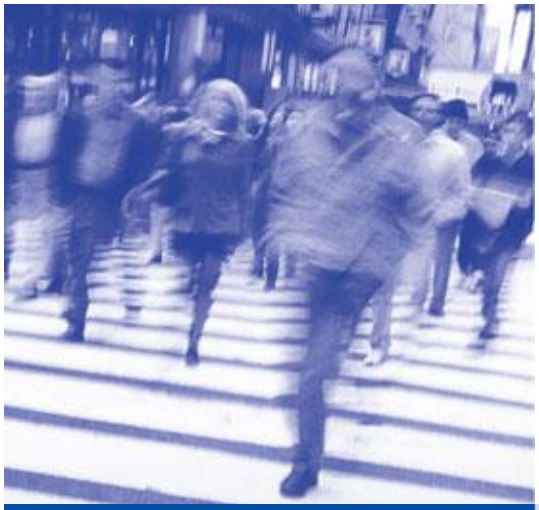

2020 CiViTAS
Cleaner and better transport in cities

DESTINATIONS

Measure Evaluation Result

MAD 7.3 - Smart PT traveller information service and

MAD 7.4 - Public Transport Smart Multi-task Ticketing System, in open standards

Project Acronym:	DESTINATIONS
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THE CIVITAS INITIATIVE
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Executive Summary

Intelligent transport systems are one of the main ways smart cities are improving the daily lives of citizens, also promoting the efficiency and sustainability of their systems. Before the DESTINATIONS project, Horários do Funchal (HF), the main regional public transport operator, contended with very limited and obsolete operational systems which had frequent technical failures.

Under such circumstances, this measure had decisive technological importance, as the main goal was to improve the operation through integrated and innovative software solutions, more efficient equipment, testing advanced information systems, and a ticketing and fleet control system, with special attention to impaired users. To achieve this, HF installed an innovative solution that integrated the AVL (Automatic vehicle location) and ticketing system, and a GIST System, dedicated to scheduling optimization software for public transportation, into one single piece of equipment. Focused on providing an inclusive service for all passengers, HF subcontracted a solution to test an integrated system to support disabled passengers to safely board the bus, providing them with all the necessary information to use the public transport (PT) network. Following this, HF acquired 5 new, autonomous photovoltaic information panels, equipped with card reading and a speaker to facilitate the reading of information by people with disabilities. To reinforce the sales network, 3 vending machines with PT products and information were installed at strategic locations.

This measure did not have a complete evaluation due to the non-implementation of some actions. However, the results achieved with the ticketing and AVL integrated solution are very positive. From one side, the solution allowed for greater fleet availability, by not having the vehicles immobilized for technical repairs, easing the maintenance and exploitation sector, and, on the other hand, given the new and more efficient software the failures are less critical, requiring reduced time to solve the problems from a reduced number of failures. This implementation also represented advantages for the bus drivers by easing the onboarding operation with just one piece of equipment to manage. Overall, the solution achieved a more efficient operation and introduced more attractive and user-friendly systems.

The sense of urgency to proceed with a new ticketing solution was the most relevant driver. In addition, the necessity to keep pace with an increasing technological market full of possibilities and innovative updates was vital in order to invest in integrated mobility and more efficient solutions. The social inclusion factor promoted the advance of the implementation once there was social pressure to provide inclusive services for customers with all kinds of physical limitations.

On the other side, HF struggled with several barriers that hampered the successful implementation of the foreseen actions. Legally, the international inter-urban tender process represented significant uncertainty for all transport operators, once there was a possibility of integration between all transport operators, which postponed several activities of the measure. The available suppliers encountered problems at several levels, from integration barriers with the existing ticketing system to the limited hardware options available. The implementation of the website and mobile application were postponed several times due to delays with the full ticketing system implementation. These activities were connected to each other and a constraint in one therefore affected the other.

Finally, the COVID-19 situation had a major impact on the implementations that were suspended, as by a central order of the Regional Government on 02 of April 2020 declared that all new investments in the public sector should be approved first by the government, including what was in the investment plan.

The complicated process that HF had to go through to develop and implement this measure resulted in an important learning opportunity. It allowed for the preparation of more careful and demanding tender processes for the complete ticketing system, as the entire process allowed for scrupulously defining the technical requirements so as to be more demanding with the solution.

Following the work developed under MAD 7.3 and MAD 7.4, HF accomplished the acquisition of the integrated ticketing system, under the SIB-RAM project, approved in December 2019 and co-financed by ERDF (European Regional Development Fund). The SIB-RAM project gives continuity of the requirements defined under measure MAD 7.4 and the pilot test performed with the integrated console with the ticketing and AVL systems. The new project will provide HF with more accessible means of payment, without the need to move to physical sales kiosks. A regional ticketing standard will be created, which can integrate all operators in the region. The ticketing system will make it possible to benefit from territorial continuity, given that it will be possible to use one single card (GIRO) in another national operator. The system will allow multiservice, with customers being able to use public transport and other regional services.

A Description

Intelligent transport systems drive innovation in public transport, providing operational advantages for all involved, especially the passengers. Before DESTINATIONS, HF operational systems had several limitations related to the obsolete systems and to the frequent technical system failures, so there was constant pressure on systems to go ahead with improvements to repair the systems somehow. These measures have a technological importance to HF, as the core of these measures is to improve the operation through integrated solutions that compromise innovative equipment and software solutions, through demonstration of advanced information systems, ticketing, and fleet control system, with special attention paid to impaired users.

In September 2018, HF initiated an innovative pilot test in 15 buses that integrated the AVL (Automatic vehicle location) and ticketing system into one single piece of equipment. The solution allowed the simplifying of the on-board operation, as it brought more reliable real-time information to the customers, and for planning and monitoring purposes. Given the results from the pilot test, HF decided to extend this from 15 buses to 57 buses.

