Copy No: .....

ADVISOR
Final Evaluation Report
IST-1999-11287 Deliverable R8.4

Classification: Public.

Author : M. Renard [VIGITEC]

Reviewed : S. Velastin [Kingston University]
M. Naylor [Thales Research & Technology]
D. Bastin [Bull]
M. Thonnat [Inria]
F. Bremond [Inria]
F. Cupillard [Inria]

Date : 31 March 2003

The ADVISOR Consortium consists of:

Thales Research & Technology	Coordinator	United Kingdom
VIGITEC SA	Principal Contractor	Belgium
Bull SA	Principal Contractor	France
INRIA	Principal Contractor	France
University of Reading	Principal Contractor	United Kingdom
Kingston University	Principal Contractor	United Kingdom

DISTRIBUTION LIST

Copy Number

1	European Commission	Christos Pipitsoulis
2	Thales Research & Technology	Michael Naylor
3	VIGITEC	Michel Renard
4	Bull	Dominique Bastin
5	INRIA	Monique Thonnat
6	University of Reading	Stephen Maybank
7	Kingston University	Sergio Velastin

(Distribution applies to Issue 1 onwards.)

Classification: Public

Documents, which are classified as Public, may be distributed outside the Distribution which appears above.

MODIFICATION RECORD

Version: ADVISOR-DOC-039_(DRAFT_A) R8.4.DOC
Date: 28 February 2003
Author: M. Renard
Purpose: To be used as guidelines for Final Evaluation

....

Version: ADVISOR-DOC-039_(DRAFT_B) R8.4.DOC
Date: 31 March 2003
Author: M. Renard
Purpose: Review by partners

....

Version: ADVISOR-DOC-039_(Issue1) R8.4.DOC
Date: 26 May 2003
Author: M. Renard
Purpose: Official delivery

....

Version:
Date:
Author:
Purpose:

EXECUTIVE SUMMARY

ADVISOR is a project that intends to improve management of public transport networks through the improved use of CCTV cameras. The project undertakes to integrate several developments in picture content detection and analysis with technologies for annotating video images, and presenting them for inspection by CCTV operators when trigger events occur.

In other words, the goal of ADVISOR is to assist human operators by automatic selection, recording and annotation of "interesting" images such as "abnormal" crowd and individual's behaviours. Metro stations have been used as experimentation sites for test beds (providing video recordings) and final demonstrator (on site installation).

Three main evaluation milestones have been programmed during the project's life : after the completion of Test Bed 1, Test Bed 2 and Final Demonstration prototypes respectively. They were conducted according to the Evaluation Plan previously set-up and described in Deliverable R8.1.

The present document reports the final evaluation performed by the end-users associated with the project, i.e. STIB (metro of Brussels) and TMB (metro of Barcelona) during the one week evaluation session that was organised in March 2003 at the central control room of TMB for operators and representatives from Brussels and Barcelona.

The Final demonstrator took inputs from both live cameras from a station of the Barcelona metro network and pre-recorded video collected from multiple cameras of sites provided by TMB (Barcelona) and STIB (Brussels).

The ADVISOR final prototype had the following four main functions :

- Capture and Video Streaming
- Machine Vision Processing (Motion Detector + Crowd Monitor + Behaviour Recognition)
- Archive, Search and Retrieval
- Human Computer Interface

It is through the Human Computer Interface (HCI) that the ADVISOR system has been made available to End-users. This HCI has allowed them to activate some functions and also to be alerted by the system as new interesting events or incidents are detected. At this final level of development of the project, most of the functionality had been implemented, which allowed complete demonstration and credible evaluation.

The following events/situations have been used for the final evaluation :

- Interesting crowd movements
    - overcrowding

    - blocking entry/exit
- Individual delinquency
    - violence
    - people without ticket (jumping over the barriers)
    - vandalism

The evaluators have been in a position to verify how the ADVISOR system detects such situations and their evaluation has been both quantitative (when relevant) and qualitative.

Three different aspects of the system have been evaluated by the End-users, i.e. the “user acceptance”, the “impact” and the “socio-economic consequences”, each of the aspects being managed as follows :

- User acceptance evaluation
    - Usefulness of the system
    - Operating the system
    - Using the system
- Impact evaluation
    - Impact on safety
    - Impact on security
    - Impact on traffic efficiency
    - Impact on personnel motivation
    - Impact on passengers behaviour
- Socio-economic evaluation in which we provide a calculation of implementation costs and we propose to compare these costs with the potential benefits
    - Benefit gained from the increased number of passengers
    - Other social benefits

The final evaluation reported in the present document describes how the ADVISOR system has been very well appreciated by the relevant potential users, i.e. the metro companies.

They have acknowledged the efficiency of the ADVISOR system and confirmed that it could help them to increase the efficiency of their work. They recognised that many of its functions could not be provided by any other existing system, which demonstrates its innovative and advanced nature. This definitely confirms the success of the ADVISOR project.

Table of Contents

List of Figures

List of Tables

List of Forms

1 Document Overview

This is the Final Evaluation Report for the ADVISOR project. It provides the report of the final evaluation performed by the End-users according to the Evaluation Plan previously defined (Deliverable R8.1 – ref. 5 in §1.1).

We have structured the present document keeping the following objectives in mind :

- establish the link with the contractual tasks as defined and described in the project programme (Technical Annex – ref. 1 in §1.1)
- explain how the outcomes of other project work-packages are exploited

The present deliverable includes :

- Document Overview
  - This section gives an overview of the sections in the document; it includes references and a list of definitions for acronyms.
- Introduction
  - This section gives a brief introduction to ADVISOR Work-package 8 and on the tasks covered by the present deliverable.
- Final Evaluation Report
  - This section presents the results of the evaluation performed by the End-users at the end of the project.

1.1 References

The following Project specific documents are referenced:

Reference 1.
IST Proposal Number IST-99-11287, Annex 1 – "Description of Work" ADVISOR Project Issue 2 dated 01/05/2002

Reference 2.
IST Proposal Number IST-99-11287 V_1.xls A0 – Contract Preparation Forms (CPF) for the ADVISOR project dated 25/10/99

Reference 3.
Project Presentation IST-1999-11287 Deliverable R0.1dated 03/07/2001

Reference 4.
Operator HCI Specifications IST-1999-11287 Deliverable R5.1_Issue 2 dated 25/01/2003

Reference 5.
Evaluation Plan and First Evaluation Report IST-1999-11287 Deliverables R8.1and R8.2 Issue 2 dated 28/02/2002

Reference 6.
Second Evaluation Report IST-1999-11287 Deliverables R8.3_Issue 1 dated 24/01/2003

1.2 Abbreviations and Definitions

The following Project specific terms, abbreviations and definitions apply:

ADVISOR	-	**A**nnotated **D**igital **V**ideo for **I**ntelligent **S**urveillance and **O**ptimised **R**etrieval (this project)
EC	-	European Commission
IST	-	Information Society Technologies
PASSWORDS	-	**P**arallel and real time **A**dvanced **S**urveillance **S**ystem **W**ith **O**perator assistance for **R**evealing **D**angerous **S**ituations (a project within the 3^{d} Programme)
AVS-PV	-	Advanced Video-Surveillance for Prevention of Vandalism in the metro (a project within the 4th Programme)
CONVERGE	-	A project within the 4th Programme that has supported activities of Transport Sector projects in the areas of consensus promotion, system architecture, validation, and standardisation. It has helped in the production of design and application principles for in-vehicle human-machine interfaces, identified key user needs for transport telematics services, and prepared a final synthesis of all transport projects' evaluation results
PRISMATICA	-	PRo-active **I**ntegrated systems for **S**ecurity **MA**nagement by **T**echnological, **I**nstitutional and **C**ommunication **A**ssistance A project within the 5th Programme (Growth) that deals with economic aspects, information processing, information systems, safety and social aspects in the domain of Public Transport
STIB	-	**S**ociété des **T**ransports **I**ntercommunaux de **B**ruxelles (Brussels metro)
TMB	-	**T**ransports **M**etropolitans de **B**arcelona (Barcelona metro)
SRWT	-	**S**ociété **R**égionale **W**allonne du **T**ransport (Charleroi metro)
WP#	-	Work-package number
HCI	-	Human-Computer Interface
CCTV	-	Closed Circuit Television
TECHNICAL ANNEX	-	IST Proposal Number IST-99-11287, Annex 1 Issue 2 – “Description of Work” ADVISOR Project dated 01/05/2002

2 Introduction

This introduction relates to ADVISOR Work-package 8 and the tasks covered by the present deliverable R8.4 within the overall context of the project.

2.1 ADVISOR Project Overview

ADVISOR is a project that intends to improve management of public transport networks through the improved use of CCTV cameras. The project undertakes to integrate several developments in picture content detection and analysis with technologies for annotating video images and presenting them for inspection by CCTV operators when trigger events occur. Metro stations have been used as experimentation sites for a demonstrator system.

The goal of ADVISOR is to assist human operators by automatic selection, recording and annotation of "interesting" images such as "abnormal" crowd and individual's behaviours.

Since CCTV operators would usually have potentially thousands of cameras available at the same time, but only a limited number of monitors, the assistance provided by ADVISOR should increase their efficiency, and help compensate for limited human attention span. ADVISOR will thus generate better use of transport infrastructure by improved safety and security of the environment.

Whilst there are many potential applications within the public transport sector at large (train, metro or bus stations, airports etc.) and other similar environments where "interesting" crowd or individual's behaviour might be detected (city centres, shopping malls etc.). ADVISOR has been focussed on metro stations.

2.2 ADVISOR Work-package 8

Work-package 8 deals with Evaluation and Assessment of the ADVISOR system from the End-user point of view.

As described in the project Technical Annex (see 1.1 above), three main evaluation milestones have been planned, i.e. after the completion of Test Bed 1, Test Bed 2 and Final Demonstration prototypes, respectively. These three evaluation steps are performed in tasks T8.3 to T8.5.

In order to conduct this evaluation process according to the three steps mentioned above on the one hand, and to be able to capture inputs from different persons and organisations on the other, a consistent evaluation plan has been set-up. This plan includes the definition of the end-user requirements that have to be considered for the evaluation, as well as the strategy to be followed during the whole evaluation process. These definition tasks were performed in tasks T8.1 and T8.2.

As usual, the work achieved had to be reported in deliverables. Although the

evaluation plan had to be prepared in an internal report (deliverable R8.1) which was not required to be published, we published and submitted it together with the first evaluation report (deliverable R8.2).
The table below summarises and clarifies the relationship between the tasks of work-package 8 and their outcomes.

TASKS and SUB-TASKS of work-package 8	DELIVERABLES
T8.1 : Formulation of the set of possible End-user Requirements - Events to be detected - General rules of design T8.2 : Definition of the Evaluation Strategy - Evaluation criteria - Evaluation methodology	R8.1 - Evaluation Plan (internal report)
T8.3 : First intermediate Evaluation	R8.2 - First Evaluation Report
T8.4 : Second intermediate Evaluation	R8.3 - Second Evaluation Report
T8.5 : Final Evaluation	R8.4 - Final Evaluation Report

2.3 Other work-packages linked with Evaluation and Assessment

It is relevant to mention here that other project work-packages in the work achieved have direct impact or relationship with the present work-package 8 on Evaluation and Assessment.

WP1 : End-user Requirements

End-users have participated to describe the security problems they encounter and to define their needs and priorities that finally constitute a list of events or situations that would be processed within the project.

The "Final End-user Requirements" have been described in another Deliverable submitted earlier in the project schedule (R1.1). This outcome of the work package has been used to prepare the Evaluation Plan (R8.1).

WP5 : Human-Computer Interface (HCI)

The ADVISOR system had to be made available to End-users through an appropriate Human Computer Interface (HCI) that would allow them to activate some functions and also to be alerted by the system when new interesting events or incidents would be detected.

The HCI specifications are described in deliverable R5.1 (Reference 4 in section 1.1. above).

In practice, "made available to End-users" means, in the framework of the project, that the ADVISOR Human Computer Interface (HCI) has been prepared for and has been used during the intermediate steps of and final evaluation of the system.

WP7 : Validation

The scientific and technical performance of the ADVISOR system has been tested and validated in a separate work-package (WP7). It deals with the measurement of performance and efficiency such as response time, detection rate, false alarm rate, processing speed, etc.

This validation has been performed by the project partners using the same incremental process as the one envisaged for the evaluation by the end-users. It means that test beds 1 and 2 as well as final demonstration have been followed by both a validation process (WP7) and an evaluation process (WP8).

2.4 Project Assessment

Evaluation and assessment is a key step in the development and implementation process of a system such as ADVISOR. In view of further possible industrialisation, any decision about

- whether the design or functionality of the system should be modified and updated,
- whether and how the system should be implemented,

should be made on the basis of sound knowledge about the performance and impacts of the system.

Assessment has been defined as *"the process of determining the performance and/or impacts of a candidate system, usually in comparison to a reference case (existing situation or alternative systems), and usually including an experimental process based on real-life trials, often involving users"*[1].

Firstly, we have to recall that ADVISOR was a research project that aimed at realising – in a laboratory - a final demonstrator that would be installed in a real metro station for a few days at the end of the project schedule, i.e. for a short duration. Consequently, the following factors have to be taken into account :

- The installation of a pilot application has not been foreseen in the contract, which means that the "experimental process based on real-life trials" would be replaced by laboratory off-line testing based on pre-recorded video sequences
- There is no reference case that could be utilised (neither an existing nor an alternative system). Even the conventional operations could not be considered as

[1] CONVERGE project (see section 1.2) – Deliverable D2.3.1 : Guidebook for Assessment of Transport Telematics Applications – version 3.2 dated September 1998 – by ERTICO (B) and Transport Research Laboratory (UK)

a reference since the local operator has only a reduced number of available monitors on which s/he displays images "on demand". S/he has currently no possibility to monitor all the cameras of her/his network simultaneously.

