL	**2.779.374**	**9.533.628**	**977.928**	**734.615.722**	**432.815**
TOTAL (ton.)	**2,78**	**9,53**	**0,98**	**734,62**	**0,43**

The overall monetisation for emissions savings are shown in the next table.

Year	BAU CASE (A) -€				CIVITAS CASE (B) - €				BENEFIT (A-B) - €			
	NOx	HC	CO2	PT	NOx	HC	CO2	PT	NOx	HC	CO2	PT
2012	15,72	692,36	23.739,16	18,70	16,90	666,57	19.635,18	19,77	-1,18	25,79	4.103,99	-1,06
2013	15,88	699,28	23.976,55	18,89	17,06	673,23	19.831,53	19,96	-1,19	26,05	4.145,03	-1,07
2014	16,11	709,77	24.336,20	19,17	17,32	683,33	20.129,00	20,26	-1,21	26,44	4.207,20	-1,09
2015	16,36	720,42	24.701,25	19,46	17,58	693,58	20.430,94	20,57	-1,22	26,83	4.270,31	-1,11
2016	16,60	731,22	25.071,76	19,75	17,84	703,99	20.737,40	20,88	-1,24	27,24	4.334,36	-1,12
2017	16,85	742,19	25.447,84	20,05	18,11	714,55	21.048,46	21,19	-1,26	27,65	4.399,38	-1,14
2018	17,10	753,32	25.829,56	20,35	18,38	725,26	21.364,19	21,51	-1,28	28,06	4.465,37	-1,16
2019	17,36	764,62	26.217,00	20,66	18,66	736,14	21.684,65	21,83	-1,30	28,48	4.532,35	-1,17
2020	17,62	776,09	26.610,26	20,97	18,94	747,18	22.009,92	22,16	-1,32	28,91	4.600,34	-1,19
2021	17,89	787,73	27.009,41	21,28	19,22	758,39	22.340,07	22,49	-1,34	29,34	4.669,34	-1,21
2022	18,15	799,55	27.414,55	21,60	19,51	769,77	22.675,17	22,83	-1,36	29,78	4.739,38	-1,23
2023	18,43	811,54	27.825,77	21,92	19,80	781,31	23.015,30	23,17	-1,38	30,23	4.810,47	-1,25
2024	18,70	823,72	28.243,16	22,25	20,10	793,03	23.360,53	23,52	-1,40	30,68	4.882,63	-1,26
2025	18,98	836,07	28.666,80	22,59	20,40	804,93	23.710,94	23,87	-1,42	31,14	4.955,87	-1,28
2026	19,27	848,61	29.096,81	22,92	20,71	817,00	24.066,60	24,23	-1,44	31,61	5.030,21	-1,30
2027	19,56	861,34	29.533,26	23,27	21,02	829,26	24.427,60	24,59	-1,46	32,08	5.105,66	-1,32

ANNEX 6 Structure and questions of the Survey

SECTION A: PERSONAL DATA

Main residence

A1 **Postcode** ☐☐☐ ☐☐☐☐

Place _____
Parish _____
District _____

A2 **Sex**

(1) Male ☐
(2) Female ☐

A3 **Age**

(1) Less than 25 ☐
(2) 25 – 34 ☐
(3) 35 – 44 ☐
(4) 45 – 55 ☐
(5) Over 55 ☐

SECTION B: DAILY TRAVEL

B1 **Usually how many trips you make daily?**

Nº of trips ☐

B2 **Did you made any transfer on this trip?**

Indicate the number transfer made ☐

B3 **Until the end of last year did you usually travelled in SMTUC public transportation?**

(1) Yes ☐
(2) No ☐

B4 **If you answered No, please indicate how normally you travelled by that date?**

(1) Car driver ☐
(2) Passenger car ☐
(3) Bike ☐
(4) Walking ☐
(5) Taxi ☐
(6) Bus ☐
(7) Train ☐
(8) Motorcycle ☐
(9) Other (specify) _____

B5 **If you have changed your mode of travel, the new ticketing system (tickets or bus pass) had an influence on your decision making?**

(1) Yes ☐
(2) No ☐

B6 **What is your level of satisfaction with the ticketing systems? (1 - Very Dissatisfied 2 - Dissatisfied; 3- Satisfied; 4 - Very Satisfied)**

Satisfaction	1	2	3	4
New system?				
Old system?				