In December 2017, HF acquired the GIST3 System, which is the base system where the operator configures the service and assigns the drivers and the buses, with a connection to the maintenance service. The software allowed for the reduction of integration failures between the previous systems (GIST, AVL, and ticketing), consequently reducing manual interventions to correct the failures.

Dedicated to providing an inclusive service for all passengers, HF included a set of innovative solutions to improve the information service, with particular attention to passengers with special needs. Firstly, this was achieved through an integrated system that supports passengers to safely board the bus (NextStop app), providing the necessary information to use the PT network through a set of systems, equipment, and mobile app, regardless of the limitation (blind or deaf). Complementarily, HF acquired 5 new photovoltaic information panels, that besides the modern design and the autonomous infrastructure, are equipped with mechanisms that facilitate the reading of information by people with disabilities, and have card reading facilities and a speaker incorporated.

Another relevant component of this measure was the reinforcement of the sales network at the main gateways of the Region, where HF installed 3 vending machines, that besides selling tickets, sells touristic products, as a mobility product.

The modernization of the PT management systems was essential to ensure a more efficient operation, designed to minimize the costs to the operator and to introduce a more attractive and user-friendly way to use public transport.

This measure had the cooperation of the local partners:

- ARDITI - Agência Regional para o Desenvolvimento da Investigação, Tecnologia e Inovação, contributing to the definition of the technical requirements.
- AREAM - Agência Regional da Energia e Ambiente da Região Autónoma da Madeira, CMF- Câmara Municipal do Funchal, and SRETC - Secretaria Regional da Economia Turismo e Cultura, participating in the meetings to define the idea concept and negotiate the best location for the equipment’s to be installed on the outside (Information panels and vending machines).

A1 Objectives and outputs

City policy level objectives

- Improve mobility information for all users
- Improvement of quality of life
- More attractive tourist destinations and PT satisfaction
- Increased cost effectiveness of transport services
- Enhance smart ticketing solutions

Specific measure objectives

- Deployment of intelligent transport systems in the public transport operator
- Improve public transport attractiveness and demand
- Test reliable new ticketing options
- Improve efficiency of the operational management systems
- Deployment of specific solutions for impaired users

Outputs

- Requirements for 1 new PT information website and app
- 1 scheduling optimization software for public transportation
- 5 new on-street photovoltaic information panels and 3 new public information monitors
- 3 PT vending machines
- 57 buses with integrated ticketing and AVL system
- 1 solution specially designed for mobility impaired users – mobile app – AppNextStop[1]

Supporting activities

During the preparation phase, an HF team visited the Guaguas partner, the PT operator in Las Palmas de Gran Canaria, to exchange requirements for ticketing systems and information systems.

A2 Inter-relationship with other measures

These measures are linked with other DESTINATIONS measures, as follows:

- **MAD 2.1** - Sustainable Regional Mobility Plan in touristic regions – The new Regional integrated mobility and tourism platform enabling all users, residents and tourists, to have a unique platform to check all tourism and mobility information, was developed together with the HFs new website and mobile app.
- **MAD 7.2** - Attractive Public Transport – The reorganization of the PT management system, enabled new customer-oriented products, such as redesigned timetables and better information at bus stops, making PT clearer, tourist friendly, and effective.
- **MAD 6.2** - Green credits: A Business Model for Mobility, Sustainability and Tourism – The plan to have a mobile app with the connection of the ticketing system and the green credit

[1] Extra-output with DESTINATIONS budget

scheme has a dependency on the ticketing system. During the project it was not possible to develop the complete solution for green credits, but a plan was defined for the green credit scheme to be launched when the new ticketing system is complete.

A3 Target groups and/or affected part of the city or region

The main target groups affected with the implementation of these measures are PT users in general, including residents and tourists, and the public transport of the urban service of Funchal, and the interurban service of HF (Curral das Freiras, Camacha, Santo da Serra and Santana), with special attention to mobility-impaired users.

A4 Stakeholder involvement

Stakeholder name	Activities description
ANAM – Airport of Madeira	ANAM was contacted to analyse the best place for a vending machine for PT tickets and information.
APRAM – Ports of Madeira	APRAM was contacted to analyse the best place for a vending machine for PT tickets and information.
Association of the disabled in Madeira island	The association was contacted to collect the needs of disabled people to access PT information, specifically blind people, so as to be supported in the pilot test.

Table 1: Stakeholder involvement

B Measure implementation

B1 Situation before CIVITAS

Before DESTINATIONS, HF PT management systems had several constraints related to the outdated systems, registering frequent technical failures.

HF faced operational constraints with the PT information systems. The company website and mobile app were outdated, not user-friendly, and with limited functionalities that needed such improvements, the best solution would be a brand-new development. The PT information panels installed showed serious limitations given the need to be connected to electricity, and technically, the panels were outdated, not allowing flexibility in the presentation of information and, in some cases, were presenting unformatted information. In addition, they were not adapted for people with disabilities.

The back office operational systems, for the AVL (Automatic vehicle location), GIST (support system for operational planning), and Ticketing Systems, also had limited functionalities, technical failures, and were obsolete. Besides being outdated, the HF Ticketing System was frequently registering critical crashing situations. The ticketing framework was composed of a

separate ticketing system and a fleet control system, with considerable operational disadvantages: more equipment on board, difficulties to make the integration between the two systems, low information regarding the geographic position of each entry, and complex maintenance processes. At an operational level, given that the buses are highly technological tools which can collect and manage enormous data sources (ticketing, AVL, etc), the on-board equipment became complex and there was the need to integrate tools and functions. Moreover, the collected data from customers had several problems.