Secondly, as mentioned above (2.3), the intrinsic technical performance measurement has been achieved within work-package 7 (Validation). The ADVISOR project overall assessment is consequently achieved by both the technical validation performed in work-package 7 and the evaluation process conducted according to the Evaluation Plan.

As far as assessment and measurement of success are concerned, the following table details the link to be established between the assessment criteria described in the project Technical Annex (reference 1 in §1.1 above) and both the processes of technical validation and evaluation.

Project assessment	**Validation**	**Evaluation Plan ref.**[2]
Demonstration of computer vision techniques operating on compressed digital video inputs	X	-
Integration of the techniques via open interfaces	X	-
Demonstration of detection of anomalous events : ?? detection rate ?? false alarm rate ?? response time	X	-
Sustained recording of multiple video inputs in a format that allows efficient retrieval of data	X	3.5.2.2
Demonstration of improved performance in detection and recognition of anomalous events through learning via feed-back from the operator	X	3.5.2.3 3.5.2.4
Quantifiable reduction in operator workload in terms of faster response to incidents and better management of CCTV resources	-	3.5.2.2 3.5.2.4
Increased awareness in the operators of the flow of people through their network	-	3.5.2.1
Use of low cost, commercial technology	-	3.5.4
User acceptance	-	3.5.2
Impact analysis	-	3.5.3
Social cost-benefit analysis	-	3.5.4
Economic analysis	-	3.5.4
Technical analysis	X	-

Table 1. Link between project assessment and validation / evaluation processes

[2] The references mentioned are the sections of Deliverable R8.1-2 Issue 2

3 Final Evaluation Report

3.1 Introduction

The final evaluation has been organised to capture the End-user feed-back when the final demonstrator was ready.

To this purpose, a one week evaluation session was organised in March 2003 at the central control room of TMB (metro of Barcelona) for operators from Brussels and Barcelona.

This was in fact the final milestone where all the developments available at the end of the project were put together and made available to all the project partners and the End-users present, i.e. STIB (metro of Brussels) and TMB (metro of Barcelona).

The ADVISOR Evaluation Plan defines a number of objectives and a strategy based on sound understanding of the User needs and requirements. It is based on a generic assessment process scheme and identifies six key stages, which are illustrated in the figure below.

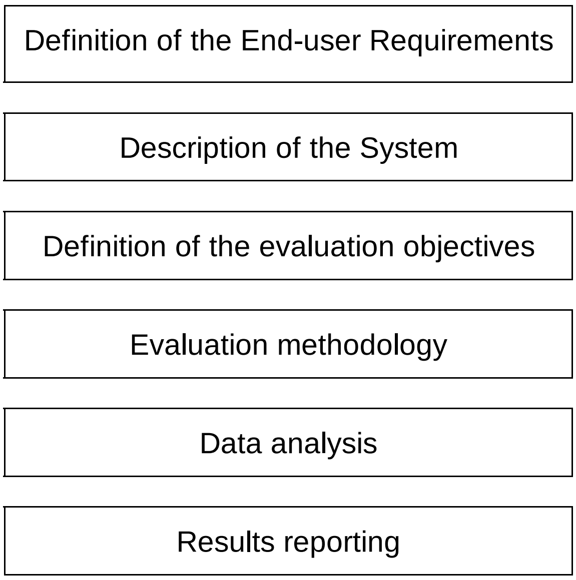


Figure 1. ADVISOR Evaluation Plan

The demonstrator built at the end of the project and installed in Barcelona was the final complete prototype and consequently, allowed most of the full evaluation process described in the Evaluation Plan. This final evaluation has been conducted according to the relevant parts of the different stages of this Evaluation Plan.

3.2 Definition of the End-user requirements for the final evaluation

User requirements have been captured in the framework of WP1 at the beginning of the project.

End-users have expressed functional and operational requirements for the ADVISOR system, i.e.:

(a) What the system has to detect so as to help them to solve some problems encountered, and

(b) How the system has to interact with the operators and security staff in order to be efficiently integrated into their security management.

These End-users requirements have been described in section 3.3 of the Evaluation Plan. For the final demonstrator, most of them have been addressed according to the development achieved so far. In summary, these were:

3.2.1 Required events to be detected for the Final Demonstrator

The main effort has been focused on developments able to detect the situations most required by the End-users (recorded in Deliverable R1.1). Taking the results obtained so far into account, the following events/situations have been used for the final evaluation :

Interesting crowd movements

- overcrowding
- blocking entry/exit

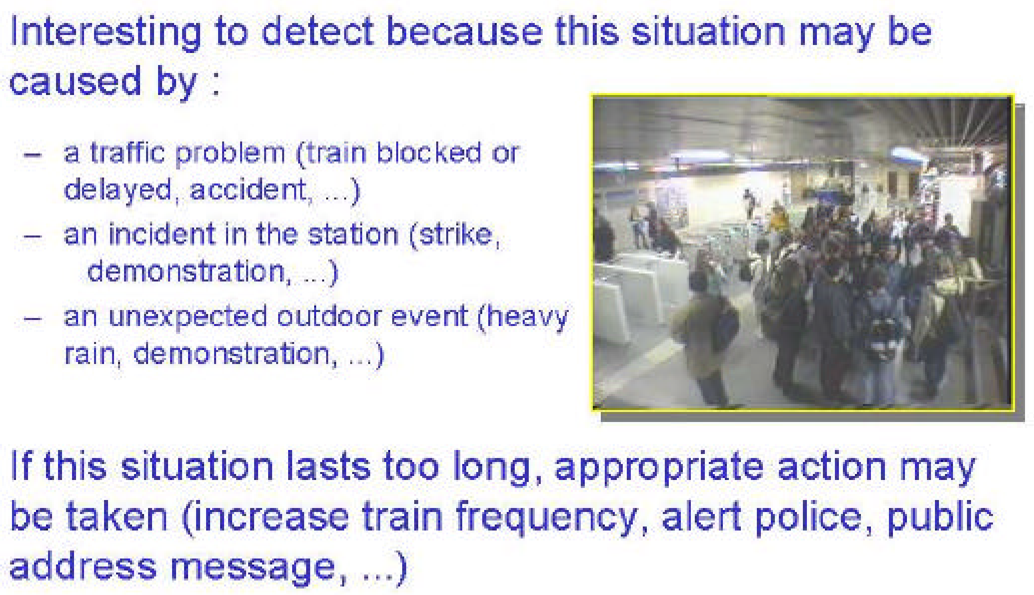
Individual delinquency

- violence
- people without ticket (jumping over the barriers)
- vandalism

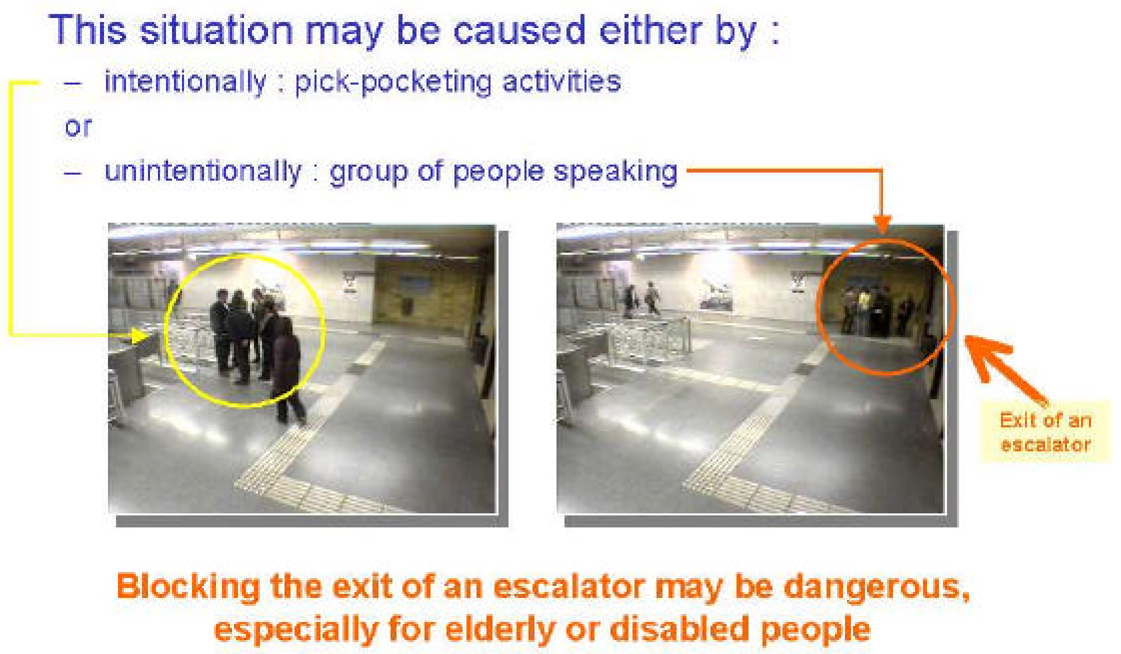
The evaluators have been in a position to verify how the ADVISOR system detects such situations.

We give below a short summary of each of these situations and the reasons why it is relevant to ADVISOR to detect them and alert the operators accordingly.

3.2.1.1 Overcrowding



3.2.1.2 Blocking entry/exit



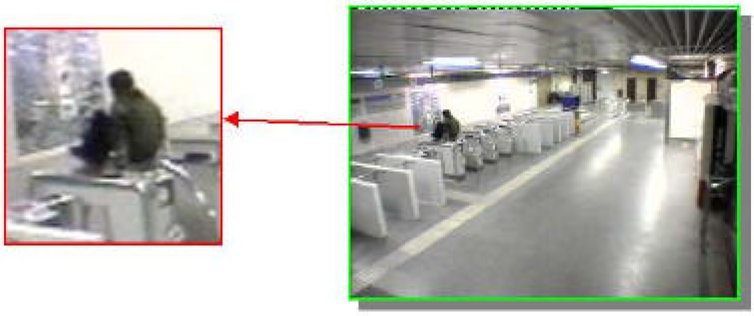
3.2.1.3 Violence

Is the most important situation to be detected since it may have dramatic consequences for the victims but also a strong impact on the feeling of insecurity of other passengers

Obviously such situations require immediate and urgent action

3.2.1.4 People without ticket (jumping over the barriers)

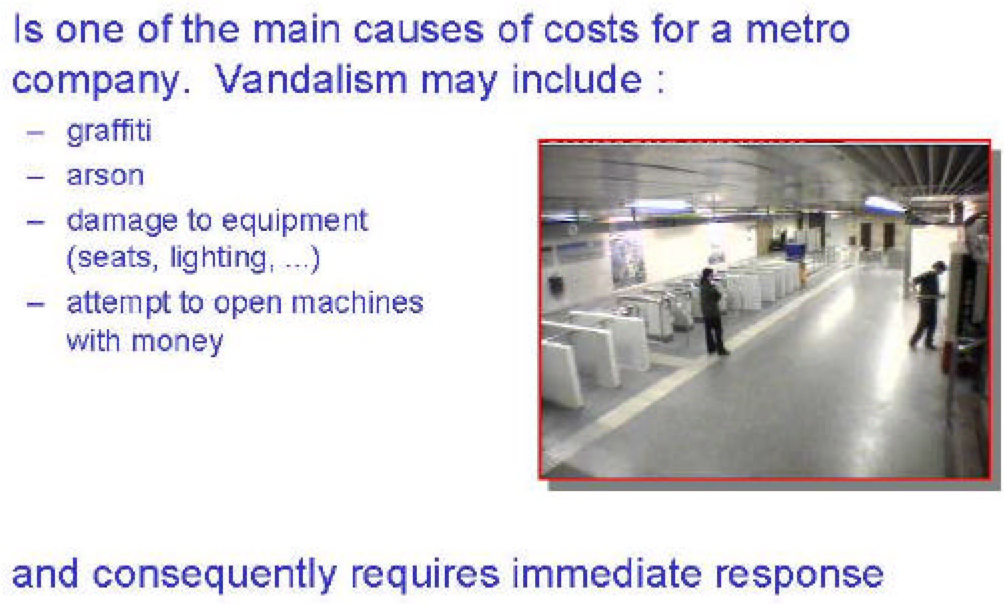
Without ticket = jumping above barriers



Fare evasion should be detected :

- To avoid economic losses
- To show to honest passengers that fraud does not remain unpunished
- To improve the feeling of security of all the passengers by demonstrating that the company exercises its authority in its own domain

3.2.1.5 Vandalism



3.2.2 Required general rules of design for Test-Bed 2

As described in more detail in section 3.3.2 of the Evaluation Plan (see reference 5 in above section 1.1), the complete list of the general rules of design are:

- Designed with the general principle of assisting the operator instead of attempting to replace her/him
- Managing the alarms (detected events or situations) according to existing rules (information – management – acknowledgement)
- Possible automation or semi-automation of tasks not requiring the operator's decision
- Configurable according to company's policies, time schedule, and operator's responsibility
- Designed for integration into an hierarchical architecture
- Secure access to operations and information
- Easy-to-use and adapted to the level of understanding of the users
- Adapted to the working environment

From the above list of requirements, all but the following one could be addressed by developments achieved at the final demonstrator milestone:

- Possible automation or semi-automation of tasks not requiring operator's decision

The reason was mainly that, for practical as well as for safety issues, it has not been possible to connect the ADVISOR prototype to other equipment available in metro infrastructure like public address system, telephone switch box, etc.

