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# DESTINATIONS



## D8.6

Definition of the procedure for the measure and the evaluation of technical system performance indicators

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## Abstract

This Deliverable proposes a methodology for the measure and the evaluation of the ITS performance indicators during the system's operation and the definition/planning and management of operative processes enabling this objective (i.e. definition of the performance indicators and expected targets, definition and management of data collection processes, etc.).

Furthermore, the Deliverable explains how to use the results of the monitoring process of performance indicators at contractual level in order to check the level of compliance of the contractual obligations guaranteed by the Contractor and how to apply "penalties" scheme accordingly.

Appropriate resources must be planned by CIVITAS DESTINATIONS sites to carry out this process which plays a key role not only for the operation of ITS solutions but also for the success of the project demonstration measures supported by the ITS systems.

## Project Partners

Organisation	Abbreviation	Country
Horários do Funchal, Transportes Públicos	HF	PT
Agência Regional da Energia e Ambiente da Região Autónoma da Madeira	AREAM	PT
Câmara Municipal Do Funchal	CMF	PT
Secretaria Regional da Economia Turismo e Cultura	SRETC	PT
Agência Regional para o Desenvolvimento da Investigação, Tecnologia e Inovação	ARDITI	PT
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Euro Project Consult	EPC	FR
Istituto di Studi per l'Integrazione dei Sistemi	ISINNOVA	IT
European Integrated Project	EIP	RO

Organisation	Abbreviation	Country
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# Glossary

**Acceptance criteria** – the criteria adopted to decide when the performance verification is successful or not

**Acceptance of the system** – all the testing process is successful, it states that the system complies with the defined technical specifications allowing the acceptance by the Contracting Organisation

**Contracting Organisation** – the Entity signing the supply/service contract with the Contractor (eventually related to a part of the supply/service previously tendered)

**Contractor** – the Entity (company or consortium of companies) signing the supply/service contract with the Contracting Organisation

**ITS (Intelligent Transport System)** – ICT systems supporting the planning/operation of mobility/transport services

**Technical specifications** – technical, functional, operational characteristics/features of the ITS

**Testing/acceptance process** – is the process which ends/follows the implementation of the system. It states if the system provided by the Contractor is fully responsive to all the requirements defined in the technical specifications by the Contracting Organization.

# 1 Executive Summary

The Deliverable's structure consists of:

- A description of the role of Task 8.3.4 and D8.6 (main output of the Task) in WP8 highlighting their positioning in the whole guidance/tutoring process covering from ITS design to system operation (section 3). This section clarifies the scope of D8.6 and it details the implications of the adoption of the measure/evaluation of the performance indicators at contractual level
- A suggested methodology to carry out the whole process of measure/evaluation of performances indicators of ITS solutions (section 4). This methodology encompasses the definition of the performance indicators (section 4.1), the definition of the time period when the verification can take place (section 4.2), the definition of the target values of the performance indicators (section 4.3), the specification of the procedures for data collection (section 4.4), the definition of rules to calculate the achieved values of the performance indicators (section 4.5) and the definition of acceptance criteria (section 4.6)
- Some guidelines to define an organizational structure and related operational procedures supporting the processes included in the methodology (section 5). This section details the key resources to be allocated, it describes their role and main activities they are in charge of.

## 2 Introduction

The tests occurring in the acceptance phase of the ITS systems have proven the achievement of the target performance level defined in the contractual obligations. The achievement of the target values of the performance indicators means that the ITS is reliable and efficient enough to support the operation of local CIVITAS DESTINATIONS measures properly over the demonstration phase.

However, once entered into operation, ITS must maintain a high performance level during the demonstration period. In order to monitor the performance level of ITS during the operation, the tests carried out in the acceptance phase must be repeated and structured as an “on-going” and continuous procedure. The methodology and recommendations provided in this Deliverable support the Site Managers and the Measure Leaders in structuring this process in order to manage the related contractual obligations (warranty) in a proper way.

Furthermore the process for monitoring and evaluating the technical performance indicators of an ITS system plays a key role in the service operation as it helps the Site Managers and the Measure Leaders in identifying when the performance of the system (and probably of the supported measure) are going down, to understand when the degradation of the performance is caused by the system or when it is caused by inappropriate operational procedures or irregular external conditions and to plan corrective actions (if required).