The GIST system was seriously limited and had significant integration limitations with the AVL system. The importation of the bus driver shift plates from the GIST to the on-board consoles first implied integration for subsequent importing to the onboard ticketing console, which often generated failures (data integration problems) and had to be handled manually.

The physical HF sales network plays an important role in the sales structure of the PT operator, considering that 27,8% of tourists (Madeira statistics form 2016[2]) and 16,7% of the population (Madeira statistics from 2018) in Madeira are more than 65-years old, and considering that Madeira receives yearly around 1.700.000 tourists, mostly senior tourists, through the airport and port. Before DESTINATIONS, the sales network was limited, especially with regards to visitors.

B2 Innovative aspects

- **Targeting specific user groups -** The AppNextStop system is an entire solution dedicated to users with serious physical constraints that limit their use of public transport. The 6 new photovoltaic panels also target the impaired users, once it includes a Giro card (the ticket card and the monthly pass card) reading function and an option for audible sound, adapted for the deaf and blind.
- **New conceptual approach** - HF is the first public transport operator in the Region to test a solution focused on impaired users (AppNextStop). Also, the ticketing system implements a new conceptual approach by implementing a solution that integrates the fleet control system with the ticketing system, in one piece of equipment.
- **New physical infrastructure solutions** - The 6 new photovoltaic panels have an innovative physical infrastructure, with a modern design and autonomous infrastructure. Besides the innovative software component, the ticketing system includes new physical infrastructure, the onboard console, that integrates all the needed operational equipment. Also, the overall AppNextStop system bets on the use of new technology (RFID, antennas, etc.), also implementing new innovative physical infrastructure.
- **New method/solution** - The ticketing system provides new solution/method for the previous problem related to the existing onboard equipment, as it integrates the procedures.

B3 Technology development

HF defined the technical requirements for each system that was purchased and implemented during the project. To define the correct requirements, contact was established with many suppliers, and the advantages and disadvantages of each was weighed. Also, the interaction

[2] Regional Directorate of Statistics of Madeira

with GUAGUAS partner was important to orient the requirements definition process of the ticketing system and information panels.

Special attention was given to user-friendly technologies, to ensure easier processes in the back office and facilitate the interactions for the drivers.

When developing the tender process for these new systems, it was important to plan the management costs for the next years, guaranteeing lower costs than previous years.

Internally, the technological department was responsible for coordinating the new systems test, together with each area involved in the process (Exploitation, Commercial, Fleet management and Training areas).

B4 Actual implementation of the measure

The MAD 7.3 and MAD 7.4 measures are important technological measures for HF, as they allowed the PT operator to improve its operation through several fronts, implementing integrated solutions that are comprised of innovative equipment and software solutions:

Ticketing and the fleet control systems

HF started to analyse all the technical requirements needed for a new integrated ticketing system to overtake the actual limitations of the separate ticketing and fleet control system. In a medium public transport company, it is always difficult to make a technological transition such as this, considering the relevant financial and technical resources needed. For a company like HF, the main problem is how to find a complete solution. Trying to update the old ticketing system, however, turned out to be more expensive and not feasible compared to starting with a new system.

Figure 1: Training with the new ticketing and AVL equipment

Considering that the HF ticketing framework was composed by a separate ticketing system and fleet control system (AVL System), with considerable operational disadvantages, HF decided to proceed with tests with a more efficient solution, that integrated both systems.

In September 2018, HF initiated a pilot test that integrated the AVL and ticketing system in one single piece of equipment in 15 buses, allowing onboard ticket sales and fleet control system from just one piece of equipment/console. Such a system has a connection with the SAE system (Exploitation Support System), which synchronizes with the bus.

The integrated system simplifies the on-board ticketing operation as it facilitates the tickets sales process for drivers, especially to large groups. In the console, the driver can see the sequence of bus stops, making it easier to sell tickets in inter-urban services with different tariff zones.

The system also brings more reliable real-time information to customers, and for planning and monitoring purposes.

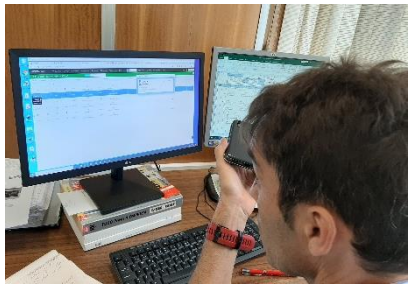

Figure 2: Testing and configuring the service information to use the new AVL system

In case of failure, the repair is performed separately from the bus, the console is removed and another is installed, resulting in no necessary immobilization of the bus.

Despite the tests initiated in September 2018 on 15 buses, the ticketing system was crashing and registering serious failures. On several situations, HF felt the need to proceed with improvements to repair the system somehow. The first step was to launch a tender to have access to the Application Programming Interface (API) of the ticketing system to develop new ticketing options, but this tender failed for legal reasons. Later, HF tried to acquire a new API, but in such case, all the ticketing related equipment needed to be replaced, with considerable costs. In January 2019, HF contacted the current ticketing supplier to adapt the actual system to the new needs (special tickets for students, free passes, new pay options), but the supplier asked for a new subcontract to analyse the possible solutions.

Given the constant constraints with the ticketing supplier and to launch the tender from one side, and the good results achieved under the pilot test in 15 buses, HF decided to extend the pilot developed under the 15 buses, to another 42 buses (to a total of 57 buses with the integrated system). In December 2020, complete training was provided to the bus drivers regarding the new equipment. Then, HF's exploitation department started to analyse and improve the system to better manage the daily public transport operation and service (delays, unscheduled trips, etc.), with the objective to facilitate the work on the control centre. Data collected was analysed to support public transport planning.

The tests performed with the Ticketing and the Fleet control systems showed crucial improvements from a technical perspective but also operationally for all involved sectors, including the bus drivers. Following such achievements, HF will upscale the solution and concluded the tender process to subcontract the entire ticketing and fleet control system. All the knowledge regarding the ticketing system requirements collected with the development of MAD 7.4 were used to implement an integrated ticketing system with the support of the ERDF.