Mainly, all these requirements managed are addressed through the functionality of the Human Computer Interface.

3.3 Description of the system for the Final Demonstrator

Since the system had to be evaluated by different people working in different organisations from different countries and currently operating various security systems, it was necessary to provide them with a clear and concise description of the key characteristics of the system to be evaluated.

3.3.1 General Overview

The ADVISOR system is described in the following documents :

- ADVISOR project work-programme (see §1.1 – reference 1 above)
- Project Presentation - Deliverable R0.1 (see §1.1 – reference 3 above)
- Operator HCI Specifications – Deliverable R5.1 (see §1.1 – reference 4 above)

The two last documents mentioned above have been used to prepare the description of the system for the evaluators.

The Final prototype (demonstrator) was sited at TMB in Barcelona. It took inputs from both live cameras and pre-recorded video collected from multiple cameras of sites provided by TMB (Barcelona) and STIB (Brussels).

The figure below gives an idea about what could be an ideal wide implementation of the system.

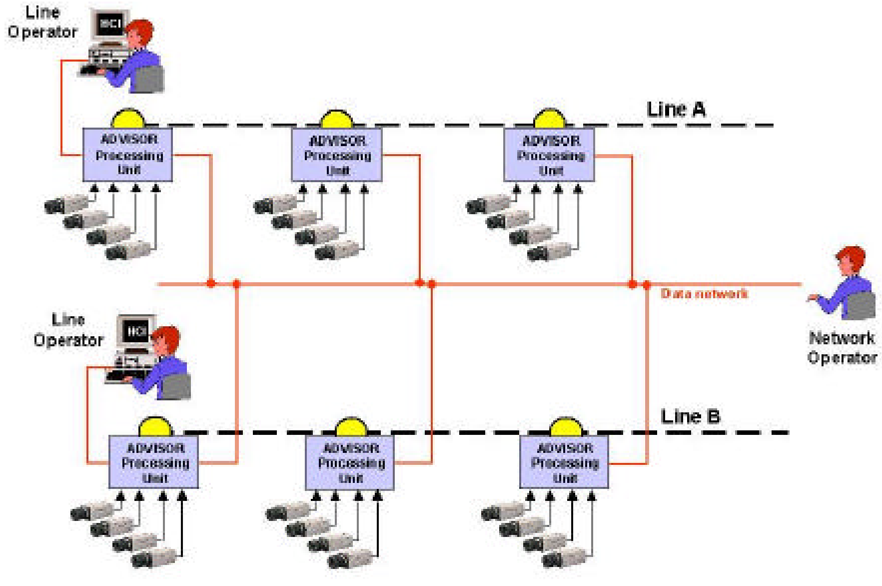


Figure 2. Typical wide implementation of the ADVISOR System

Then, we give the corresponding "limited" implementation of the final demonstrator

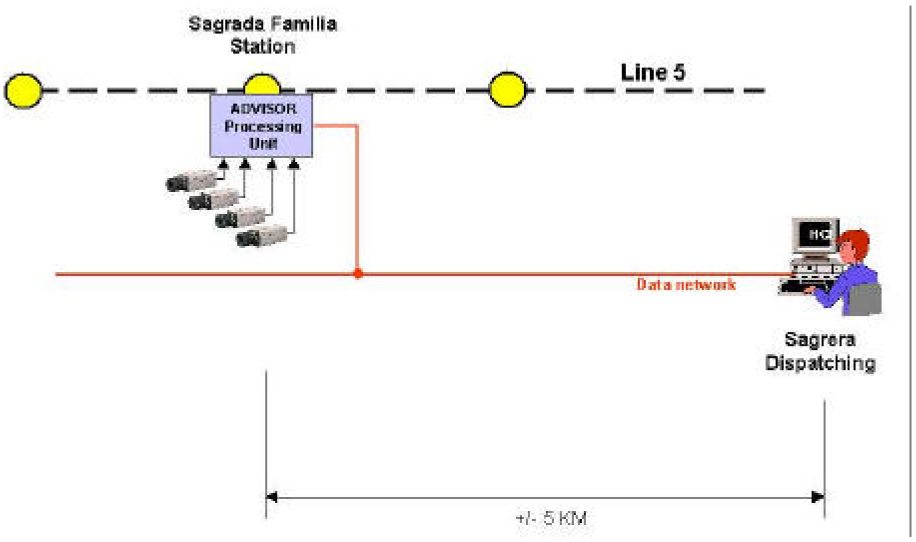


Figure 3. Implementation of the final prototype

Finally, the figure below shows the functional blocks, which are implemented in the final demonstrator.

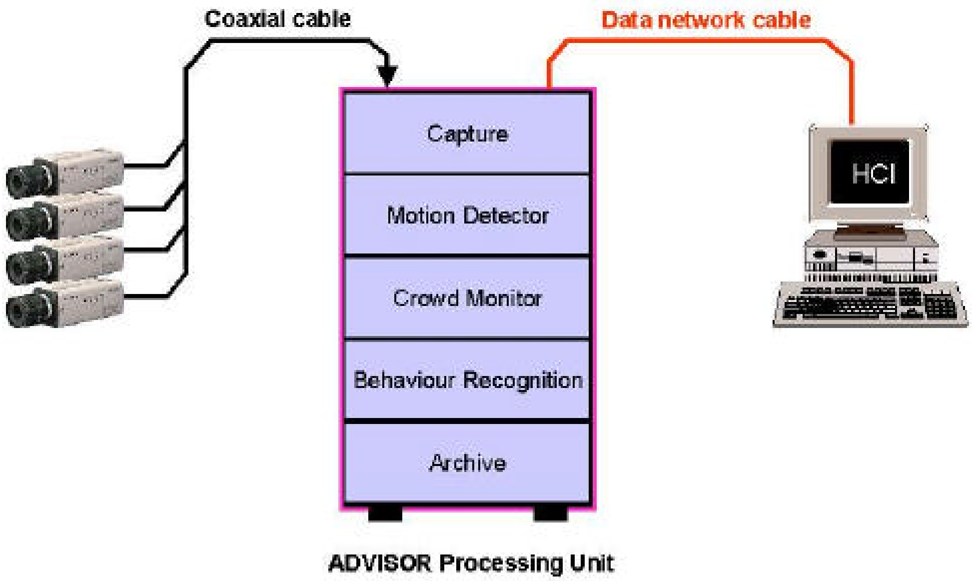


Figure 4. Final Demonstrator system functional blocks

The ADVISOR final prototype has the following four main functions which are described below:

- Capture and Video Streaming
- Machine Vision Processing, made of:
    - Motion Detector
    - Crowd Monitor
    - Behaviour Recognition
- Archive, Search and Retrieval
- Human Computer Interface

3.3.2 Capture

The Capture module digitises (captures) the video input from analog video sources (represented in the figures above by four cameras). It compresses the video information to maximise storage capacity and to minimise communications bandwidth requirements. In addition, it adds audit trail related information to the header of the captured images (Time stamping). Finally, it transmits the compressed images to other modules within the system using IP-Multicast.

In addition to operation with external inputs, the capture functionality also includes a mode of operation whereby previously captured video sequences can be played into the system from the hard drive. This mode of operation is useful for system debug and validation.

It is capable of operating with either colour or monochrome video sources.

The ADVISOR system captures and processes video images at a nominal rate of five equally spaced images per second per input. Images are reduced to quarter normal size with a square pixel shape and an image matrix of 384 x 288 pixels.

The resultant reduced image is then encoded according to the Baseline-JPEG standard to provide a constant quality image. The target maximum long term mean image record size is 40 Kbytes.

We fed the final demonstrator with both interesting sequences recorded at STIB and TMB stations and live cameras from the Sagrada Familia metro station (on line 5 of the TMB metro network).

This is illustrated in Figure 5 below.

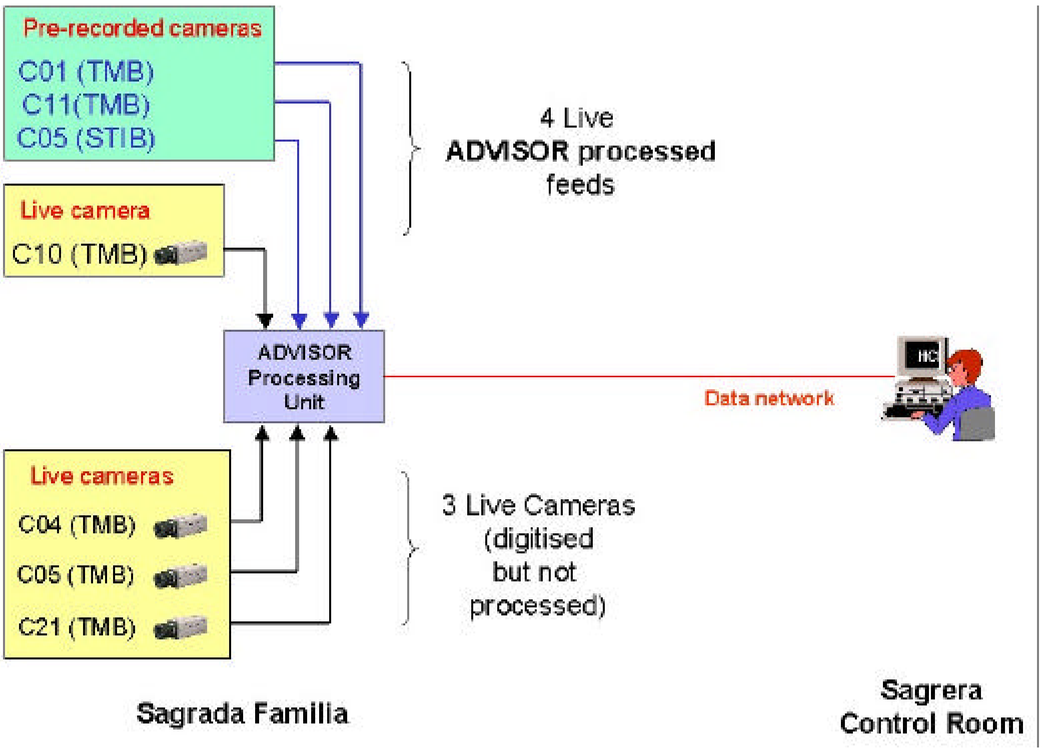


Figure 5. The capture functional block of the ADVISOR System

3.3.3 Machine Vision Processing

The machine vision algorithms process the video sources inputs in order to recognise the specific events/situations mentioned above (§**3.2.1**).

The following scenarios are recognised by the final version of the ADVISOR system that generates an output to be further presented as an alarm to the operator.

- **Overcrowding.** Overcrowding corresponds to the situation when a large density of people is detected in the scene. We do not need to check if the detected people are moving or blocked in the scene. A threshold is defined to set up the level of density of people that triggers this alert. This situation can be detected in any location in the scene.
- **Blocking or obstructing a recognised entrance or exit.** Blocking corresponds to the situation when a group of people (at least 2 people) has stopped in a predefined zone for a little while (at least 4 seconds) and can potentially block the path of other people. This situation may reflect a "simple" dangerous situation (talking people block the exit of an escalator for example), but also may be an indication of pick-pocketing activities (the victim seems to be

"accidentally" blocked by talking people but in fact it is a way to allow them to steal).

- **Violence (fighting and aggression).** Violence scenario corresponds to the situation when a group of people (at least 2 people) are pushing, kicking or grasping each other for a little while (at least 2 seconds) or when a person has fallen down at the bottom of a group of people. This violence scenario includes fighting behaviour (2 people belonging to the same group of people are fighting together) and aggression behaviour (1 or several persons attack an isolated person): these two behaviours are recognised in the same way. Identification of these behaviours will be subjective. It would be clear to a human operator when an incident is "violence". It must be dealt with at any location, at any time and on any day of the week. This situation is probably the one which generates the highest feeling of insecurity.
- **People without ticket (jumping over the barriers).** People without ticket corresponds to the situation when a person approaches the validation barrier, accelerates, jumps over the barrier, then arrives on the other side of the barrier. This situation is detected only around the validation barriers.
- **Vandalism (against a piece of equipment).** Vandalism scenario corresponds to the situation when a person approaches a ticket vending machine, stays a little while close to this machine, goes away, comes back a second time towards the machine, then stays again a little while close to the machine. In general, when a person tries to break a machine, he is waiting to be alone to act. For this reason, when somebody else enters the scene, the person goes away from the machine and waits again to be alone. This scenario is detected only around a piece of equipment defined as a sensitive equipment.

The following behaviour types would generally be used in the formulation of more complex behaviour recognition. It will however be possible to use any of the following behaviour types to trigger alarms if required.

- An individual or group is stopped
- An individual or group is walking
- An individual or group is running
- A lively group
- An empty scene
- A group in a blocking zone
- A group is stationary
- A group is stationary for a long period of time

3.3.4 Archive, Search and Retrieval (ASR)

The key functions of the Archive, Search and Retrieval process are as follows.

- Storage/Replay of video - Tools to create, maintain and search the archive of annotated images

- Store feedback from operators through appropriate bookmarks
- Post Incident Analysis - May be performed through the HCI by appropriately querying the archive server.
- Re-transmission of operator selected image sequences over the ADVISOR network
- Support for a single HCI.

The ASR is able to continuously store four video streams at five frames per second. A capacity sufficient for storage of recording at this rate for a period of three days is implemented in the Demonstrator.