The following condition can be established about the strict relation linking the performance of the ITS system to the performance of the demonstration service: a high performing ITS is a

mandatory requirement to operate an efficient service, but alone it is not enough, as operational procedures, responsibilities and supporting conditions must be guaranteed too.

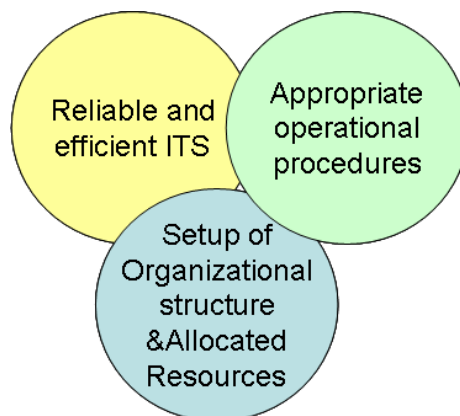
According to this role in Task 8.3 (see section 3.1), this Deliverable focuses on the process for monitoring and evaluating the technical performance of ITS supporting the demonstration of mobility measures within the CIVITAS DESTINATIONS project. The target of the Deliverable doesn't encompass the monitoring of performance indicators of the service operation which are not related to supporting technological solutions but rather on operational/organizational dimensions. Regardless, the process described in the Deliverable can be extended and adapted for the monitoring of wider typologies of indicators.

### 3 Positioning D8.6 into the project

A reliable and efficient ITS is one of the enabling factors to provide a high-quality mobility service. However, this is not enough by itself, as the quality of the service depends also on other factors belonging to operational and organizational dimensions (see Figure 1):

- Appropriate procedures to properly manage the ITS are defined and put into practice
- The need in terms of organizational resources are assessed and the people allocated according to the defined structure
- Role and responsibilities required for the operation of ITS is assigned to each person in order to comply with the defined procedures.

This deliverable focuses on the technical side providing guidelines to Site Managers and Measures Leaders on how to monitor and assess the level of performance achieved by the ITS during the service operation (once it was signed off).



**Figure 1:** Factors impacting the quality of a mobility service

#### 3.1 Role of Task 8.3.4 in WP8

As already indicated in D8.3, the success of the demonstration measures in the CIVITAS DESTINATIONS project is assured when four milestones are achieved one by one (Figure 2):

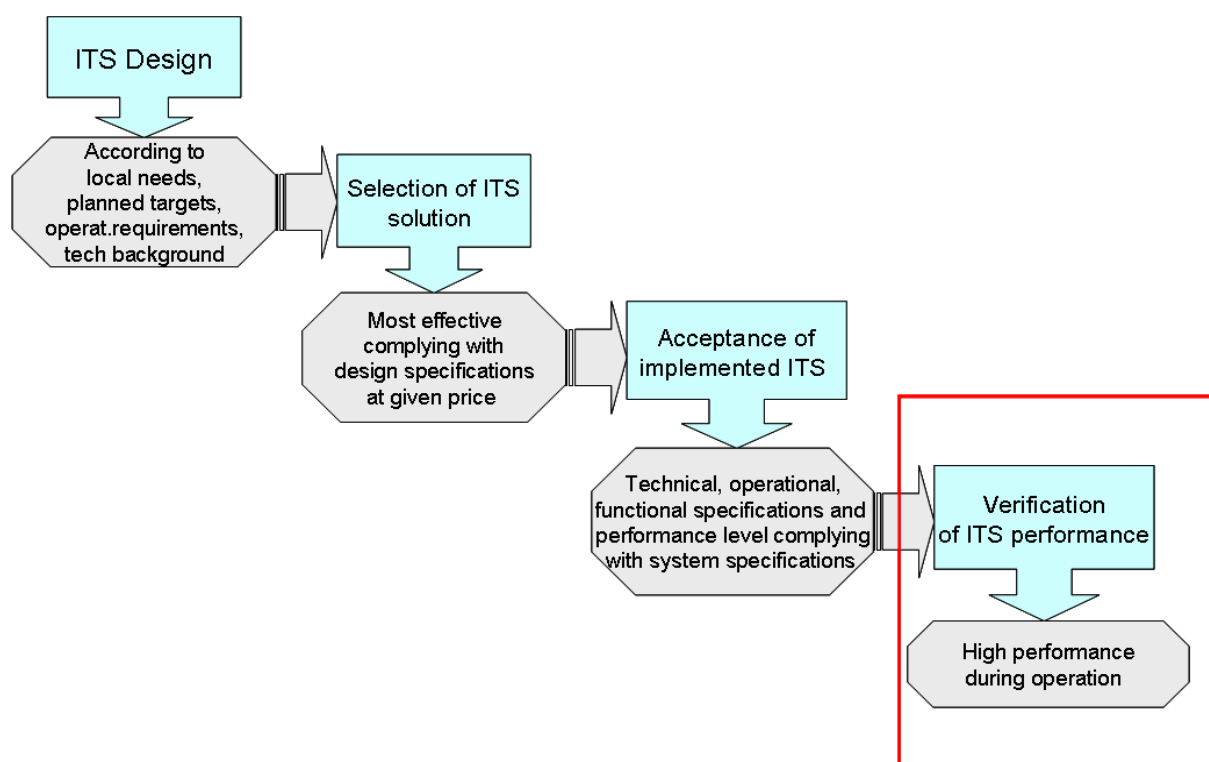
1. The implementation of an ITS system properly designed in order to comply with the planned objectives to be achieved for the improvement of mobility services, to address