This survey has been carried out in September 2012 and has been used for the assessment of the modal shift for the ex-post results, as well as the Baseline and Business as Usual scenarios through specific questions (B3, B4 and B5). The survey has been also used for the assessment of the Acceptance level (Question B6).

The survey was carried out to customers by face to face interviews on board of the SMTUC buses.

The sample was drowned on the basis of the lines used by the passengers, i.e., the number of interviews chosen in each line is defined according to the demand of the line relative to the overall SMTUC demand.

The dimension of the sample was defined according to the specifications of the quality management auditors which supervise the all process in line with the ISO 9001 standard.

The quality management auditors considered 500 interviews as (a minimum) suitable to assess quality evaluation by PT passengers in Coimbra. However, SMTUC volunteered to go above this number

From the total universe of passengers, 775 surveys, adjusted proportionately to the various lines that make up the network of public transport (PT) in Coimbra were carried out of which 750 were validated.

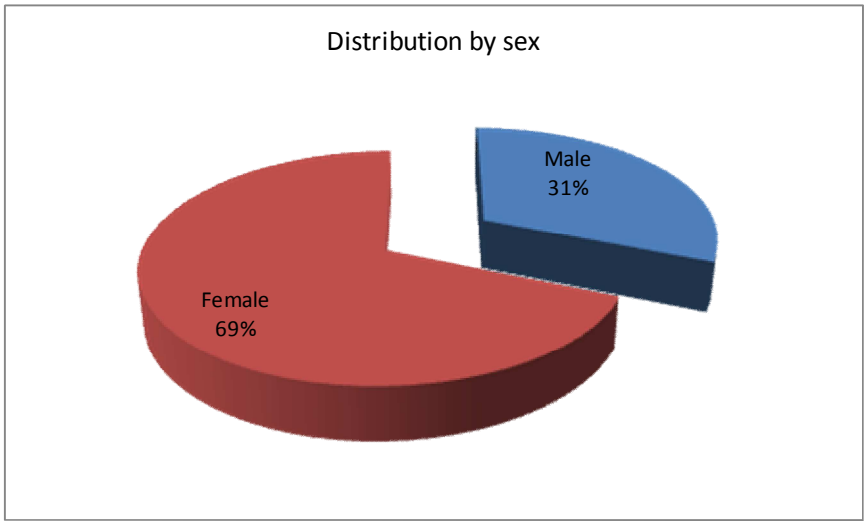
This sample is considered significant compared to the universe of users of public transport, was based on the Assessment Survey of Customer Satisfaction - Users of Liner for the year 2012, focusing on a sample universe of 750 surveys.

The survey was divided into two sections, the first relating to the identification of the respondent's personal data, including the main residence, sex and age.

The second part, aimed at determining the commuting of respondents, the number of daily trips and transfer. Similarly, this second part sought to evaluate the change in mode of transport registered, as well as the shifting of the universe of respondents who made this change.

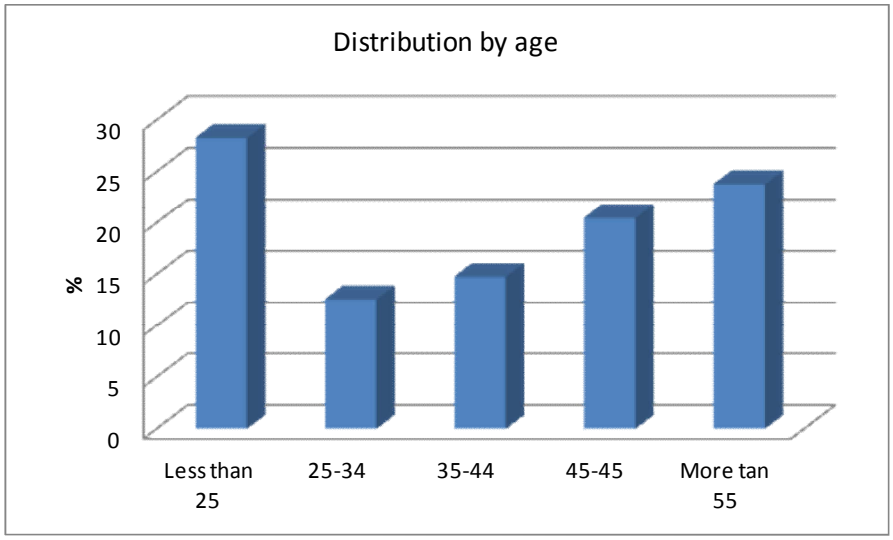
Finally, sought to determine the degree of satisfaction of the new ticketing system implemented in 2012, as well as the old system was replaced.