At the same time as being capable of continuous recording four video streams at five frames per second, it is possible to retrieve and replay four video streams according to search queries from the Human Computer Interface (HCI) based on the following criteria:

- Type of behaviour (as listed in section 3.3.3)
- Station (one or more)
- Camera (one or more)
- Date/Time (begin/end)
- Operator bookmark

As a result to the queries, the ASR returns to the HCI a list of relevant image sequences available. During the replay of stored images, the following retrieve control commands from HCI will be possible :

- Play forward of an image sequence
- Play backward of an image sequence
- Pause the play-back of an image sequence
- Fast forward of an image sequence
- Fast backward of an image sequence
- Jump to the end of a sequence
- Jump to the beginning of a sequence
- Stop the play-back of an image sequence (in this case, the corresponding screen is switched back to the previously selected video source)
- Play beyond the beginning/end of an image sequence

3.3.5 Human Computer Interface (HCI)

The HCI presents the operator with an interface to the system. With the HCI, the operator is able to select live camera views, receive alert messages and search the Archive.

The functionality implemented in the HCI for the final demonstrator are most of the functionality originally foreseen in the HCI specification document (Deliverable R5.1 – reference 4 in section 1.1 above).

They are detailed in the table below.

Relevant section in R5.1	Description of the function	Implemented in the Final Demonstrator	Comments and remarks
HCI specifications for system operations (WHAT it does)			
Basic operations			
4.1.1.1	Manual selection of cameras	X	see note (1) below
4.1.1.2	Possibility to simultaneously see different cameras	X	
4.1.1.3	Possibility for the operator to annotate the sequence that he is watching	X	see note (2) below
4.1.1.4	Possibility to emphasise a tracking process	X	
4.1.1.5	Functions to manage the archiving system (image search, retrieval, …)	X	
Alarm operations			
4.1.2.1	Switches automatically interesting images	X	
4.1.2.2	Alarm messages	X	
4.1.2.3	Fast switching of "alarm" images	X	
4.1.2.4	Alert : flashing light, buzzer, …		see note (3) below
4.1.2.5	Automatic functions : local record, message printing, logbook data, ...		see note (3) below
4.1.2.6	Proposes relevant actions		see note (3) below
4.1.2.7	Assists operators (automatic call, public address message, ...)		see note (3) below
Advanced operations			
4.1.3.1	Set-up of cameras		see note (4) below
4.1.3.2	Possibility to enter calibration data		see note (4) below
4.1.3.3	Possibility for the operator to give a feed back to the machine (issues concerned : relevance of the alarms, auto-learning of the system, validation, …)	X	see note (5) below
HCI specs for security management (HOW to integrate into existing security system)			
4.2.1.1	Configurable access to information	X	see note (6) below
4.2.1.2	Hierarchical architecture (central control room, outposts, ...)	X	see note (6) below
4.2.1.3	Conflict management and priorities		see note (3) below
4.2.1.4	Few training needed	X	
4.2.1.5	Monitoring of the access to information	X	see note (7) below
HCI specifications for the operators (HOW it looks like)			
4.3.1.1	Ergonomic and aesthetic design	X	
4.3.1.2	User-friendly, intuitive	X	
4.3.1.3	Simple, adapted to the understanding level of the operators	X	
4.3.1.4	Alarms adapted to the environment : flashing light, buzzer, …		see note (3) below

Table 2. HCI functionality implemented in the final demonstrator

Note (1) : "encoding" mode is not implemented because it was only relevant for one of the ADVISOR End-users (TMB)

Note (2) : in the version of the HCI for the final demonstrator, some characters still remain forbidden (the commonly called “wildcards”)

Note (3) : due to a lack of time, it has been decided to not implement this function because it was not essential for the project

Note (4) : although the functionality exists in the ADVISOR system, it is not possible to access it from the HCI in the final demonstrator version

Note (5) : through the bookmarking function the operator could provide her/his feed-back that can be further analysed by the developers in order to refine the software

Note (6) : is only possible through the configuration file in the version of the HCI that was ready for the final demonstrator

Note (7) : the necessary information is generated by the HCI, but it is only possible to retrieve this information directly from the Archiving module in the version of the HCI that was ready for the final demonstrator

3.4 Definition of the objectives and criteria for the final evaluation

The evaluation objectives and criteria are detailed in section 3.5 of the ADVISOR Evaluation Plan (Deliverable R8.1).

In summary, the identification and definition of evaluation objectives primarily needs to be based upon the definition of user needs. What are the key questions to which the users, decision makers and other stakeholders concerned in the project must have answers ?

With evaluation objectives, there should correspond criteria for making judgments and possible choices. The evaluation objectives should relate closely to the implementation and use of the system. At this final level of development, evaluation objectives should address needs and requirements of the security management, the operators, the technical staff and the commercial/marketing management of the metro companies. Public authorities and passengers should ideally be involved as well.

As it is the final milestone of technical development, it is now relevant to try to evaluate “impact” or “socio-economic” consequences of a possible implementation of the system.

However, taking into account the limited deployment of the demonstrator, the “User Acceptance” evaluation is by far the most relevant to be performed.

3.4.1 User acceptance evaluation criteria

User acceptance evaluation aims to estimate users’ attitudes to and perception of system investigated, usually based on questionnaire surveys, interviews, etc …

Here, the users are the operators, the technical staff and the security management of the metro companies associated to the project, i.e. STIB (metro of Brussels) and TMB (metro of Barcelona).

Integration criteria as defined in the Evaluation Plan (Deliverable R8.1 – reference 5 in section 1.1 above) have not been possible to evaluate due to the limited “integration into the current security system” actually realised. However, most of the issues necessary to set-up the ADVISOR system according to the integration requirements of the metro companies have been developed, the users have not been able to test it and evaluate it seriously.

Consequently, only the sub-criteria marked in the table below have been defined as being possible to evaluate “from the acceptance point of view” at this final stage of development of the project.

User acceptance criteria for Final Evaluation

Usefulness criteria		
✍	Relevance of the alarms generated	
✍	Sufficiency of the information provided	
✍	Worth of the information provided	
✍	Work-ability of the information provided	
Operating criteria		
✍	Human control	
✍	Efficiency of the switching functions	
✍	Efficiency of the search and retrieving functions	
✍	Alarm management	
	Value of added (semi-) automated tasks	see note (1) below
Integration criteria		
	Configuration ability according to company policies	see note (2) below
	Configuration ability according to user	see note (3) below
	Configuration ability according to circumstances/environment	see note (4) below
	Co-operation in multi-users architecture	see note (5) below
	Secured access to the system	see note (6) below
Using criteria		
✍	Clearness of information / messages	
✍	Adaptation to users' understanding	
✍	Easiness to learn	
✍	Adaptation to work environment	
✍	General ergonomics of the HCI	

Figure 6. User Acceptance Criteria for the Final Evaluation

Note (1) : no automated tasks have been implemented because no physical link with other existing equipment of the control room has been actually realised (analog recorder, printer, telephone switching board, public address system)

Note (2) : most of the characteristics of the ADVISOR system have been developed in order to comply company policies but the users have not had the possibility to change (configure) anything by themselves

Note (3) : it was possible to adapt the system according to the mother language of the user

Note (4) : nothing specific has been actually realised (loudspeaker, flashing light)

Note (5) : however two Human Computer Interface have been connected to the system during the demonstrator sessions, only one has been used by the evaluators

Note (6) : the system was secured by a password, but the users have not really evaluate this issue

3.4.2 Impact evaluation criteria

Impact evaluation is the measurement or estimation of the impacts (effects) of the system for the safety, security and traffic management teams of the companies involved in the evaluation.

For the reasons explained in the Evaluation Plan (Deliverable R8.1 – reference 5 in section 1.1 above), the impact evaluation has been based on modelling supported by discussion with the users concerned.

In a real deployment situation, the fact that people cannot monitor all cameras is an important consideration. For example, the detection of an event automatically needs to be placed in the context that without system support, such events would go unnoticed.

It is realistic to estimate that the various possible impacts will highly depend on the implementation scale of the system. Therefore, the following four "theoretical" implementation scales have been considered (according to the description of section 3.5.3.1 of the above mentioned Evaluation Plan) when evaluating the different impact criteria:

- 2%, corresponding to a "pilot" installation covering a normal station but without relevance at the network level
- 10%, corresponding to an "assessment" installation, covering a small branch of the metro network which should allow to verify real impact on a limited scale
- 50%, corresponding to a partial but exploitable coverage.
- 100%, corresponding to a full coverage and related exploitation.

The following evaluation criteria have been defined:

- o Impact on safety
  - For each implementation level, it should be evaluated by estimating the number of accidents that could have been avoided if the ADVISOR system had been implemented, compared with the current number of accidents per year.
  - The users have been requested to evaluate impact on safety taking into

account whether (a) traffic has/has not been interrupted and (b) people have/have not suffered injuries.

- Impact on security
  - For each implementation level, it should be evaluated by estimating the number of security events that could have been avoided (or limited in consequences) if the ADVISOR system had been implemented, compared with the current number of security events per year.
  - The users have been requested to evaluate impact on security taking into account whether (a) equipment has/has not suffered and (b) people have/have not suffered (with and without injuries so as to take verbal aggressions into account).
- Impact on traffic efficiency
  - The issues addressed here are (a) regularity of traffic, (b) delays due to abnormal up and downloading time of persons, (c) limitation of the access to the trains, etc …
  - Since these situations are not reported in too much detail at the company level, we tried to capture qualitative evaluation through estimation of the feelings of the most skilled persons.
  - For each implementation scale, the traffic managers have been requested to comment and give a qualitative appreciation of the potential impact of the system.
- Impact on personnel motivation evaluation
  - Impact on motivation of personnel is supported by available data even less than for the three points above.
  - Discussions with relevant people were foreseen to try to evaluate the potential impact, taking into account: (a) recorded influence of past implementation of improved working tools and (b) comments made by the people during the evaluation sessions.
  - Results from the evaluation of User Acceptance (and in particular, the Using criteria (see 3.4.1 above)) will be considered.
- Impact on passenger behaviour evaluation
  - The evaluation of the impact on passenger behaviour may be attempted considering that both real and perceived safety and security influence the number of passengers as well as their travel attitude.
  - From discussion with relevant and experienced managers of the metro companies, we tried to evaluate the impact of an increased level of safety and security on (a) the total number of passengers, (b) the under-utilised traffic time slots and (c) the number of travellers using some “dangerous” metro stations.

3.4.3 Socio-economic evaluation and related criteria

Socio-economic evaluation aims at estimating the “social” gains or losses (the global economic gains and losses, for all members of society) as the result of implementing the system in comparison with existing situation (“do minimum” vs “do something”).

The social gains (or losses) should be evaluated using appropriate criteria, certainly including direct and indirect costs and benefits, but also non-monetary factors if those are affected significantly by the system under study.

However, such evaluation encounters some problems because the benefits should include passenger satisfaction or comfort, improved quality of service, and reduced accident risk which are all very difficult to measure or to estimate. Moreover, there is often little evidence that the benefits are created from the system implementation.

This is why, in the particular case of ADVISOR (a prototype implemented on a very limited scale during a very limited period of time), the socio-economic evaluation might only be envisaged from a potential point of view.

In the Evaluation Plan (Deliverable R8.1 – reference 5 in section 1.1 above), we had foreseen evaluation of socio-economical aspects of the ADVISOR system from both inside and outside the project itself.

Indeed, as far as Socio-economic benefits are concerned, we also would consider the work achieved in PRISMATICA, a concurrent project of the IST Programme (see 1.2) which dealt with these types of issues more specifically. The expected relevant data from PRISMATICA would consequently be considered in the ADVISOR evaluation.

Providing that the results of previous categories of evaluation were positive (“User Acceptance Evaluation” and “Impact Evaluation”), we would attempt to evaluate socio-economic aspects as follows :

- estimation of the ADVISOR system implementation costs
- estimation of benefits gained from additional passengers
- other socio-economic benefits

This reasoning is neither exhaustive nor scientifically and financially very precise. However, taking the context of a development project into account, it seems a pragmatic and realistic approach to address at least one aspect of the socio-economical impact and at the same time to provide valuable inputs for possible further development, industrialisation and exploitation of the ADVISOR concept.

3.5 Evaluation methodology

According to this (fourth) stage of the Evaluation Plan, we had to determine :

- Who are the evaluators ?
- The evaluation indicators
- The evaluation capture

3.5.1 The evaluators involved

Table 9 of the Evaluation Plan (Deliverable R8.1 – reference 5 in section 1.1 above) shows which type of evaluators should be involved according to which evaluation criteria.

In order to comply with this rule and taking into account the present evaluation objectives, the following evaluators were invited to the different part of the final evaluation.

It has to be noted that due to time schedule at the end of the project, it has not been possible to involve Public Authorities and Passengers (possibly represented by an association) into the evaluation.

- ***User Acceptance evaluation :***
  - Security Operator
  - Security Supervisor
  - Security Manager
  - Traffic Manager
- ***Impact evaluation :***
  - Security Supervisor
  - Security Manager
  - Traffic Manager
- ***Socio-economic evaluation :***
  - Security Manager
  - Traffic Manager
  - Marketing Manager

Evaluators of both STIB and TMB were freely selected by the persons responsible for the project (at the request of VIGITEC) according to a brief description of the evaluation objectives. Moreover, representative from SRWT (metro of Charleroi [B)) who attended the final presentation in Barcelona, kindly contributed to the impact evaluation.