the local needs and to adapt to operational procedures and technological background (Task 8.3.1 – D8.3)

2. The selection of the most effective (from a technical and economical point of view) solution (Task 8.3.2 – D8.4) complying with the requirements defined in the design phase
3. The testing of ITS functionalities and performance provides good results according to the planned specifications and performance (Task 8.3.3 – D8.5)
4. The ITS performances are proven to be high and stable over time

The abovementioned point 4 is the objective to be assured by Task 8.3.4 and, in particular, by this deliverable as the main output of the task itself.



**Figure 2:** Milestones to assure high quality of mobility demonstration services

In particular Task 8.3.4 is strictly related to Task 8.3.3 as:

- Task 8.3.3 relates to the contracting of ITS. Here, guidelines are provided on how to define the obligations which the Contractor must satisfy during the operation of the system (once it has been accepted) and to set the targets to be achieved in terms of technical performance
- Task 8.3.4 provides guidelines on how to monitor the level of performance achieved by ITS during its operation, enabling the application of the contractual prescriptions which are defined in the contract.

### 3.2 Scope of D8.6 and relation with contract management

In order to monitor the level of performance achieved by ITS during its operation, the tests already carried out for the acceptance of the system (see D8.5, performance verification, section 8) must be translated into an on-going process and repeated over time.

The deliverable aims to provide guidelines on how to adapt the methodology described in D8.5 for the acceptance of the system to the above-mentioned purpose.

As introduced in section 3.2, the procedure established to monitor the level of performance achieved by ITS during its operation can be applied for:

- The management of the warranty period (after the system's acceptance)
- The management of following maintenance contracts eventually established with the Contractor.

In the following, a detailed example is provided relating to the management of the warranty period (supposed to be 12 months long). A guarantee is given by the Contractor to the Contracting Authority as a safeguard in case the system will not assure the target performance defined in the Contract.

The 12 months warranty period is divided into four sub-periods: each of the sub-periods lasts 3 months.

The Contract defines the target performance to be achieved by the system (at the end of each sub-period) relating to each of the indicators.

Over each 3 months sub-period, the real performance guaranteed by the system is calculated (see section 4.5).