GIST3 System - Scheduling optimization software for public transportation

A new scheduling optimisation software (GIST3) that produces new timetables, spider maps, and GTFS (General Transit Feed Specification) information was purchased and implemented in HF in December 2017. The solution required some configuration steps, through which, HF staff adjusted the PT information to prepare the timetables accordingly to the new image.

The GIST3 is the base system where the operator defines the physical network and service (bus stops, bus lines, timetables), and then assigns the drivers (taking into account factors such as holidays and hours worked) and the buses with a connection to the maintenance service. This makes it

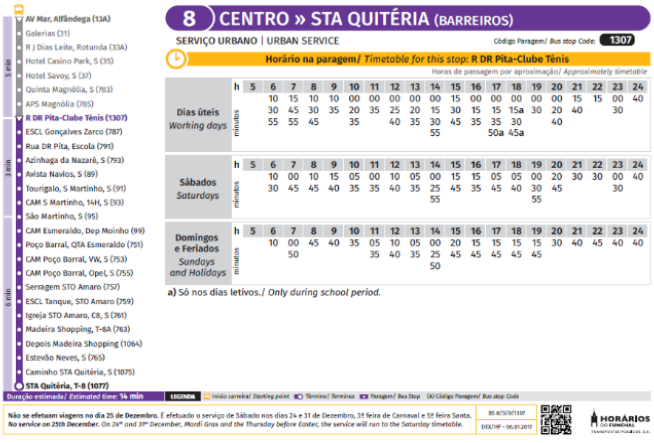
8 CENTRO » STA QUITÉRIA (BARREIROS)
SERVIÇO URBANO | URBAN SERVICE
Horário na paragem/ Timetable for this stop: R DR Pita-Clube Ténis
Dias úteis / Working days
Sábados / Saturdays
Domingos e Feriados / Sundays and Holidays
a) Só nos dias letivos./ Only during school period.

Figure 3: New timetable example

clear which bus is available. The new system has the possibility to be directly linked to the future ticketing system. It will also allow the current integration failures between the GIST, the intermediate system to support the exploitation and AVL, and the ticketing system to be reduced, and consequently, to reduce the manual interventions to correct these failures.

In December 2020, the exploitation department received specific training in this GIST3 System with the objective to plan more efficient networks. The data collected from the new ticketing and fleet control systems will be important information to plan a public transport network which is more efficient and accessible for passengers.

HF website and mobile app

HF analysed, in depth, all the technical requirements sought for the development of the website and the mobile app. However, the completion of the requirements and the launch of the awarding process was postponed several times for different reasons. From one side, due to the technical complexity of the foreseen solutions, and from the other side, due to the technical connection with the new ticketing system and the green credit scheme (MAD 6.2).

The integration with the other systems hampered the progress of the development throughout the project, and alternative solutions had to be considered. The local partners dedicated some time to research if it would be better to subcontract the green credit system together with the HF website and app or separately. Also, the constraints on the progress of the new ticketing system delayed the development of the website and mobile app. A delay in one system caused delays in the progress of the others.

In addition, the international inter-urban tender process represented significant uncertainty for all transport operators, once there was a possibility of integration between all transport operators, which also contributed to postponing the development of the website and mobile app.

In 2020, HF decided to proceed with a simpler solution and closed the requirements, leaving the integration requirements with the new ticketing system and the green credit scheme to be analysed in future developments, together with the new ticketing system (SIB-RAM project). In February 2021, HF and SRETC started working together with the supplier to develop the new HF website, mobile app, and the mobility and tourism platform (MAD 2.1). The development of the 3 solutions progressed well during the last months of DESTINATIONS (until May 2021), and will continue beyond the project, with the official launch of the solutions foreseen for September 2021.

NextStop Mobile App – solution for mobility impaired users

Over the years, HF have been implementing a set of initiatives to provide a more accessible service for all. Following the requests of users with special needs, in May 2020 HF initiated a pilot test under DESTINATIONS (as extra output) for a solution to provide disabled users with better information services. The NextStop is composed of two subsystems (at the bus stop and on board the bus) and a mobile app.

The passengers with special needs carry an RFID card, which is configured according to the type of disability. The RFID card number is used to login on the NextStop app and the card is used to validate the presence of the passenger at the bus stop and on board the bus.

For blind people, the solution is comprised of the mobile app NextStop, a Bluetooth headset, and remote control, to allow the passenger to hear the instructions and interact with the mobile app application. When configured for deaf users, the passengers can see all the necessary information on the mobile app, at the subsystem's panels on the bus stop, and on board the bus. The subsystems at the bus stops shows the time until the next bus and its destinations, as the subsystem on the bus provides real time information to the passengers regarding its location and next stops. The mobile app was developed for android and iPhone.