STIB (metro of Brussels), the evaluators were :

- Security Operator
- Security Supervisor
- Security Manager
- Traffic Manager

TMB (metro of Barcelona), the evaluators were :

- Security Operator (very experienced, skill level of a Security Supervisor)
- Security Supervisor

- Traffic Manager
- Marketing Manager

SRWT (metro of Charleroi), the evaluator was :

- Traffic Manager

However all the types of evaluators foreseen were not able to attend the final evaluation, one could say that the evaluators involved were able to correctly evaluate the ADVISOR system and to provide the necessary feed-back to the project.

3.5.2 The evaluation indicators

According to the rules defined in the Evaluation Plan, during the User Acceptance evaluation, each evaluator had to provide his opinion or feelings on the ADVISOR system so that the results he gave could be further exploited and compared with the corresponding results given by another equivalent evaluator possibly belonging to another metro company.

Therefore, each criteria has been evaluated separately and according to quite strict rules. Evaluators have been requested to provide their judgement by giving a mark from A to D. The meaning of these letters are[3] :

- A = very, very good, very well
- B = more than medium, more than satisfactory
- C = less than medium, less than satisfactory
- D = no, not at all, absolutely not

3.5.2.1 User Acceptance indicator forms

Below, are given the **models** of the "User Acceptance" evaluation forms that have been filled in by the evaluators.

They had to fill in the forms with their marks, i.e. A to D, according to their evaluation of the criteria. They were helped by the question that "define" briefly each criterion.

Each evaluator has been requested to indicate his job function so that we were able to assess the categories of staff to which he belongs.

Form 1. (reference used for consistency with previous documents only)

[3] It has to be noted that, according to suggestions made by the Evaluators at Test Bed 2 level, the ranking system for the final evaluation was from A to D instead of D to A.

Your name : ……………………..……………………..	Date of the evaluation : …………………			
Please, circle according to your function ---->	Security Operator	Security Supervisor	Security Manager	Traffic Manager
Event/situation w.r.t. place combination / Usefulness criteria	**Overcrowding**			
	Halls (semi-open area)	Platforms	Corridors	Stairs and escalators
Relevance of the alarms generated Do the alarms (detection) provided by the system have an obvious relationship with my security problems ?				
Sufficiency of the information provided Do the relevant alarms (detection) provided by the system have an unambiguous relationship with my security problem ?				
Worth of the information provided Are the relevant and sufficient information that I receive from the system difficult or impossible to obtain from other detectors ?				
Work-ability of the information provided Do the received relevant, sufficient and worthwhile information allow or help me to take good decisions ?				

Form 2. Evaluation of Usefulness Criteria for Overcrowding

Form 3. (reference used for consistency with previous documents only)

Your name : ……………………..……………………..	Date of the evaluation : …………………			
Please, circle according to your function ---->	Security Operator	Security Supervisor	Security Manager	Traffic Manager
Event/situation w.r.t. place combination / Usefulness criteria	**Blocking entry / exit**			
	Halls (semi-open area)	Platforms	Corridors	Stairs and escalators
Relevance of the alarms generated Do the alarms (detection) provided by the system have an obvious relationship with my security problems ?				
Sufficiency of the information provided Do the relevant alarms (detection) provided by the system have an unambiguous relationship with my security problem ?				
Worth of the information provided Are the relevant and sufficient information that I receive from the system difficult or impossible to obtain from other detectors ?				
Work-ability of the information provided Do the received relevant, sufficient and worthwhile information allow or help me to take good decisions ?				

Form 4. Evaluation of Usefulness Criteria for Blocking entry / exit

Your name : ……………………..………………………..	Date of the evaluation : …………………			
Please, circle according to your function ---->	Security Operator	Security Supervisor	Security Manager	Traffic Manager
Event/situation w.r.t. place combination / Usefulness criteria	**Violence**			
	Halls (semi-open area)	Platforms	Corridors	Stairs and escalators
Relevance of the alarms generated Do the alarms (detection) provided by the system have an obvious relationship with my security problems ?				
Sufficiency of the information provided Do the relevant alarms (detection) provided by the system have an unambiguous relationship with my security problem ?				
Worth of the information provided Are the relevant and sufficient information that I receive from the system difficult or impossible to obtain from other detectors ?				
Work-ability of the information provided Do the received relevant, sufficient and worthwhile information allow or help me to take good decisions ?				

Form 5. Evaluation of Usefulness Criteria for Violence

Your name : ……………………..………………………..	Date of the evaluation : …………………			
Please, circle according to your function ---->	Security Operator	Security Supervisor	Security Manager	Traffic Manager
Event/situation w.r.t. place combination / Usefulness criteria	**Detection of persons without tickets**			
	Halls (semi-open area)	Platforms	Corridors	Stairs and escalators
Relevance of the alarms generated Do the alarms (detection) provided by the system have an obvious relationship with my security problems ?				
Sufficiency of the information provided Do the relevant alarms (detection) provided by the system have an unambiguous relationship with my security problem ?				
Worth of the information provided Are the relevant and sufficient information that I receive from the system difficult or impossible to obtain from other detectors ?				
Work-ability of the information provided Do the received relevant, sufficient and worthwhile information allow or help me to take good decisions ?				

Form 6. Evaluation of Usefulness Criteria for Detection of people without ticket

Your name : …………………...……………………….	Date of the evaluation : …………………			
Please, circle according to your function ---->	Security Operator	Security Supervisor	Security Manager	Traffic Manager
Event/situation w.r.t. place combination / Usefulness criteria	Vandalism			
	Halls (semi-open area)	Platforms	Corridors	Stairs and escalators
Relevance of the alarms generated Do the alarms (detection) provided by the system have an obvious relationship with my security problems ?				
Sufficiency of the information provided Do the relevant alarms (detection) provided by the system have an unambiguous relationship with my security problem ?				
Worth of the information provided Are the relevant and sufficient information that I receive from the system difficult or impossible to obtain from other detectors ?				
Work-ability of the information provided Do the received relevant, sufficient and worthwhile information allow or help me to take good decisions ?				

Form 7. Evaluation of Usefulness Criteria for Vandalism

Your name : ……………………………...……………………..	Date : ……………	
Please, circle according to your function ---------------------------------->	Security Operator	Security Supervisor
Operating criteria		Quotation
Human control Do I receive assistance from the system ? In which extend do I keep the control of the system ? Do I have the possibility to verify the information provided by the system ?		
Efficiency of the switching functions Do the switching functions allow me to perform my job efficiently when no alarm occurs ? Do the switching functions allow me to perform my job efficiently when one or several alarms occur ?		
Efficiency of the search and retrieval functions Am I always able to introduce all the searching requests that I wish ? Do I receive relevant answers to my requests from the system ? Am I able to efficiently "travel" within the images made available from the system ?		
Alarm management Are the alarm messages easy to exploit ? Are the alarms easy to process ?		

Form 8. Evaluation of Operating criteria

Form 9. (reference used for consistency with previous documents only)

Your name : …………………………….....………………………..		Date : ……………
Please, circle according to your function --------------------------------->	Security Operator	Security Supervisor
Using criteria		Quotation
Clearness of information / messages Are all the messages that are provided by the system simple, clear and unambiguous ?		
Adaptation to users' understanding Are all the messages communicated to and actions required from operators well adapted to their level of understanding ?		
Easiness to learn Is it easy to learn and use the system ?		
General ergonomics of the HCI Is the ADVISOR system user-friendly ? Is the ADVISOR system pleasant to use ?		

Form 10. Evaluation of Using criteria

3.5.2.2 Impact evaluation forms

Below, are given the **models** of the "Impact" evaluation forms that have been filled in by the evaluators.

They had to fill in the forms according to their feeling, opinion, experience. As mentioned before, this part of the evaluation was more qualitative than quantitative however quantitative outcomes were sought.

In several cases, the answers provided had to be related to the typical implementation scales defined and recalled in above section 3.4.2.

These models refer respectively to :

- Impact on safety and security
- Impact on traffic efficiency : reduction of delays
- Impact on traffic efficiency : better adaptation of the number of trains
- Impact on passenger behaviour : potential increase of the number of passengers
- Impact on passenger behaviour : potential expansion of the travelling hours
- Impact on passenger behaviour : potential increased used of the dangerous stations

IMPACT ON SAFETY

Traffic interrupted	People with injuries	Nbre accidents per year	Percentage could have been avoided if implementation scale =			
			2%	10%	50%	100%
	■					
■						
■	■					

IMPACT ON SECURITY

Equipment has suffered	People have suffered	Nbre accidents per year	Percentage could have been avoided if implementation scale =			
			2%	10%	50%	100%
	■					
■						
■	■					

Form 11. Evaluation of the Impact on Safety and Security

IMPACT ON TRAFFIC EFFICIENCY - DELAY

How many times per day is a train delayed ?		
Which are the causes ?		……………………………………………………………….. ……………………………………………………………….. ………………………………………………………………..
How is this situation detected ?		……………………………………………………………….. ………………………………………………………………..
Could it have been possible to avoid it ?		……………………………………………………………….. ………………………………………………………………..
Expected impact of ADVISOR system to avoid delay		
if implementation scale is	2%	……………………………………………………………….. ……………………………………………………………….. ………………………………………………………………..
	10%	……………………………………………………………….. ……………………………………………………………….. ………………………………………………………………..
	50%	……………………………………………………………….. ……………………………………………………………….. ………………………………………………………………..
	100%	……………………………………………………………….. ……………………………………………………………….. ………………………………………………………………..

Form 12. Evaluation of the Impact on Traffic efficiency : reduction of delay

IMPACT ON TRAFFIC EFFICIENCY - ADAPTATION OF TRAIN NUMBERS

How many times per week is it necessary to modify the traffic ?		
Which are the causes ?		…………………………………………………………….. …………………………………………………………….. ……………………………………………………………..
How is this situation detected ?		…………………………………………………………….. ……………………………………………………………..
Could it have been possible to avoid it ?		…………………………………………………………….. ……………………………………………………………..
Expected impact of ADVISOR system to better adapt train numbers to traffic		
if implementation scale is	2%	…………………………………………………………….. …………………………………………………………….. ……………………………………………………………..
	10%	…………………………………………………………….. …………………………………………………………….. ……………………………………………………………..
	50%	…………………………………………………………….. …………………………………………………………….. ……………………………………………………………..
	100%	…………………………………………………………….. …………………………………………………………….. ……………………………………………………………..

Form 13. Evaluation of the Impact on Traffic efficiency : adaptation of train number

IMPACT ON PASSENGERS BEHAVIOUR - NUMBERS

In what extend the number of passengers could be extended if the ADVISOR system was implemented ? *Provide a comment and give your opinion for each of the following situations that could be improved by ADVISOR.*	
Less overcrowding	…………………………………………………………………………… …………………………………………………………………………… …………………………………………………………………………… …………………………………………………………………………… ……………………………………………………………………………
Less blocking entry/exit	…………………………………………………………………………… …………………………………………………………………………… …………………………………………………………………………… …………………………………………………………………………… ……………………………………………………………………………
Less violence	…………………………………………………………………………… …………………………………………………………………………… …………………………………………………………………………… …………………………………………………………………………… ……………………………………………………………………………
Less persons without tickets	…………………………………………………………………………… …………………………………………………………………………… …………………………………………………………………………… …………………………………………………………………………… ……………………………………………………………………………
Less vandalism	…………………………………………………………………………… …………………………………………………………………………… …………………………………………………………………………… …………………………………………………………………………… ……………………………………………………………………………

Form 14. Evaluation of the Impact on Passenger Behaviour : number increase

IMPACT ON PASSENGERS BEHAVIOUR - TRAVELLING HOURS

In what extend could the passengers travel later than currently if the ADVISOR system was implemented ? *Provide a comment and give your opinion for each of the following situations that could be improved by ADVISOR.*	
Less overcrowding	…………………………………………………………………………… …………………………………………………………………………… …………………………………………………………………………… …………………………………………………………………………… ……………………………………………………………………………
Less blocking entry/exit	…………………………………………………………………………… …………………………………………………………………………… …………………………………………………………………………… …………………………………………………………………………… ……………………………………………………………………………
Less violence	…………………………………………………………………………… …………………………………………………………………………… …………………………………………………………………………… …………………………………………………………………………… ……………………………………………………………………………
Less persons without tickets	…………………………………………………………………………… …………………………………………………………………………… …………………………………………………………………………… …………………………………………………………………………… ……………………………………………………………………………
Less vandalism	…………………………………………………………………………… …………………………………………………………………………… …………………………………………………………………………… …………………………………………………………………………… ……………………………………………………………………………

Form 15. Evaluation of the Impact on Passenger Behaviour : travelling hours

IMPACT ON PASSENGERS BEHAVIOUR - USAGE OF "DANGEROUS" STATIONS

In what extend could the most "dangerous" stations more utilised if the ADVISOR system was implemented ? *Provide a comment and give your opinion for each of the following situations that could be improved by ADVISOR.*	
Less overcrowding	……………………………………………………………………………… ……………………………………………………………………………… ……………………………………………………………………………… ……………………………………………………………………………… ………………………………………………………………………………
Less blocking entry/exit	……………………………………………………………………………… ……………………………………………………………………………… ……………………………………………………………………………… ……………………………………………………………………………… ………………………………………………………………………………
Less violence	……………………………………………………………………………… ……………………………………………………………………………… ……………………………………………………………………………… ……………………………………………………………………………… ………………………………………………………………………………
Less persons without tickets	……………………………………………………………………………… ……………………………………………………………………………… ……………………………………………………………………………… ……………………………………………………………………………… ………………………………………………………………………………
Less vandalism	……………………………………………………………………………… ……………………………………………………………………………… ……………………………………………………………………………… ……………………………………………………………………………… ………………………………………………………………………………

Form 16. Evaluation of the Impact on Passenger Behaviour : dangerous stations

3.5.2.3 Socio-economic evaluation forms

Taking the practical circumstances into account, the forms used for this part of the final evaluation have not been submitted to "evaluators" to be filled in, but have been first calculated and filled in by the project partners and submitted afterwards to the metro companies for comments and improvement.