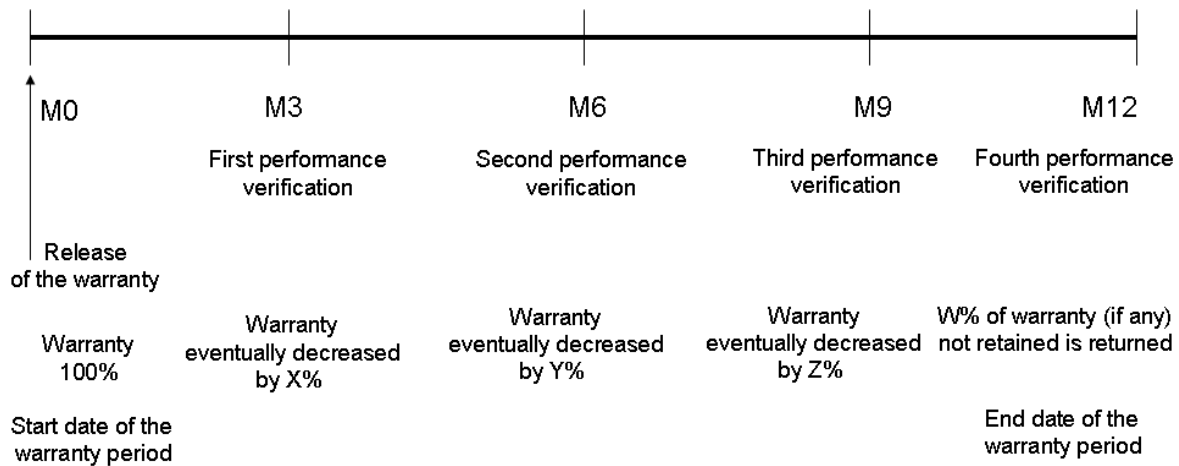
At the end of each sub-period, a comparison between the real (measured) performance and the target value (for each indicator) is carried out. If the measured value of the performance indicator is lower than the target set in the Contract, the guarantee released by the Contractor is decreased proportionally (see section 3.2): the difference is retained by the Contracting Authority. If the measured value of the performance indicator is equal (or higher) than the target set in the Contract, the guarantee released by the Contractor is not decreased.

At the end of each sub-period, the previous procedure is repeated.

Once the 12 months period has expired, the final amount of the guarantee still available is given back by the Contracting Authority to the Contractor.

If the measured value of one (or more) performance indicator is lower than a minimum threshold established in the Contract, the Contract itself can be terminated and all the guarantee is retained by the Contracting Authority. This prescription can be applied at the end of each sub-period or at the end of the whole warranty period.

The example (graphically represented in Figure 3) can be directly transferred to a maintenance contract where the approach is similar.



**Figure 3:** Conceptualization of the process for the verification of ITS performance and contractual implications

## 4 Methodological approach

The methodology adopted includes the following activities:

- The identification of the performance indicators
- The definition of the time period for the verification
- The definition of the target values of the performance indicators
- The specification of the procedures for data collection
- The definition of rules to calculate the achieved values of the performance indicators
- The definition of acceptance criteria

In the following, key guidelines are provided related to the activities previously mentioned.

### 4.1 Definition of the performance indicators

The performance indicators were already indicated in D8.5 and here they are repeated for convenience.

The performance indicators can be divided into two categories:

- *“Reliability”* of the system (or sub-system). This category of indicators can be calculated as the ratio between the time when the system or sub-system provides all the functionalities in a proper way and the total planned operational time. (A server may be rated on 24/7 availability; an AVM/AVL workstation may be rated against the operational hours of the Control Centre, etc.)
- *“Level of performance”* guaranteed by the main functionalities of the whole system over a defined monitoring time period. These indicators are strictly related to the functionalities of each kind of system and then they are specifically defined for each system typology. Some examples of performance indicators are provided in the following (the selected ITS come from D8.3):

- Info-mobility (platform for the aggregation of contents, APP, web portal, etc.)
  - *Response Time Index*: time (seconds) required to display information upon the request sent by the user
  - *Load Index*: number of simultaneous info requests generated by client (end users) devices which are processed by the system
- Fleet Monitoring and User Information System
  - *Monitoring Index*: number of trips which are monitored by the system over the total number of service operated trips
  - *Event Identification Index*: number of events generated during the operated service which are correctly identified over the total number of occurred events
  - *Real-time Information Provision Index*: number of real-time information which are correctly generated over the total number of real-time information generated during the operated service
- E-ticketing system
  - *Completed Transactions Index*: number of validation/selling operations not completed and not annulled by the users over the total number of validation/selling operations which have been started
  - *Progressive Transactions Index*: verification of the congruency of the sequence of the progressive ID codes assigned by the system to the transactions. This sequence should not include any replication of codes (there cannot be two operations with the same ID code) and any missing ID code (there is an operation managed by the system which has not been registered)
- Shared Vehicle Management System:
  - *Pick-up/release Index*: number of pick-up/release operations correctly completed over the total number of operations;
  - *Monitoring Index*: number of trips which are monitored by the system over the total number of operated trips;
  - *Event Identification Index*: number of events which are correctly identified over the total number of events occurring during the service.
- Parking Management System
  - *Occupancy Index*: number of available lots identified by the system compared to the real number of available lots.