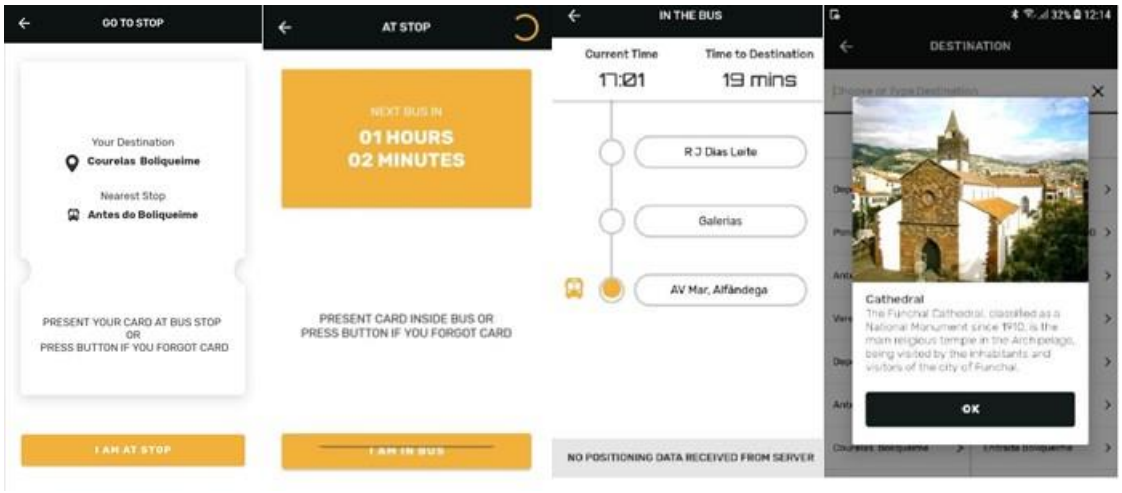

Figure 4: NextStop mobile app main screens

The NextStop application has an additional functionality, which is the touristic points of interest. When the passengers pass (walking, going to a bus stop, or inside the bus) a configured point of interest, the information about the place is displayed on the main screen. So, the mobile app can be also used by tourists, providing useful information for tourists.

5 Informative photovoltaic panels and 3 new public information monitors

After assessing the market for innovative information panels and studying the case of Guaguas, HF defined the main requirements for the information panels. During the research phase to define the requirements for this information equipment, the local team contacted the Guaguas partners. It was decided to acquire 5 new on-street photovoltaic information panels. The equipment is autonomous, provides real-time information about the schedules, and integrates other functionalities such as card reading and an incorporated speaker, specifically for impaired users. Complementarily, HF acquired 3 new public information monitors to provide better information to the passengers, installed outdoors, indoors, and at a mixed location.

Figure 5: Photovoltaic panels under configuration and tests

Both solutions, once acquired, initiated configuration phases and tests. Although, due to the COVID-19

situation, the installation of the informative panels was suspended due to the supplier being located on the mainland and travel was highly limited. However, HF resumed the configuration phase and proceeded with tests with the solution. The initially planned 10 panels were not acquired, as it was decided to go for a more robust, autonomous system, which was adapted for impaired users.

3 PT products vending machines

Following feedback received from the regional partners and the results from the surveys applied at the airport of Madeira and port of Funchal (MAD 2.1), where several tourists highlighted the need to have PT selling kiosk and dedicated PT information at the main arrival points of the Region, HF identified an improvement opportunity, to promote PT right at the tourist's arrival.

HF analysed several solutions available on the market that could reinforce the sales network. However, the requirements definition process took longer than expected because the existing solutions on the market did not met HF's needs. So, several interactions and negations followed with the solution providers to better understand how HF could adapt the existing solutions to their needs.

HF closed the requirements for the vending machines and once the equipment was acquired, the local partners initiated the configurations and tests. However, due to the COVID-19 pandemic, the tourism sector was strongly affected, particularly the cruise business with no cruises disembarking in Madeira since March 2020. Hence, HF had to suspend the installation of the machines at the cruise port and at the tour operator shop (carristur) at Lido, waiting for the resuming of the cruise business and tourism, foreseen for the second semester 2021. Otherwise, the installation would require a significant maintenance effort from HF's team, with no use of the machines, given the absence of tourists.

In February 2021, HF proceeded with the installation of 1 vending machine at the airport, the only gateway receiving few tourists. The machine sold PT information (maps, guides, and timetables) and PT products (tickets), and the vending machine was covered with PT information vinyl (MAD 7.2).

The remaining machines are planned to be installed when cruise tourism returns, foreseen for the second semester 2021.

Figure 6: Vending machine at the airport

C Impact evaluation

C1 Evaluation approach

Expected impacts and indicators

Impact category	Impact indicator	Unit of measure
Transport	1 - Reliability of the new AVL system (Average nº of times the system crashed)	Nº/ month
Transport	2 - Reliability of the new AVL system (Average nº of hours to solve the problem)	H/ month
Transport	3 - Reliability of the new ticketing system (Average nº times the system crashed)	Nº/ month
Transport	4 - Reliability of the new ticketing system (Average nº hours to solve the problem)	H/ month
Transport	5 – Satisfaction with the new ticketing and AVL equipment	Nº (1 to 5)

Table 2: Expected impact and indicators

Method of measurement

Impact indicator	Method*	Frequency			Target Group	Domain (demonstration area/city)
		Bef.	Dur.	After		
1 - Reliability of the new AVL system (Average nº of times the system crashed)	DC	M9	M28	M40	PT Company	City
2 - Reliability of the new AVL system (Average nº of hours to solve the problem)	DC	M9	M28	M40	PT Company	City
3 - Reliability of the new ticketing system (Average nº of times the system crashed)	DC	M9	M28	M40	PT Company	City
4 - Reliability of the new ticketing system (Average nº of hours to solve the problem)	DC	M9	M28	M40	PT Company	City
5 - Satisfaction with the new ticketing and AVL equipment	S	-	-	M54	Bus drivers	City

*(Data collection (DC), Estimation (E), Survey (S)

Table 3: Method of measurement

Detailed description of the indicator methodologies:

1 and 2 - Reliability of the new AVL system – This indicator is measured in terms of nº of times the system crashed and the average nº of hours required to retrieve the system. HF is

responsible for collecting data for this indicator by making a query in the online SIGO platform owned by the company and selecting the data for the 15 buses where the system is installed, for the years under analysis, 2016, 2017, 2018, and 2019.

3 and 4 - Reliability of the new ticketing system – This indicator is measured in terms of nº of times the system crashes and average nº of hours required to retrieve the system. HF is responsible for collecting data for this indicator by making queries in the online SIGO platform that the company owns and selecting the data for the 15 buses where the system is installed, for the years under analysis, 2016, 2017, 2018, and 2019.