Therefore, we directly present these filled in forms (17 to 28) in the Evaluation Results section 3.9.2 below.

3.5.3 Evaluation Capture

One of the main problems in such an evaluation is to apply the same process throughout the different possible sessions. A full process has been defined in the Evaluation Plan, however it was anticipated that actual processes followed during evaluations would be adapted according to available material and practical circumstances.

*In order to facilitate the process, the **Human Computer Interface** as well as all the **forms** presented above have been developed and/or translated into three different language versions : English, French and Spanish.*

3.5.3.1 Description of the process for the Final Evaluation

In summary, the evaluation capture process has been :

- Installation of the ADVISOR prototype at Sagrada Familia station of the TMB (Barcelona) metro network. See explanation in section 3.3.1 above.

o ***User Acceptance evaluation***

- The project was presented and explained so that the evaluators could understand the context in which they would have to work. In particular, they had to clearly understand that they are seeing a demonstration prototype. The explanations were in the mother language of the evaluators, i.e. respectively in French for STIB people and in Catalan for TMB people.
- The prototype was explained and operated by the project partner leading the evaluation session. Questions were answered.
- Afterwards, the evaluation forms and indicators were explained to the evaluators.
- Then, they had the opportunity to use the system during one hour with the presence of the project partner leading the evaluation session. At the end of this phase they were able to manipulate the functions they would use in reality without difficulties.

- During the next days, they worked alone with the system. Attention was given to ensure that each evaluator worked individually and for about the same duration.
- When the period of working was finished, we requested the evaluators to fill in the questionnaires (forms) shown in above section 3.5.2.1 (User Acceptance evaluation forms).
- Each evaluator filled in his questionnaires (forms) individually and completed comments, remarks and suggestions when he found it appropriate.
- Quick consistency checks were performed and questions asked when necessary.

o ***Impact evaluation***

- There was an extended presentation and explanation of the ADVISOR prototype to the different relevant Managers who had to be involved in the impact evaluation.
- An evaluation package was prepared, consisting of a summary of the present document together with the different forms and the necessary explanations. Once again, this impact evaluation package has been prepared in the mother language of the evaluators.
- The package was sent to the relevant evaluators. Additional explanations were by phone or E-mail.
- Then the evaluators filled in the forms in draft form.
- Finally, clarification discussions have been held in order to check consistency and relevance of the answers.

o ***Socio-economic evaluation***

- Estimation of the implementation costs by the project partners with the assistance of the relevant metro company managers.
- Capture of the PRISMATICA project outcomes through information exchange and E-mail and phone discussions.
- Preliminary socio-economic evaluation document written by the project partners and submitted to the relevant metro company managers for approval and comment.
- Writing the final version of the Socio-economic evaluation part of the evaluation.

All the data captured during the evaluation sessions was collected and referenced for further processing.

3.5.3.2 Data gathering protocol

In the next pages, we present the full data gathering protocol according to the process explained above and related to the final evaluation.

DATA GATHERING PROTOCOL		FINAL DEMONSTRATION									
Reference step	Participants involved in the process / Operations to be performed	Project partners	Security Operator	Security Supervisor	Security Manager	Traffic Manager	System Manager	Maintenance Enginee	Marketing Manager	Public Authorities	Passengers
1	Installing the prototype or the mock-up										
1a	*in a lab at project partner's premises*										
1b	*in a room at metro company premises*										
1c	*on site at metro company premises*	■									
2	Meeting the evaluators to explain the context, describe the system and the evaluation process	■	■	■	■	■			■		
3	Demonstration of the prototype by the relevant project partner(s) + answering the questions	■	■	■	■	■			■		
4	Let the evaluator operate the ADVISOR system some minutes with the assistance of the relevant project partner(s) + answering possible practical questions	■	■	■	■						
5	Let the evaluator operate the ADVISOR system during some hours, using recorded sequences containing events/situations to be detected										
5a	*without any observer*		■	■							
5b	*with an observer*		■	■							
6	Let the evaluator operate the ADVISOR system 3 to 4 days in a realistic environment using a mix of live cameras and recorded sequences										
6a	*without any observer*		■	■							
6b	*with an observer*		■	■							
7											
7a											
7b											
8	Meeting the evaluators to explain the forms to be filled in	■	■	■	■	■					
9	The evaluators fill in the relevant forms individually										
9a	USER ACCEPTANCE: Form 1 - Evaluation of Usefulness criteria for Rapid increase of crowding level										
9b	Form 2 - Evaluation of Usefulness criteria for Overcrowding		■	■	■	■					
9c	Form 3 - Evaluation of Usefulness criteria for Unbalanced floor occupation										
9d	Form 4 - Evaluation of Usefulness criteria for Blocking entry / exit		■	■	■	■					
9e	Form 5 - Evaluation of Usefulness criteria for Violence		■	■	■	■					
9f	Form 6 - Evaluation of Usefulness criteria for Detection of persons without tickets		■	■	■	■					
9g	Form 7 - Evaluation of Usefulness criteria for Vandalism		■	■	■	■					
9h	Form 8 - Evaluation of Operating criteria		■	■	■	■					
9i	Form 9 - Evaluation of Integration criteria										
9j	Form 10 - Evaluation of Using criteria		■	■	■	■					

DATA GATHERING PROTOCOL			FINAL DEMONSTRATION									
Reference step		Operations to be performed / Participants involved in the process	Project partners	Security Operator	Security Supervisor	Security Manager	Traffic Manager	System Manager	Maintenance Enginee	Marketing Manager	Public Authorities	Passengers
9k	IMPACT	Form 11 - Expected Impact on Safety and Security				■	■					
9l	IMPACT	Form 12 - Expected Impact on Traffic Efficiency - Delay				■	■					
9m	IMPACT	Form 13 - Expected Impact on Traffic Efficiency - Adaptation of Train Numbers				■	■					
9n	IMPACT	Form 14 - Expected Impact on the Number of Passengers				■	■					
9o	IMPACT	Form 15 - Expected Impact on the Travelling Hours				■	■					
9p	IMPACT	Form 16 - Expected Impact on the Usage of "Dangerous" Stations				■	■					
9q	SOCIO-ECONOMICAL	Forms 17 & 18 - Installation costs (equipment)	■									
9r	SOCIO-ECONOMICAL	Forms 19 to 21 - Installation costs (manpower)	■									
9s	SOCIO-ECONOMICAL	Form 22 - Training costs (preparation)	■									
9t	SOCIO-ECONOMICAL	Form 23 - Training costs (manpower of the trainees)	■									
9u	SOCIO-ECONOMICAL	Form 24 - Operating costs	■									
9v	SOCIO-ECONOMICAL	Form 25 - Maintenance costs (spares)	■									
9w	SOCIO-ECONOMICAL	Form 26 - Maintenance costs (manpower for the maintenance of the equipment)	■									
9x	SOCIO-ECONOMICAL	Form 27 - Maintenance costs (update documentation and further training)	■									
9y	SOCIO-ECONOMICAL	Form 28 - Summary and calculation of the Implementation Costs	■									
10												
11		Individual interviews with the evaluators about :										
11a	USER ACCEPTANCE	Usefulness										
11b	USER ACCEPTANCE	Operating										
11c	USER ACCEPTANCE	Integration										
11d	USER ACCEPTANCE	Using										
11e	IMPACT	Safety	■		■	■	■					
11f	IMPACT	Security	■		■	■	■					
11g	IMPACT	Traffic efficiency	■		■	■	■					
11h	IMPACT	Personnel motivation	■			■	■					
11i	IMPACT	Passenger behaviour	■			■	■					
11j	SOCIO-ECONOMIC	Estimation of the installation costs										
11k	SOCIO-ECONOMIC	Estimation of the training costs										
11l	SOCIO-ECONOMIC	Estimation of the operating costs										
11m	SOCIO-ECONOMIC	Estimation of the maintenance costs										
12		Additional questions - answers - comments in individual sessions	■	■	■	■	■	■		■		

Table 3. Data gathering protocol for the final evaluation

3.6 Data Analysis for the final evaluation

Evaluation captured from both End-user metro companies associated with ADVISOR have been analysed in order to produce relevant and consistent material. The analysed data should then enable possible update and refinement of specifications as well as further development driven by User requirements.

For what concerns its quantitative part (User Acceptance evaluation only), the final ADVISOR evaluation has produced marks (A to D). To simplify comparisons, those letters have been transformed into figures as follows :

A	=	0,95
B	=	0,65
C	=	0,35
D	=	0,05

This very simple system allowed us to process the marks from different operators together.

For what concerns the qualitative part of the evaluation, we first reviewed all the comments made by the evaluators during the individual talks and during the general discussion.

Afterwards, and for each criterion to be evaluated, we tried to extract relevant comments or suggestions to improve the ADVISOR system in view of a possible future industrialisation.

The quantitative tables and related comments are presented below in sections 3.7.1.1 - 3.7.2.1 - 3.7.3.1 below.

Our review of the evaluation is presented in sections 3.7.1.2 - 3.7.2.2 - 3.7.3.2 below.

Partial conclusions are attempted in sections 3.7.1.3 - 3.7.2.3 - 3.7.3.3 below.

3.7 User Acceptance Evaluation Results Reporting for the final evaluation

Below, we review the evaluation forms, comments, suggestions and remarks provided by the operators to each evaluation “User Acceptance” relevant criteria. The complete list of User Acceptance criteria is available at section 3.5.2 of the Evaluation Plan (Deliverable R8.1).

It is important to keep in mind that the End-user evaluators have access to the ADVISOR system only through the Human Computer Interface.

To understand many of the comments or suggestions made, it would be useful to have a knowledge of the Human Computer Interface. Relevant information can be found in deliverable R5.1 “Operator HCI Specifications” (see reference at 1.1).

In the different tables of the next sections, the evaluators are named EV1, EV2, and EV3. According to section 3.5.1, this corresponds to the following :

EV1 : STIB Security Supervisor (+ Assistant to Security Manager)

EV2 : STIB Security Operator (+ good knowledge of traffic)

EV3 : TMB Security Operator

3.7.1 Usefulness criteria

3.7.1.1 Evaluation tables and additional comments

a) ***<u>"Overcrowding" situation</u>***

Usefulness criteria \ Event/situation w.r.t. place combination	Overcrowding						
	Halls (semi-open area)						
	EV1	EV2	EV3	EV1	EV2	EV3	Mean
Relevance of the alarms generated Do the alarms (detection) provided by the system have an obvious relationship with my security problems ?	C	B	A	0,35	0,65	0,95	0,650
Sufficiency of the information provided Do the relevant alarms (detection) provided by the system have an unambiguous relationship with my security problem ?	C	B	B	0,35	0,65	0,65	0,550
Worth of the information provided Are the relevant and sufficient information that I receive from the system difficult or impossible to obtain from other detectors ?	A	A	A	0,95	0,95	0,95	0,950
Work-ability of the information provided Do the received relevant, sufficient and worthwhile information allow or help me to take good decisions ?	B	A	A	0,65	0,95	0,95	0,850

It has to be noted that most of the overcrowding situations were detected in the field of view of a camera that overlooked the escalator from one of the platforms. Consequently, a few seconds after that a large number of people disembarked from the train they entered into the field of view of this camera and were triggered as "overcrowding" alert.

This means that from the operator's point of view, the station was not really overcrowded however, strictly speaking, it was not a false alarm. This particular situation explains why some operators have scored the *<u>relevance</u>* of this detection quite low.

Even if they agree that this overcrowding detection was correct from the ADVISOR point of view, it revealed however that additional information should be necessary to make the difference between such a situation and a real overcrowding. This explains the low score given for the *<u>sufficiency</u>* criteria.

However, the evaluators agreed that no other existing system could provide them with this information and judged very positively the *<u>worth</u>* of ADVISOR.

Globally, they were convinced to be able to exploit the information provided.

b) ***“Blocking entry/exit” situation***

The blocking situations detected in the hall (mezzanine) referred to pick pocketing activities, however the blocking situations detected at the top of the escalator referred to dangerous and unwanted situations.

Usefulness criteria \ Event/situation w.r.t. place combination	Blocking entry / exit						
	Halls (semi-open area)						
	EV1	EV2	EV3	EV1	EV2	EV3	Mean
Relevance of the alarms generated Do the alarms (detection) provided by the system have an obvious relationship with my security problems ?	C	B	A	0,35	0,65	0,95	0,650
Sufficiency of the information provided Do the relevant alarms (detection) provided by the system have an unambiguous relationship with my security problem ?	C	B	B	0,35	0,65	0,65	0,550
Worth of the information provided Are the relevant and sufficient information that I receive from the system difficult or impossible to obtain from other detectors ?	A	A	A	0,95	0,95	0,95	0,950
Work-ability of the information provided Do the received relevant, sufficient and worthwhile information allow or help me to take good decisions ?	B	A	B	0,65	0,95	0,65	0,750

Usefulness criteria \ Event/situation w.r.t. place combination	Blocking entry / exit						
	Stairs / escalators						
	EV1	EV2	EV3	EV1	EV2	EV3	Mean
Relevance of the alarms generated Do the alarms (detection) provided by the system have an obvious relationship with my security problems ?	B	B	A	0,65	0,65	0,95	0,750
Sufficiency of the information provided Do the relevant alarms (detection) provided by the system have an unambiguous relationship with my security problem ?	B	B	C	0,65	0,65	0,35	0,550
Worth of the information provided Are the relevant and sufficient information that I receive from the system difficult or impossible to obtain from other detectors ?	A	A	A	0,95	0,95	0,95	0,950
Work-ability of the information provided Do the received relevant, sufficient and worthwhile information allow or help me to take good decisions ?	B	A	B	0,65	0,95	0,65	0,750

The evaluators estimated it to be much more *relevant* to receive alerts about dangerous situations.