## 4.2 Definition of the time period for the verification

The definition of the time period to be used for the repetition of the performance test during the operation of the system is the result of a balance between two conflicting needs:

- The period should be short enough

- to manage the procedure for data collection (see section 4.4) in a proper way and consuming not too many resources for that
- to keep the performance of the system under control (this is required to identify any possible deviations from target values and put into practice the required corrective actions)
- The period should be long enough
  - to make the test statistically relevant, avoiding bias effects due to irregular conditions/events that may occur
  - to use the results of the performance tests for the management of contractual prescriptions (see section 3.2).

### 4.3 Definition of target values of the performance indicators

The target values of the performance indicators should be defined in terms of percentage calculated over the time sub-period (see section 3.2). The target values of the performance indicator can be estimated considering:

- the total number of events corresponding to 100%
- the number of errors or irregular cases which are assumed as acceptable in the real operational conditions in order not to affect the system operation (and the service demonstration).

### 4.4 Definition of data collection procedures

The data collection procedure can be based on a mix of the following modalities:

- Data collected automatically (e.g. by the monitoring tools of the system itself)
- Data collected manually through targeted tests
- Data collected by the requests of maintenance interventions (e.g. to calculate the reliability indicators). When a troubleshooting application is used to manage the interactions between Contracting Organization and Contractor for the maintenance, this data becomes automatically collected too.

The identification of the most suitable modalities for data collection depends on the performance indicator to be considered and on the system architecture/functionalities.

In case of adoption of manual procedure, the required test must be specified according to D8.5.

### 4.5 Rules to calculate the value of the performance indicators

In order to calculate the value of the performance indicators, it is fair to eliminate:

- Data/Test results generated by wrong management procedures which result in a deviation from system functionality from specifications or low performance

- Data/Test results generated when the supporting conditions for system operations don't comply with the specifications
- Data/Test results generated by failures which are out of the responsibility of the Contractor.

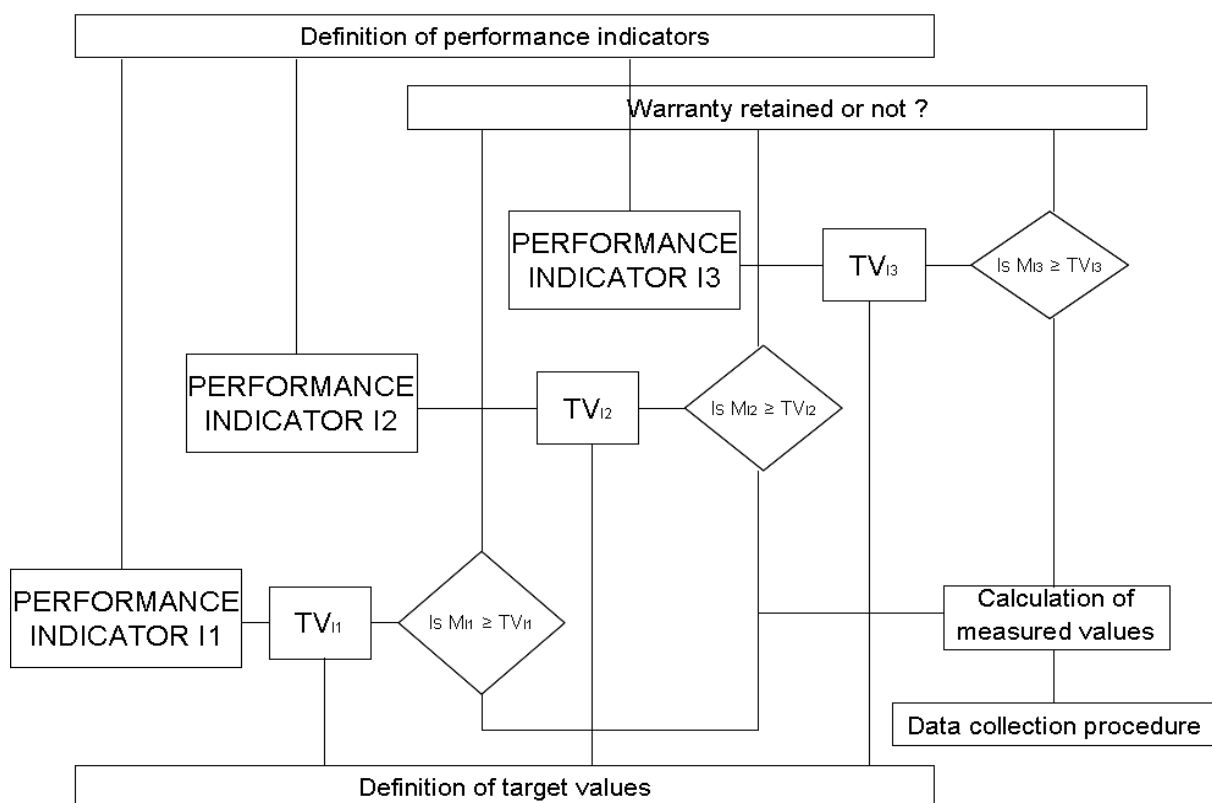
These events should not be affected by the value calculated for the performance indicators in order not to introduce “bias” effects.