For the analysis investigations conducted, the responses highlight a universe of respondents that are spread over about 68% female and 31% male.



With respect to the distribution of respondents by age, they are divided with particular for younger step (less than 25) and which corresponds mostly to the age population school.

Moreover, the weight of the population over 55 years, although at a lower expression level than younger also proves decisive in the universe consulted. In other distributions, it is evident that the weight older ages (45-55) have the universe of passengers, to the detriment of younger ages (25-34) showing a trend in the use of TP on the part of the population aged more advanced.



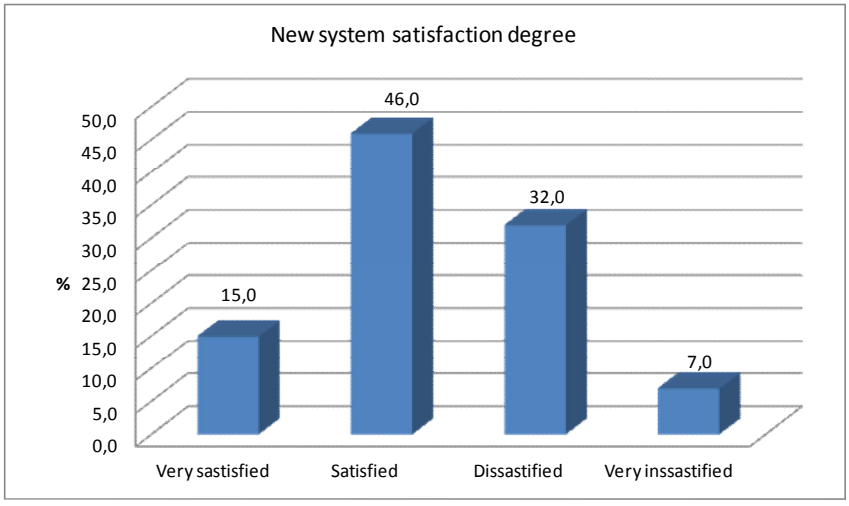
Concerning the mode of travel used this period as well as the influence of the new ticketing system, implemented in 2012, as a determining factor in this change, from the total number of responses (736), about 91% of respondents revealed not have changed their mode of travel, which means they were already regular users of public transport, over the previous year.

The remaining 9.1% answered affirmatively to the question, indicating that there was a change in their usual mode of travel, that is, began to use the TP in the previous year.

Regarding the influence of the new ticketing system as a key factor in changing the mode of travel 13.4% revealed that this was the reason that led to the transfer of individuals to TP , which corresponds to 1.2% of the total 736 respondents in this survey.