Once again, ADVISOR does not make any difference between both scenarios and provides similar information in both cases, which is reflected in the quite low score given for the *sufficiency* of the information provided.

The evaluators recognised that no other system could provide them such information and considered that they could exploit the information in most of the cases.

c) ***"People without ticket" situation***

Event/situation w.r.t. place combination / Usefulness criteria	People without ticket						
	Halls (semi-open area)						
	EV1	EV2	EV3	EV1	EV2	EV3	Mean
Relevance of the alarms generated Do the alarms (detection) provided by the system have an obvious relationship with my security problems ?	na	na	B	na	na	0,65	0,650
Sufficiency of the information provided Do the relevant alarms (detection) provided by the system have an unambiguous relationship with my security problem ?	na	na	A	na	na	0,95	0,950
Worth of the information provided Are the relevant and sufficient information that I receive from the system difficult or impossible to obtain from other detectors ?	na	na	A	na	na	0,95	0,950
Work-ability of the information provided Do the received relevant, sufficient and worthwhile information allow or help me to take good decisions ?	na	na	A	na	na	0,95	0,950

Unfortunately, Evaluators 1 and 2 considered that this situation was not relevant to them and gave the same very low score (D) for all the criteria however they did not mean that the detection was wrong or useless.

We preferred to inhibit their quotes, writing a "not applicable" and taking only the Evaluator 3 opinion into consideration for this situation.

It has to be noted that the Evaluator 3, who is an experienced operator, judged the relevance level of this detection not as high as his management did during the user requirements capture phase of the project.

It might reflect a difference of perception about the importance to arrest cheaters but it might also be an evolution in the thinking since the beginning of the ADVISOR project.

In fact, from the discussions held afterwards, it seems that the installation of other physical barriers (much more difficult to jump over) is envisaged.

d) ***"Violence" situation***

Usefulness criteria \ Event/situation w.r.t. place combination	Violence						
	Halls (semi-open area)						
	EV1	EV2	EV3	EV1	EV2	EV3	Mean
Relevance of the alarms generated Do the alarms (detection) provided by the system have an obvious relationship with my security problems ?	A	A	A	0,95	0,95	0,95	0,950
Sufficiency of the information provided Do the relevant alarms (detection) provided by the system have an unambiguous relationship with my security problem ?	A	A	C	0,95	0,95	0,35	0,750
Worth of the information provided Are the relevant and sufficient information that I receive from the system difficult or impossible to obtain from other detectors ?	A	A	A	0,95	0,95	0,95	0,950
Work-ability of the information provided Do the received relevant, sufficient and worthwhile information allow or help me to take good decisions ?	B	A	A	0,65	0,95	0,95	0,850

Usefulness criteria \ Event/situation w.r.t. place combination	Violence						
	Platform						
	EV1	EV2	EV3	EV1	EV2	EV3	Mean
Relevance of the alarms generated Do the alarms (detection) provided by the system have an obvious relationship with my security problems ?	A	A	A	0,95	0,95	0,95	0,950
Sufficiency of the information provided Do the relevant alarms (detection) provided by the system have an unambiguous relationship with my security problem ?	A	A	C	0,95	0,95	0,35	0,750
Worth of the information provided Are the relevant and sufficient information that I receive from the system difficult or impossible to obtain from other detectors ?	A	A	A	0,95	0,95	0,95	0,950
Work-ability of the information provided Do the received relevant, sufficient and worthwhile information allow or help me to take good decisions ?	B	A	A	0,65	0,95	0,95	0,850

Detection of violent situations was the most important request expressed by the users at the beginning of the project.

It is likely that all the Evaluators have been convinced by the way ADVISOR could detect such situations.

As it was already the case for the first situations above, ADVISOR is however unable to tell the difference between aggression and fighting people for example. In the first case, a victim suffers from real injuries. In the second case, fighting people cause a strong feeling of insecurity to the other passengers. Evaluator 3 would have preferred to receive more precise information.

e) ***<u>"Vandalism" situation</u>***

Event/situation w.r.t. place combination / Usefulness criteria	Vandalism						
	Halls (semi-open area)						
	EV1	EV2	EV3	EV1	EV2	EV3	Mean
Relevance of the alarms generated Do the alarms (detection) provided by the system have an obvious relationship with my security problems ?	na	na	A	na	na	0,95	0,950
Sufficiency of the information provided Do the relevant alarms (detection) provided by the system have an unambiguous relationship with my security problem ?	na	na	A	na	na	0,95	0,950
Worth of the information provided Are the relevant and sufficient information that I receive from the system difficult or impossible to obtain from other detectors ?	na	na	A	na	na	0,95	0,950
Work-ability of the information provided Do the received relevant, sufficient and worthwhile information allow or help me to take good decisions ?	na	na	A	na	na	0,95	0,950

Unfortunately, during the evaluation days, Evaluators 1 and 2 did not see any vandalism situation. This is most likely due to the fact that this part of the pre-recorded sequences did not arrive during their session. That is the reason for the "not applicable" note in the table above.

There are very few other comments to add since Evaluator 3, who has had the opportunity to see the vandalism situations, scored all the usefulness criteria very highly.

3.7.1.2 Review of the evaluation results for the usefulness criteria

The results obtained do not reveal any clear difference that should depend on the function of the evaluators. It just seems that Evaluator 1 has been a little more severe than the others.

Therefore, we will briefly analyse the results of the three evaluators together, trying to extract some useful information for possible further development.

- ***On relevance of the alarms generated***

Relevance of the alarms generated has been scored as follows :

- Overcrowding : 65%
- Blocking : 65% (for the scenario on pick-pocketing activities)
  75% (for the unwanted dangerous situations)
- People without ticket : 65%
- Violence : 95%
- Vandalism : 95%

This clearly confirms the original user requirements where Violence and Vandalism were very high on the “importance” scale attributed to the different needs expressed at the beginning of the project.

The need for the detection of people without tickets should probably be reassessed before continuing development in that direction. Indeed, since the beginning of the project, other physical barriers have been envisaged which make the detection with surveillance cameras less relevant. Probably, other detection means could be envisaged that should be more robust and reliable than the image based detection.

Overcrowding and blocking situations require better definition in order to separate wanted and unwanted blocking as well as normal and abnormal overcrowding. At this stage of development, it was not feasible to do this. However, taking other points into consideration (arrival of a train, position of the people, combining standing people with running people) could offer new and additional ideas to better focus possible future development.

- ***On sufficiency of the information provided***

  Sufficiency of the information provided has been scored as follows :

  - Overcrowding : 55%
  - Blocking : 55%
  - People without ticket : 95%
  - Violence : 75%
  - Vandalism : 95%

  These results are very consistent with the comments made above. Overcrowding, blocking and violence should be separated respectively into normal / abnormal, wanted / unwanted and aggression / fighting situations to allow clear and fast interpretation from the operators.

  People without ticket and vandalism speak better by themselves, however it has to be noted that we only used vandalism against equipment situations. In both cases, the required human action seems unambiguous and, anyway, does not depend on much more detailed information about the situation.

- ***On worth of the information provided***

  Worth (value) of the information provided has been scored as follows :

  - Overcrowding : 95%
  - Blocking : 95%
  - People without ticket : 95%
  - Violence : 95%
  - Vandalism : 95%

  This is obviously a very impressive score that confirms that ADVISOR really add a very high value to existing surveillance cameras.

Nevertheless, for what concerns the detection of people without ticket, we should try to investigate other possible ways before trying to improve the current level of development.

On the contrary, for the four other situations detected, we are quite confident that ADVISOR really does something that no other existing system on the market could currently do.

We are very pleased to see that the evaluators acknowledged this point.

- ***On work-ability of the information provided***

Work-ability (possible exploitation) of the information provided has been scored as follows :

- Overcrowding	:	85%
- Blocking	:	75%
- People without ticket	:	95%
- Violence	:	85%
- Vandalism	:	95%

All evaluators agreed to say that reaction time should be short to be efficient in such scenarios. However, it would depend on the operator himself to decide whether an urgent action is required or not.

It was also recognised that since the images have been recorded, they could also be exploited off-line afterwards to allow some second level reactions or decisions. This is especially true for further identification of pick-pocket, violent people and vandals.

Overcrowding and blocking situations should be solved immediately and do not require further identification of people. On the contrary, even if immediate and "in due time" action are much more difficult in the situations of vandalism, violence and people jumping over the barrier, the efficient off-line search and retrieval of the recorded images explain the very good last three scores mentioned above.

3.7.1.3 Partial conclusions on the usefulness of the ADVISOR system

The different sub-criteria used to evaluate the usefulness of the ADVISOR system have been scored between 55% and 95%.

Without any statistical ambition, but only to get a global idea, we should note that the overall mean values are :

- relevance of the alarm generated	:	79%
- sufficiency of the information provided	:	67%
- worth of the information provided	:	95%
- work-ability of the information provided	:	83%
- overall usefulness score	**:**	**81%**

Considering the comments reported above and in particular, the identified ways to reduce the weakest points, we believe that ADVISOR, after 3 years of development and possible evolution in the user needs, has strongly confirmed its usefulness.

It has also to be remarked that the results of this final evaluation are very much better than the score obtained after Test Bed 2 level of development (see reference 6 in section 1.1 above). We believe however that this is mainly due to the fact that the final demonstrator was installed in a much more realistic environment and has shown many more situations during a much longer period of time. We estimate that both evaluations could not be compared with each other from this usefulness criteria.

3.7.2 Operating criteria

3.7.2.1 Evaluation table and additional comments

Operating criteria	EV1	EV2	EV3	EV1	EV2	EV3	Mean
Human control Do I receive assistance from the system ? In which extend do I keep the control of the system ? Do I have the possibility to verify the information provided by the system ?	B	A	B	0,65	0,95	0,65	0,75
Efficiency of the switching functions Do the switching functions allow me to perform my job efficiently when no alarm occurs ? Do the switching functions allow me to perform my job efficiently when one or several alarms occur ?	B	B	B	0,65	0,65	0,65	0,65
Efficiency of the search and retrieval functions Am I always able to introduce all the searching requests that I wish ? Do I receive relevant answers to my requests from the system ? Am I able to efficiently "travel" within the images made available from the system ?	C	B	B	0,35	0,65	0,65	0,55
Alarm management Are the alarm messages easy to exploit ? Are the alarms easy to process ?	B	B	B	0,65	0,65	0,65	0,65

A number of additional comments have been provided by the evaluators about some sub-criteria. These comments are reported below.

- ***Efficiency of the switching functions***
  - Do the switching functions allow me to perform my job efficiently when no alarm occurs ?
  - Do the switching functions allow me to perform my job efficiently when one or several alarms occur ?

✍✍It should be better to close the graphical selection mode screen with a top-right corner cross like in the well known Windows environment instead of with a dedicated button.

✍✍The tracking emphasis function is insufficiently robust to be useful.

- ***Efficiency of the search and retrieving functions***
    - Am I always able to introduce all the searching requests that I wish ?
    - Do I receive relevant answers to my requests from the system ?
    - Am I able to efficiently "travel" within the images made available from the system?

✍ It should be useful to have a way to quickly compose a query (to the archive system) according to an alarm previously generated.

✍ Add a choice "all" in the list of activities to be selected in the process of creating a query to the archive system.

✍ One evaluator wanted to have a button to clean all the search window, including the previous search criteria.

✍ The archive system should filter the sequences returned to avoid that "stop and go" alarms should be considered as multiple alarms.

✍ The three evaluators requested to immediately use the VCR-like commands to start the archived selected sequences instead of the special "start" button.

✍ Layout of the "bookmarks" retrieved is not exactly the same as the layout of the "bookmarks" composed.

- ***Alarm management***
    - Are the alarm messages easy to exploit ?
    - Are the alarms easy to process ?

✍ One evaluator recommended to automatically delete the alarms acknowledged from the list. The other evaluators did not fully agree.

✍ Much more alarms should be displayed simultaneously in the ad hoc window. If not possible, it has been suggested to maximise this window.

✍ When an alarm occurs and the corresponding image is switched automatically, it should be possible to retrieve its beginning very quickly without being obliged to go into the search mode (same comment as the first one of the previous section).

3.7.2.2 Review of the evaluation results for the operating criteria

The evaluation performed by the three evaluators does not reveal clear differences between their opinion. Moreover, many of the additional comments have been made by more than one of them.

We analyse briefly the scores obtained below.

- ***On the human control***

  As soon as they managed the system, the evaluators had the feeling that they had good control of it and gave good score to that criteria.

  Only one evaluator (EV1) participated in the evaluation at Test Bed 2 level of development.

  The Test Bed 2 evaluators were mainly not daily operators.

  However the evaluators of the final demonstrator have been able to work with a Human Computer Interface version in their own language and even though most of the suggestions provided during Test Bed 2 evaluation had been implemented in the meantime, the current final evaluation is only slightly better (75% instead of 72,5%).