5 - Satisfaction with the new ticketing and AVL equipment – HF was responsible for collecting data for this indicator. This indicator was measured through a survey applied to 50 bus drivers, to whom it was asked to rate on a scale from 1 to 5 (1- much worst; 5- Much better) their satisfaction on the use of the new on-board console "*how do you consider the new on-board console compared to the previous on-board sales system*?". Bus drivers would then have to evaluate the General ease of use of the console; Easy selection of the desired ticket; Console response speed; and Ease of obtaining the "End of Service" receipt.

The Business-as-Usual scenario

For the indicators 1 and 2- Reliability of the new AVL system and 3 and 4 - Reliability of the new ticketing system, a BAU was projected, considering data regarding the duration of the technical failures for the 15 buses where the integrated solution was installed. The data was collected from the HF's SIGO system regarding 2016, 2017, 2018, and 2019, and the BAU was defined as an average per month of the last 4 years.

C2 Measure results

Impact category	Impact indicator	Unit of measure	Baseline	Ex-Ante	Ex-Post
Transport	1 - Reliability of the new AVL system (Average nº of times the system crashed)	Nº/ month	1,6	1,3	0,87
Transport	2 - Reliability of the new AVL system (Average nº of hours necessary to solve the problem)	H/ month	462,0	416,0	30,4
Transport	3 - Reliability of the new ticketing system (Average nº of times the system crashed)	Nº/ month	6,0	5,4	5,87
Transport	4 - Reliability of the new ticketing system (Average nº of hours to solve the problem)	H/ month	41,9	37,7	16,6
Transport	5 - Satisfaction with the new ticketing and AVL equipment	Nº (1 to 5)	-	4,00	4,67

Table 4: Measure results

C2.4 Transport System

1 and 2 - Reliability of the new AVL system

The 15 buses that had the console installed in September 2018 registered a decrease of 43% in the average number of technical failures after the installation. The best result was in terms of the average time to solve the problems which had a decrease of 93%, from 462 to 30,4 hours.

	Before installation	After installation	%
	Jan. 2017 – Sept. 2018	Oct. 2018 – Dec.2019	
Average nº of technical failures per month	1,52	0,87	- 43%
Average nº of hours to solve the failure per month	462,0	30,4	-93%

Table 5: AVL System failures before and after new equipment installed on board

If the integrated system were not implemented, the AVL system would continue to register a significant number of technical failures (average 1,6 per month), and an even greater duration to solve the failures, as shown in Figure 7.

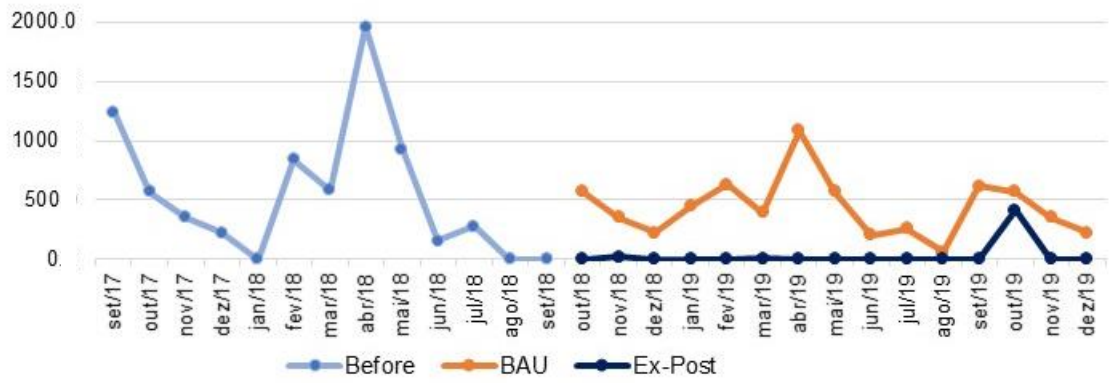

Figure 7: BAU scenario for the AVL system (Average number hours to solve the problem)

3 and 4 - Reliability of the new ticketing system

A similar trend was registered with the ticketing system, which recorded a significant decrease of 61% on the average time to solve technical failures, from 41,9 hours to 16,2 hours.

	Before installation	After installation	%
	Jan. 2017 - Sept. 2018	Oct. 2018 - Dec. 2019	
Average nº of technical failures per month	6,1	5,9	-3%
Average nº of hours to solve the failure per month	41,9	16,2	-61%

Table 6: Ticketing System failures before and after new equipment installed on board

Without the implementation of the integrated solution, the ticketing system would remain registering a considerable number of technical failures (average of 6 failures per month) with an average duration of 41,9h to solve the problem (instead of 14,2h after the implementation).

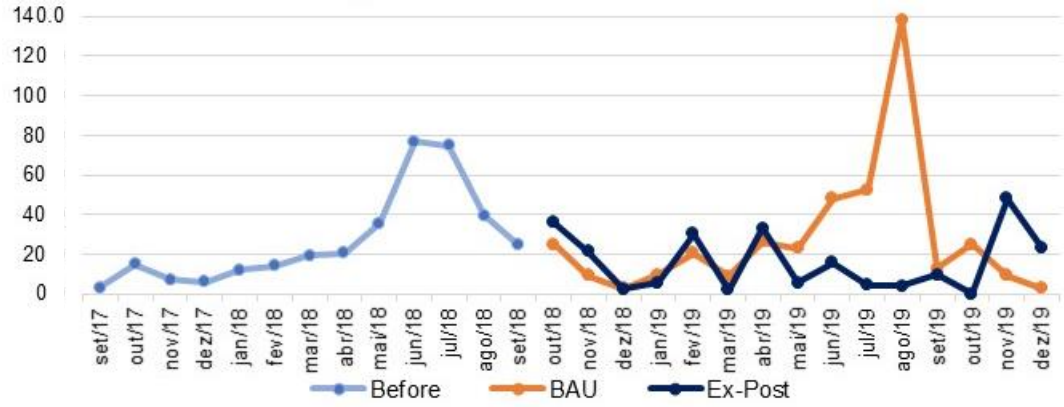

Figure 8: BAU scenario for the Ticketing system (Average number hours to solve the problem)