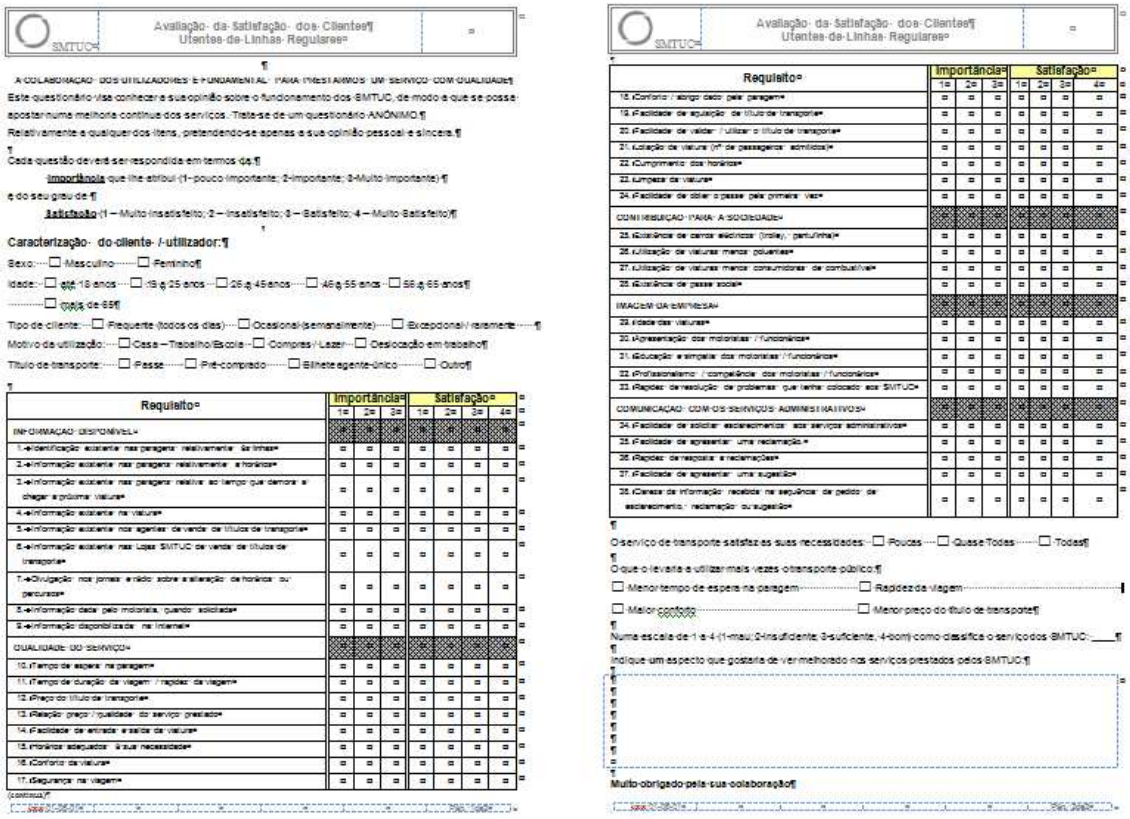
This result proves the modernity factor of this system, coupled with its functionality, as key factor in the decision of the respondents.

The evaluation of the degree of satisfaction of respondents on the new ticketing system as well as the old system replaced, revealed that regarding the new system, 15% reported being very satisfied and about 46% consider it satisfactory. Furthermore, a significant percentage (32%) showed dissatisfaction with this system and indicated a 7% high dissatisfaction.



The responses regarding the degree of satisfaction of ancient ticketing system revealed high satisfaction rates, particularly for individuals 47% very satisfied and 49% of respondents satisfied. The values for degrees of dissatisfaction are low and not even reach 5% in both cases.

ANNEX 7 Quality PT Service – Custom Satisfation Survey



Avaliação da Satisfação dos Clientes
Utentes de Linhas Regulares

A COLABORAÇÃO DOS UTILIZADORES É FUNDAMENTAL PARA PRESTARMOS UM SERVIÇO COM QUALIDADE

Este questionário visa conhecer a sua opinião sobre o funcionamento dos SMTUC, de modo a que se possa apostar numa melhoria contínua dos serviços. Trata-se de um questionário ANÓNIMO.

Relativamente a qualquer dos itens, pretendendo-se apenas a sua opinião pessoal e sincera.

Cada questão deverá ser respondida em termos da:

Importância que lhe atribui (1- pouco importante; 2-importante; 3-Muito importante) e do seu grau de

Satisfação (1 – Muito insatisfeito; 2 – Insatisfeito; 3 – Satisfeito; 4 – Muito Satisfeito)

Caracterização do cliente / utilizador:

Sexo: ☐ Masculino ☐ Feminino

Idade: ☐ até 18 anos ☐ 19 a 25 anos ☐ 26 a 45 anos ☐ 46 a 55 anos ☐ 56 a 65 anos ☐ mais de 65