## 4.6 Acceptance criteria

The acceptance criteria are based on the comparison of:

- The target value defined as indicated in section 4.3
- The measured value as calculated on the basis of the data collected (sections 4.4 and 4.5)

The process is applied for each performance indicator as indicated in Figure 4 (where the use of three performance indicators is supposed).



**Figure 4:** Flow chart for application of the acceptance criteria

## 5 Allocation of resources

Appropriate resources must be allocated in order to manage the processes of data collection, which is required to calculate the real value of performance indicators achieved by the ITS system during its operation.

At the top level, a supervisor is required for coordinating the whole process of performance indicator monitoring and for managing the contractual relationship with the manager of maintenance services appointed by the Contractor (see section 3.2). Taking into account the scenario of the demonstration of CIVITAS DESTINATIONS measures in the 6 pilot sites of the project, the supervisor (of ITS performance indicator monitoring) can be the same person responsible for the operation of the demonstration measures. He/she is in charge of the following activities:

- Coordination of the local resources (i.e. technicians, operators, etc.) in order to run the data collection processes properly, define and put into practice an action plan for daily operation and identify any corrective action required to re-align the data collection process to the action plan once a deviation is identified
- Verification of the level of compliance of data collected compared to the expectations in terms of data completeness and congruency
- Calculation of the value of the performance indicators on the basis of the collected data: the achieved value must be compared with the targets in order to apply the contractual rules accordingly
- Interactions with the responsible manager of the maintenance service of the Contractor in order to check the level of compliance with the contractual obligations and apply the prescriptions stated in the Contract in terms of:
  - Warranty retainment
  - Payments

The resources coordinated by the supervisor can be identified in the following:

- A software module responsible for carrying out the monitoring of the system's performance at central level, to analyse the log files produced by the central system's software, to verify that the data communication processes between the central software and the peripheral devices run properly and to notify the requests of maintenance interventions to the Contractor's technicians in case of failures of the central software.
- One or more (on-site) technicians responsible for carrying out the monitoring of the system's performance at peripheral level and to notify the requests of maintenance interventions to the Contractor's technicians in case of failures of the peripheral devices (i.e. on-board terminal and units, validators, automatic vending machines, info-panels, bike sharing stations, etc.).

In case specific tests are required to collect data for the evaluation of the defined performance indicators, the supervisor is in charge of the definition and the organization of these tests which are carried out by the central software and on site.

## 6 Conclusions

Based on the methodology presented in this Deliverable, Site Managers and Measure Leaders can define an “on-going” process to monitor and evaluate the technical performance indicators of any ITS supporting the operation of mobility measures to be demonstrated in the project. The methodology can be easily adapted for the monitoring and evaluation of any type of indicators measuring the performances of the service even not directly linked to technologies (i.e. issues related to procedure/organization dimensions, etc.).