The 61% average reduction in duration to solve the problem in the ticketing system and the decrease of 93% on the AVL system has a significant impact on the daily management operation of the HF fleet. Before the implementation, the failure repairs required total non-operation of the bus until the malfunction was repaired. After the installation, in case of failure, the repair is performed separately from the bus, as the console is removed and another is installed, resulting in no necessary immobilization of the bus.

5 - Satisfaction with the new ticketing and AVL equipment

Following the results of the surveys applied to the 50 bus drivers, HF was able to understand that overall, the bus drivers rated the new ticketing and AVL console with a score of 4,67, which is very positive feedback. Specifically, bus drivers identify a considerable improvement in terms of “console response speed” which has significant operational advantages allowing for quicker interventions. On the other hand, the bus drivers identify that the selection of ticket is the parameter with the least impact.

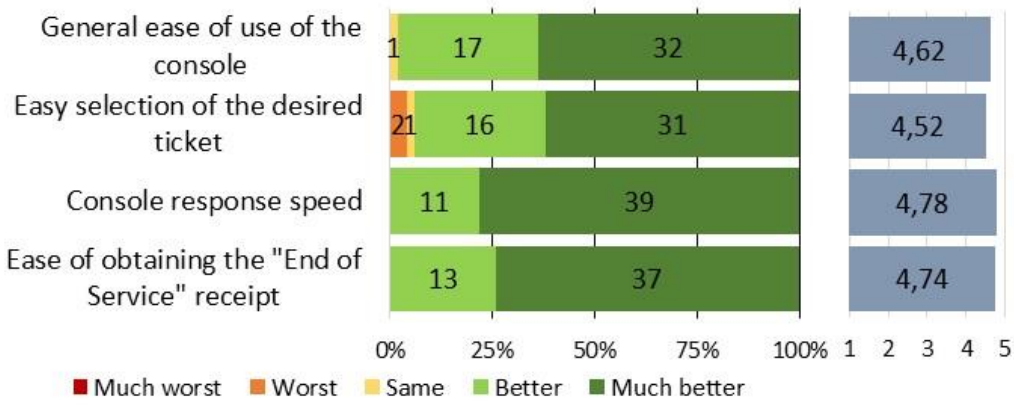

Figure 9: Bus drivers’ satisfaction with the new ticketing and AVL system

C3 Quantifiable targets

No	Target	Rating
1	Increased number of visitors to HF website, at least 10% more (215) per day	**NA**
2	Increased number of tourists that are aware of sustainable modes of transport before travelling	**NA**
3	Number of tourists using Internet on their mobile phone for tourist reasons expected to raise by 10% (increase of 53.571 tourists a year)	**NA**
4	Increased number of PT tickets sold to tourists - at least 5% more (22.681) tickets sold/year	**NA**
5	Increased total PT operational revenues - at least 2% (increase of 278,871€ in the PT operational revenues thanks to this single action)	**NA**
6	Rebalancing of transport modal share by increasing sustainable modes of at least 5% (additional 4.870 tourists using PT per year)	– **NA**
7	More attractive tourist destination	– **NA**
8	Increased cost effectiveness of transport services	– **NA**
9	* Improve reliability of the AVL system in 10% (Nº of times the system crashed)	★★★
10	* Improve reliability of the AVL system in 10% (Average hours to solve the problem)	★★★
11	* Improve reliability of the ticketing system in 10% (Nº of times the system crashed)	– **O**
12	* Improve reliability of the ticketing system in 10% (Average hours to solve the problem)	★★★
13	*Bus drivers recognising that the new ticketing and AVL system is better (4,00) that the previous console.	★★★
NA = Not Assessed O = Not Achieved ★ = Substantially achieved (at least 50%) ★★ = Achieved in full ★★★ = Exceeded		

* New target, not in GA

Table 7: Assessment of quantifiable targets

Targets 1 to 8 were planned in the grant agreement, and Targets 9 to 10 were defined during the measure development.

Targets 1, 2, and 3 were not assessed as they were related to the new website, new mobile app, and to the new ticketing systems. The development of the website and mobile app implementation were delayed due to dependencies with the full ticketing system and with the green credits schemes (MAD 6.2). As for the ticketing system, several constraints related to the complexity of the solution delayed the requirements definition process. Besides, the international public tender process for the exploitation of the interurban lines, pending since 2017, represented significant uncertainty for all transport operators, once there was a possibility of integration between all transport operators, which postponed these technological

implementations. However, HF initiated the development of the website and mobile app which will be officially launched in September 2021.

Targets 4 and 5 were not assessed because, despite HF purchasing the 3 selling machines and installing 1 machine at the airport (February 2021), due to the absence of tourism it was not possible to install the remaining 2 vending machines, or to collect proper evaluation data for the machine at the airport, considering the very few tourists received. Nevertheless, it was measure MAD 6.3, to follow the partnerships with hotels, that pursued this target.

Targets 6 and 7 were not assessed specifically in this measure as the implementations did not have a direct contribution to the rebalancing of the modal share nor on a more attractive destination. However, these targets are measured in MAD 7.2 – Attractive Public Transport, the measure with more relation and contribution for these the targets.