Tipo de cliente: ☐ Frequente (todos os dias) ☐ Ocasional (semanalmente) ☐ Excepcional / raramente

Motivo de utilização: ☐ Casa – Trabalho/Escola ☐ Compras / Lazer ☐ Deslocação em trabalho

Título de transporte: ☐ Passe ☐ Pré-comprado ☐ Bilhete a gente único ☐ Outro

Requisito	Importância			Satisfação			
	1	2	3	1	2	3	4
INFORMAÇÃO DISPONÍVEL							
1 - Identificação existente nas paragens relativamente às linhas							
2 - Informação existente nas paragens relativamente a horários							
3 - Informação existente nas paragens relativa ao tempo que demora a chegar a próxima viatura							
4 - Informação existente na viatura							
5 - Informação existente nos agentes de venda de títulos de transporte							
6 - Informação existente nas Lojas SMTUC de venda de títulos de transporte							
7 - Divulgação nos jornais e rádio sobre a alteração de horários ou percursos							
8 - Informação dada pelo motorista, quando solicitada							
9 - Informação disponibilizada na Internet							
QUALIDADE DO SERVIÇO							
10. Tempo de espera na paragem							
11. Tempo de duração da viagem / rapidez da viagem							
12. Preço do título de transporte							
13. Relação preço / qualidade do serviço prestado							
14. Facilidade de entrada e saída da viatura							
15. Horários adequados à sua necessidade							
16. Conforto da viatura							
17. Segurança na viagem							

(continua)

Avaliação da Satisfação dos Clientes
Utentes de Linhas Regulares

Requisito	Importância			Satisfação			
	1	2	3	1	2	3	4
18. Conforto / abrigo dado pela paragem							
19. Facilidade de aquisição do título de transporte							
20. Facilidade de validar / utilizar o título de transporte							
21. Lotação da viatura (nº de passageiros admitidos)							
22. Cumprimento dos horários							
23. Limpeza da viatura							
24. Facilidade de obter o passe pela primeira vez							
COMUNICAÇÃO PARA A SOCIEDADE							
25. Existência de carros eléctricos (trolley), pantufinha							
26. Utilização de viaturas menos poluentes							
27. Utilização de viaturas menos consumidoras de combustível							
28. Existência de passe social							
IMAGEM DA EMPRESA							
29. Idade das viaturas							
30. Apresentação dos motoristas / funcionários							
31. Educação e simpatia dos motoristas / funcionários							
32. Profissionalismo / competência dos motoristas / funcionários							
33. Rapidez de resolução de problemas que tenha colocado aos SMTUC							
COMUNICAÇÃO COM OS SERVIÇOS ADMINISTRATIVOS							
34. Facilidade de solicitar esclarecimentos aos serviços administrativos							
35. Facilidade de apresentar uma reclamação							
36. Rapidez de resposta a reclamações							
37. Facilidade de apresentar uma sugestão							
38. Clareza da informação recebida na sequência de pedido de esclarecimento, reclamação ou sugestão							

O serviço de transporte satisfaz as suas necessidades: ☐ Poucas ☐ Quase Todas ☐ Todas

O que o levaria a utilizar mais vezes o transporte público:

☐ Menor tempo de espera na paragem ☐ Rapidez da viagem

☐ Maior conforto ☐ Menor preço do título de transporte

Numa escala de 1 a 4 (1-mau; 2-Insuficiente; 3-suficiente, 4-bom) como classifica o serviço dos SMTUC: ____

Indique um aspecto que gostaria de ver melhorado nos serviços prestados pelos SMTUC:

Muito obrigado pela sua colaboração

Quality of service is measured by means of customer satisfaction survey periodically carried out by SMTUC:

The survey is repeated 1 time a year and is carried out to customers on face to face interviews on board of the SMTUC busses.

The sample is drowned on the basis of the lines used by the passengers, i.e., the number of interviwees choosen in each line is defined according to the demand of the line relative to the overall SMTUC demand.

The dimension of the sample is defined according to the specifications of the quality management auditors which supervise the all process in line with the ISO9001 standard.

The quality management auditors considered 500 interviews as (a minimum) suitable to assess quality evaluation by PT passengers in Coimbra. However, SMTUC voluntered to go above this number.