Target 8 was not assessed. The objective to increase the cost effectiveness of the transport services is related to the maintenance cost of the ticketing and the fleet control system. However, the system was only tested in 57 buses and HF had to keep running the old systems in parallel, with its maintenance costs. Nonetheless, considering that the new equipment on board (the console) can be replaced with other one right when needed, this avoids bus immobilization when a failure occurs, which consequently reduces the time and costs for maintenance. Also, the number of failures on these machines has been minor.

Targets 9 and 10 were Exceeded in full for the targets defined. Target 9 was more than achieved, having a reduction of 46% in the number of technical failures, and Target 10 registered a decrease of 93% in the average number of hours required to solve the problem.

For the ticketing system it was also possible to achieve very good results, with Target 12 achieving a decrease of 60% in the average number of hours to solve technical failures. Target 11, however, did not achieve the defined target, registering a decrease of only 2% in the number of technical failures.

Target 13 was Exceeded. Bus drivers recognized the operational benefits of the new ticketing and AVL system, which, in addition to making the whole interaction with the console faster, also allows simple procedures.

C4 Up-scaling of results

Up-scaling activities linked with this measure are due to be accomplished under the SIB-RAM project, approved in December 2019 and co-financed by ERDF, which consists of the acquisition of the integrated ticketing system.

The new project has a starting point from DESTINATIONS work, from the requirements process definition under MAD 7.4 and the pilot test in 15 buses under MAD 7.3. With a complete ticketing solution, it will be possible to achieve a more efficient operation, and provide customers with innovative solutions such as more accessible means of payment. Also, the ticketing system makes it possible to benefit from territorial continuity, given that it will be possible to use GIRO support (monthly pass card) on another national operator. In addition, the solution will allow multiservice, with customers being able to use public transport and other regional services.

If the solution would be scaled-up to the entire urban fleet (from 57 to 150 buses), the results achieved in terms of reduction of number of technical failures and average number of hours to solve the problems would be maximized. A more efficient operation would be accomplished,

achieving a reduction of 46% in the number of technical failures and 93% in the number of hours to solve the problem in the AVL System. As for the ticketing system, it would also be possible to achieve very good results, with a decrease of 60% in the average number of hours to solve technical failures and a reduction of 2% in the number of technical failures registered.

D Process Evaluation Findings

D1 Drivers

Due to the problems related to the provision of information about PT services to the public and the shared view and sense of urgency to proceed with a new ticketing solution, this problem related driver is seen as a great priority to solve the actual technological solutions. This necessity became even stronger given the increasing technological market full of possibilities and innovative updates, being vital to invest in integrated mobility and more efficient solutions.

At a cultural level, several drivers positively contributed to the progress of the measure. Firstly, the social inclusion factor once there is social pressure to provide inclusive services for customers with all kinds of physical limitations.

D2 Barriers

Legally, the interurban tender process represented significant uncertainty for all transport operators, once there was a possibility of integration between all transport operators, which postponed several activities of the measure.

At a technological level, it was difficult to find a capable regional supplier. The available suppliers encountered problems at several levels, from integration barriers with the existing ticketing system to the limited hardware options available. Difficulties in human resources, due to the lack of qualified and capable human resources, to design and implement the required solution for the ticketing system.

Also, organizational and administrative delays hampered the measure implementation. The implementation of the website and mobile application were postponed several times due to delays with the full ticketing system implementation and also because of delays with the green credit scheme (MAD 6.2). These activities were connected to each other and a constraint in one affected the others.

Finally, the COVID-19 situation had a major impact on the implementations that were suspended, by a central order of the Regional Government that on 02 of April 2020 declared that all new investments in the public sector should be approved first by the government, including what was in the investment plan.

D3 Lessons Learned

With the several difficulties encountered along the measure development and implementation, it was possible to prepare a more carefully and complex tender processes, as this experience allowed to define, with close attention, the technical requirements for the tender process for the new complete ticketing system, for example it was requested that the competitors provided at HF facilities a kit of demonstration, as part of the proposal, to support the decision process of

HF. Another important aspect included in the tender process was the addition of high penalties in case of system or equipment failures during the maintenance period.

E Evaluation conclusions

This measure did not have a complete evaluation as most of the contract targets were not assessed as the implementation associated was not performed or given that some of the targets were assessed under other measures as explained in Section C3. Nonetheless, the results achieved with the ticketing and AVL integrated solution, at such a limited scale (15 buses), are considered as outstanding. From one side, the solution allows greater fleet availability, by not having the vehicles immobilized for technical repairs, easing the maintenance and exploitation sector, and, on the other hand, given the new and more efficient software the failures are less critical, requiring reduced time to solve the problem as a reduced number of failures. This implementation also has advantages for the bus driver as the onboard operation is easier with just one piece of equipment to manage.

F Additional information

F1 Appraisal of evaluation approach

The evaluation process had difficulties once the SIGO system, where the evaluation data was extracted, had some problems and the databases were not providing all the required data, with some of the evaluation files being incomplete. Several interactions were necessary to report and correct the errors.

The COVID-19 pandemic caused delays and then suspended the installation of the vending machines. Moreover, the very few numbers of tourists on the island hampered the proper evaluation data collection, with basically no data to evaluate.

F2 Future activities relating to the measure

Future activities include the implementation of the SIB-RAM project, which gives continuity of the requirements defined under measure MAD 7.4 and the pilot test performed in the 57 buses with the integrated console with ticketing and AVL system. The project was approved in December 2019 and co-financed by ERDF and consists of the acquisition of the integrated ticketing system.

The new project will provide HF with more accessible means of payment, without the need to move to physical sales kiosks. A regional ticketing standard will be created, which can integrate all operators in the region. The ticketing system will make it possible to benefit from territorial continuity, given that it will be possible to use GIRO support on another national operator. The system will allow multiservice, with customers being able to use public transport and other regional services.