The questionnaire starts with 4 questions related to the interviewee – Sex, Age (<18, 19-25, 26-45, 56-65, >65),type of client (frequent, occasional, exceptional/rare use), motive of the trip (home-work/school, shopping/leisure, in service), type of ticket (pass, single ticket bought on the selling point, single ticket bought on the vehicle, other).

The main part of the questionnaire is composed of 38 specific questions related to various items related to 5 areas of the service (1-Available information, 2-Quality of service, 3-Contribution to society, 4-Image of the company, 5-Communication with the administrative services) and a specific

global customer satisfaction question that resume quality of service. In each question the people interviewed express a judgement choosing between very satisfied – satisfied – unsatisfied – very unsatisfied and about the importance of each of the 38 items choosing between very important – important – low importance.

Each question is assessed in terms of importance given (1-Not important, 2-Important, 3-Very Important) and level of satisfaction (1-Very Dissatisfied 2-Dissatisfied 3-Satisfied 4-Very Satisfied) of the user in relation to the respective item.

The next table shows the translation of the questionaires – some questions changed between questionaires, but the questions used in this measure has been maintained during all the years, only changing the order in the questionaire (questions 19 and 20 in this questionaire):

AVAILABLE INFORMATION
1. Identification of existing lines at stops
2. Information at stops about timetables
3. Information at stops about the waiting time until the next vehicle
4. Information inside the vehicle
5. Information at ticket selling points
6. Information at SMTUC ticket selling shops
7. Disclosure of information in the newspapers and radio about timetable or routes changing[3]
8. Information given by the driver, upon request
9. Information available on the Internet
QUALITY OF SERVICE
10. Waiting time at stop
11. Trip duration / speed of travel
12. Price of the ticket
13. Relation Price / Quality of the service
14. Ease of entry and exit of the vehicle
15. Adjustment of the timetable to your needs
16. Comfort of the vehicle
17. Safety during the trip
18. Comfort / protection given by the stop shelter
19. Ease of ticket purchase

[3] This question was eliminated on the 2010, 2011 and 2012 surveys.

20. Ease of ticket validation / utilization
21. Capacity of the vehicle (nr. of passengers allowed)
22. Compliance with the timetable
23. Cleanliness of the vehicle
24. Facility in obtaining the travelcard for the first time
CONTRIBUTION TO SOCIETY
25. Existence of electric vehicles (trolleybuses, electric mini-buses)
26. Utilization of less polluting vehicles
27. Utilization of less fuel consumming vehicles
28. Existence of social travelcard
IMAGE OF THE COMPANY
29. Age of the vehicles
30. Presentation of drivers / staff
31. Education and friendliness of the drivers / staff
32. Quality of driving performance of SMTUC drivers
33. Professionalism / competence of the drivers / staff
34. Quickness in the resolution of problems you may have submited to SMTUC
COMMUNICATION WITH THE ADMINISTRATIVE SERVICES
35. Facility in requesting clarifications to the administrative services
36. Facility in submmiting a complaint.
37. Response quickness in respect to complaints
38. Facility in presenting a suggestion
39. Clarity of the information obtained in response to a request for information, complaint or suggestion

The questionnaire concludes with 5 questions related to the respondent's general attitude towards the service supplied by SMTUC:

1. The transportation service meets your needs (1-Few, 2-Nearly all, 3-All)

2. What would make you consider using public transportation more often (1-Shorter waiting time at stops, 2-Higher speeds, 3-Increased comfort, 4-Lower price of the ticket)

3. How do you rate the SMTUC service on a scale of 1 to 4 (1-bad, 2-poor, 3-sufficient, 4-good)

4. Indicate a point you would like to see improved in the SMTUC service:

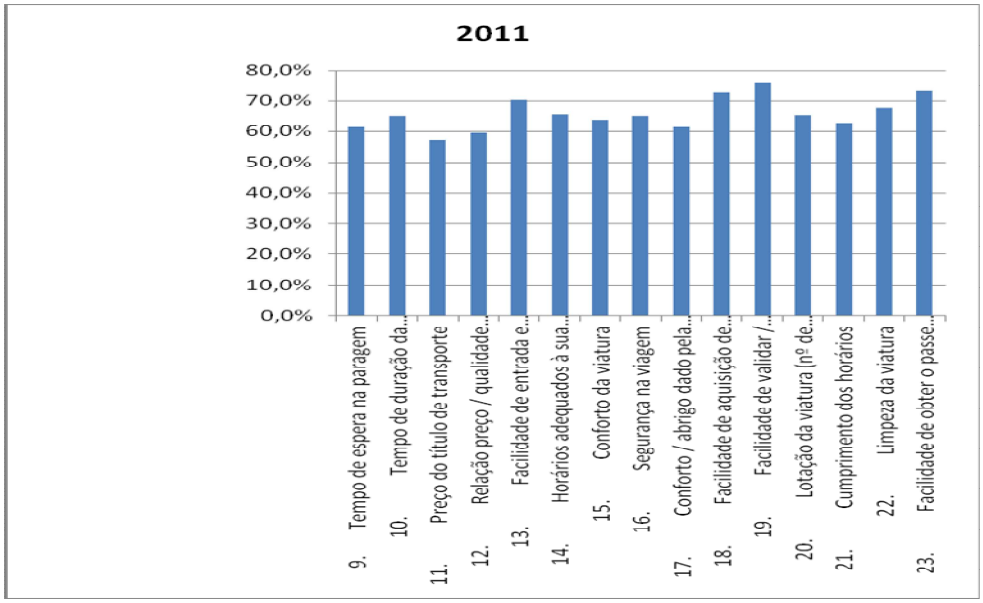
So the two questions that were considered in this measure were:

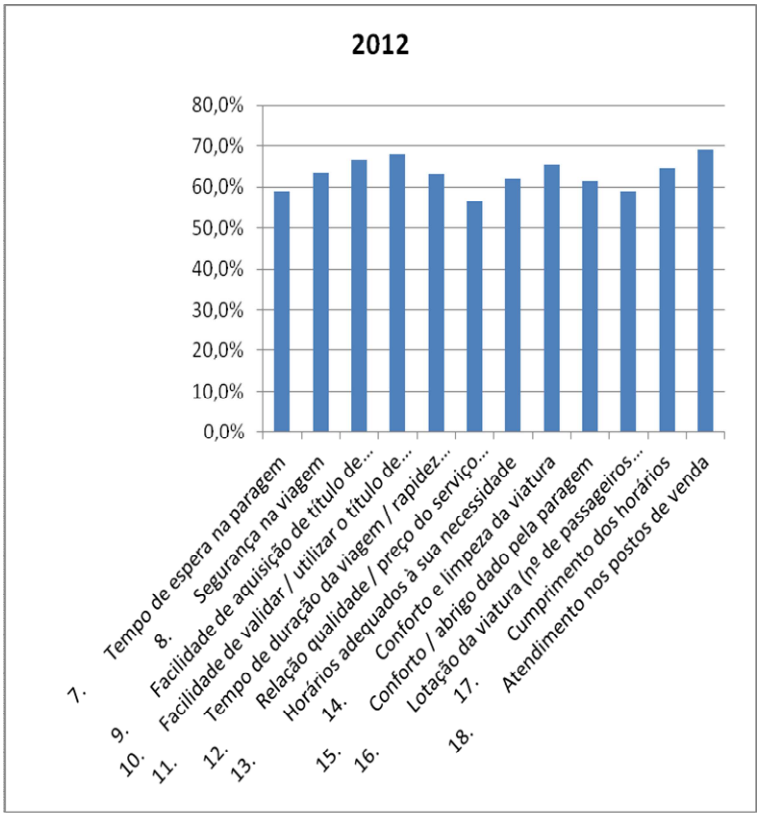
- Ease of ticket purchase

- Ease of ticket validation / utilization

The next graphs show the results of the impo

Importance given to the Quality of Service (Questions 19 and 23 in 2011 and 9 and 10 in 2012)





Level of satisfaction in relation to the Quality of Service (Questions 19 and 23 in 2011 and 9 and 10 in 2012 – red-satisfied or very satisfied / blue-unsatisfied of very unsatisfied)

2011