  Our interpretation is that much more effort should be devoted to simplify the working of the ADVISOR system. This should be a real challenge for the future, considering all the facilities that have to be exploited.

- ***On the efficiency of the switching functions***

  The evaluators of the final demonstrator have been able to work with a Human Computer Interface version in their own language and even though most of the suggestions provided during Test Bed 2 evaluation had been implemented in the meantime, the current final evaluation result is exactly the same as for Test Bed 2 (65%).

  The suggestions that were not implemented are :

  - possible use of keyboard shortcuts to select cameras and monitors
  - external monitors in addition to the four sub-screens provided

  We certainly have to consider that the Test Bed 2 switching function was implemented on a very limited scale. In the final demonstrator, the switching function were applied on both live cameras and pre-recorded cameras. Possibly, this caused some trouble and revealed a “new” complexity that could have counterbalanced the improvements made at the score level.

- ***On the efficiency of the search and retrieve functions***

  Score in Test Bed 2 evaluation was 72,5% and is now 55% however we implemented most of the suggestions made at that time.

  Considering that most of the additional comments and suggestions provided in the framework of the final evaluation are related to this criteria, we could imagine that the present score reflects much more the distance to “very good” than a real satisfaction measure.

  We also have to take into account that most of the evaluators were not the same people. In this final evaluation they were mainly daily operators and they had to use a nearly fully operational system offering numerous searching facilities. From this point of view, the current system is obviously much more complicated than the system presented during Test Bed 2 evaluation.

In particular, the various combinations of searching criteria offered makes the system very powerful but quite complicated. In the future, a special effort should be devoted to simplify again the working of these key functions of ADVISOR.

- ***On the alarm management***

The score received is equal to the score received at Test Bed 2 evaluation phase (65%). In this case, it seems however much more consistent. Indeed, we have to consider :

- that we were not able to implement the main facility requested (to move quickly from live alarm images to the immediate past images) and,
- that due to the use of pre-recorded sequences during this final evaluation, the ADVISOR system generated one alarm every 2 minutes during several hours.

Obviously, it was very challenging to manage all these alarms.

We consider that the current score reflects quite correctly a new evaluation of the system in very different circumstances. Improvements remain possible to manage better all these alarms generated.

3.7.2.3 Partial conclusions on the operating ability of the ADVISOR system

The different sub-criteria used to evaluate the operating ability of the ADVISOR system have been scored between 35% and 95%. However, we have to note that only one 35% and only one 95% scores have been given. All the other evaluations are 65%. It is consequently not astonishing that the

overall operating ability score is exactly 65%

As previously mentioned, the final demonstrator offered the possibility to evaluate the system quite realistically and quite extensively. This revealed new “difficulties” in its operating and the evaluators identified new or stressed previously identified desirable improvements.

Since the operating criteria is very important to make sure that such a system should be accepted by an operator, further development should take the remaining requirements into account.

Probably, is it relevant and fair to note that we forced the evaluators to chose between a limited number of scores for the reasons recalled in section 3.5.2 above. From that point of view, “B” (converted afterwards in 65%) is the second possible choice (“A” was nearly perfect).

From the comments and discussion held with the evaluators, the general feeling was very positive. Therefore, we believe that the 65% score obtained reflects a good evaluation but that the system could be improved to allow much more efficient operation.

3.7.3 Using criteria

3.7.3.1 Evaluation table and additional comments

Using criteria	EV1	EV2	EV3	EV1	EV2	EV3	Mean
Clearness of information / messages Are all the messages that are provided by the system simple, clear and unambiguous ?	A	A	A	0,95	0,95	0,95	0,95
Adaptation to users' understanding Are all the messages communicated to and actions required from operators well adapted to their level of understanding ?	C	A	A	0,35	0,95	0,95	0,75
Easiness to learn Is it easy to learn and use the system ?	B	A	A	0,65	0,95	0,95	0,85
Adaptation to work environment Am I able to configure the system to meet the constraints of my working environment ?	B	B	A	0,65	0,65	0,95	0,75
General ergonomics of the HCI Is the ADVISOR system user-friendly ? Is the ADVISOR system pleasant to use ?	B	B	A	0,65	0,65	0,95	0,75

The following additional comments have been made :

- ***Adaptation to user's understanding***
  - Are all the messages communicated to and actions required from operators well adapted to their level of understanding ?

    ✍✍It has to be noted that Evaluator 1, who is Security Supervisor, considered that the system in its whole is too complicated for normal Operators. On the contrary, Evaluators 2 and 3 who are Security Operators (however very experienced and skilled) found the system very easy to understand.

- ***Easiness to learn***
  - Is it easy to learn and use the system ?

    ✍✍Efficient and full exploitation of the search and retrieval facilities requires a very good understanding of the different concepts and is finally not so easy to learn.

- ***Adaptation to work environment***
  - Am I able to configure the system to meet the constraints of my working environment ?

    ✍✍Very few possibilities are provided to adapt the system to the work environment (only the language).

    ✍✍A buzzer or a loudspeaker should be provided as a minimum.

- ***General ergonomics of the HCI***
  - Is the ADVISOR system user-friendly ?
  - Is the ADVISOR system pleasant to use ?

    ✍✍The differences between the various working modes (live, retrieve, alarm) is not easy to recognise.

    ✍✍Some specialised buttons should be replaced by usual Windows environment buttons

3.7.3.2 Review of the evaluation results for the using criteria

- ***On the clearness of the information and messages***

  All the recommendations made at Test Bed 2 have been implemented and the score for this criteria goes from 72,5% to 95%

  Moreover, the fact that the HCI and all related messages have been translated into the languages of the evaluators certainly explains this very good score.

- ***On the adaptation to the users' understanding***

  We face here a curious situation, where the evaluators who are Operators judge that the system is well adapted to user's understanding, and where the evaluator who is Supervisor clearly fears that it is not.

- ***On the easiness to learn the system***

  Although the learning phase has been quite short, all the evaluators agreed that the system was very easy to learn. Once again, the improvements made since the previous intermediate evaluation (Test Bed 2) surely explain why the evaluation results go from 72,5% to 85%.

- ***On the adaptation to work environment***

It was the first time that the system had been installed in a realistic work environment. Indeed, previous intermediate evaluations occurred in laboratories.

After one week of work with the system in the TMB control room, i.e. within normal daily operation activities, it appeared clearly that such a system should alert operators not only by means of colour changes but also by means of acoustic medium (buzzer or loudspeaker).

We should note however, that the TMB evaluator gave an excellent score for this criteria (95%) which could reflect that he was familiar with the work environment. On the contrary, the STIB evaluators provided a medium score of 65% which might have been influenced by the fact that the work environment by itself was not theirs.

- ***On the general ergonomics of the HCI***

Even though all the suggestions requested during Test Bed 2 evaluation had been implemented, the evaluators made additional remarks. We have to be aware that the number of functions implemented at this latest stage of development was very high compared with the previous stage. This means that the intrinsic complexity of the system was higher, which probably requires much more attention to be paid to the general ergonomics of the HCI, so that the operators could use it in a very intuitive way.

3.7.3.3 Partial conclusions on the using of the ADVISOR system

The different sub-criteria used to evaluate the using of the ADVISOR system have been scored between 35% and 95%. However, we have to note that most of the scores given were 65% and 95%.

The overall using score is 81% which is very satisfying

However, since the using criteria is a key element to make sure that such a system should be accepted by an operator, further development should address the desirable improvements identified by the evaluators into account.

We have to note that those improvements requested are not very difficult to implement.

3.8 Impact Evaluation Results Reporting for the final evaluation

This part of the final evaluation reflects the estimation of the metro companies which supported the project about the impact that ADVISOR “could” have if it was deployed into their metro networks.

The metro companies provided useful information to evaluate the potential impact on :

- ***safety***
- ***security***

- ***traffic efficiency***
- ***personnel motivation***
- ***passenger behaviour***

Unfortunately, the forms provided in the package mentioned in section above were only partially filled in by the metro company responsible people for two reasons :

- ***they refused that sensitive data (mainly about criminality) would be published***
- ***sometimes, their statistical data did not include the necessary information***

For these reasons, we have used the information provided and completed this information by discussions and qualitative estimation provided by the concerned people.

3.8.1 Impact on safety

3.8.1.1 The users estimation of the impact on safety

Overall, STIB reports very few safety problems. Due to the fact that the metro of Brussels is usually not overcrowded, safety is well under control and accidents are very rare.

Most of the few accidents reported occur when accessing or leaving the trains. This situation being out of the scope of ADVISOR, we could not take such situations into account to evaluate its impact on safety.

STIB evaluates that ADVISOR should have a very limited impact on safety, regardless of the implementation scale (see section 3.4.2 above).

TMB records the following accidents :

Traffic interrupted	People with injuries	Number per year
No	No	Around 60
No	Yes	Around 2000
Yes	No	Around 60
Yes	Yes	Around 20

Barcelona counts about 3 millions inhabitants, which is about three times more than the number of Brussels inhabitants. Quite logically, the metro of Barcelona is much more populated than the Brussels one and safety issues are much more relevant to TMB.

Most of the accidents without traffic interruption and with people injuries occur in similar situations as mentioned above for STIB, i.e. when people access or leave trains. A small part is related to accidents in escalators, sometimes because the exit is blocked by other people. The "high" figure of about 2000 accidents consequently can not be taken into consideration within this part of the ADVISOR impact evaluation.

Most of the accidents of the last category (traffic interrupted and people with injuries) concern suicides which are currently not detected by ADVISOR and could consequently not be avoided by ADVISOR, regardless of the implementation scale.

TMB estimates that only some accidents belonging to the third category could partially be avoided by an adequate implementation of the ADVISOR system. Reasonable estimation does not exceed 10% of accidents avoided.

3.8.1.2 Partial conclusion about the impact on safety

The ADVISOR impact on safety should currently be very limited according to STIB managers. According to TMB managers, ADVISOR could help to avoid between 10 and 20 accidents each year, providing we have a wide implementation that allows detection of the relevant situations.

We must however temper this quite pessimistic evaluation. Indeed, the detection of two important situations originally defined and related to safety have not been demonstrated during the final demonstrator ("rapid increase of the crowding level" and "unbalanced floor occupation") due to a lack of recorded samples of such situations.

One could imagine that, especially for what concerns TMB, detection of those two additional scenarios could increase the percentage of avoided accidents.

Another point to consider is that the number of safety problems increases according to the size of the metro network. Brussels and Barcelona metro networks are of medium size.

3.8.2 Impact on security

3.8.2.1 The users estimation of the impact on security

Security issues include verbal and physical aggression towards passengers and metro personnel, pick-pocketing, numerous forms of vandalism and other anti-social activities.

Depending on their nature, the "incidents" may be reported by different people. For example, vandalism is usually reported by metro personnel and aggression is usually reported by the victims themselves.

Similarly, the "incidents" may be reported to different bodies. For example, passengers usually report anti-social activities to the metro personnel however they report aggressions to the metro police or even to their neighbourhood police (e.g. when they discover that they have had something stolen when they come back home).

Finally, a number of "incidents" are not reported because the people concerned believe that it is useless and they do not want to spend time with that. For what concerns verbal aggressions in particular, reporting highly depends on the perception of the victims.

These various reasons explain why the metro companies have difficulties to establish precise statistics and are consequently very reluctant to provide figures that could be misinterpreted.

As they say, "based on the figures we have, it is possible to prove that the metro is very secure or that the metro is very dangerous".

Based on the discussions we have had with the relevant company managers when trying to analyse the figures available, we established the following estimation.

	Percentage that could have been avoided	
Implementation scale	People has suffered	Equipment has suffered
2%	1%	1%
10%	2%	6%
50%	7%	20%
100%	10%	30%

It is important to note that these estimations are based on the assumption that the ADVISOR system has been "intelligently" implemented, i.e. in case of limited implementation, ADVISOR should first process the cameras installed in risky places.

The percentage of incidents that could be avoided obviously is related to the incidents that could be detected by the system and not related to the total number of incidents. The following example illustrates what is meant here: during the final evaluation sessions and presentations, we demonstrated that ADVISOR was able to detect vandalism against ticket vending machines. The 30% mentioned in the table above should be the percentage of this particular sort of vandalism that could be avoided (or limited in consequences) in case of full implementation of the ADVISOR system and providing that all the ticket vending machines are in the field of view of cameras successfully processed by ADVISOR.

It is important to understand that only the possible impact is evaluated here. From this point of view, it seems much more difficult to hope for an impact in case of "violence" situations than in case of "vandalism" situations.

3.8.2.2 Partial conclusion about the impact on security

ADVISOR potential impact on security seems much better than its potential impact on safety. We have to relate this estimation with the following points :

- safety is globally much better under control than security, which means that a metro company suffers more security "incidents" than safety "accidents". The probability of having a significant impact is consequently higher.
- security is, most of the time, related to human behaviours which are by their nature less predictable. Therefore, any help received from a system that could

allow security improvement is perceived as having potentially a high impact

- o most important requirements from the users (captured and reported in the framework of Workpackage 1) were related to security problems because their consequences could be much more damaging for the metro companies. This is logical in that the impact level is evaluated taking the potential consequences into account.

Any implementation scale of the system is helpful concerning the impact on each individual incident. However, only a significant implementation scale could have sufficient overall impact to influence the passengers and metro personnel perception and improve their subjective feeling of security. This means that we could expect two different implementation thresholds related respectively to the objective security and the subjective security.

3.8.3 Impact on traffic efficiency

3.8.3.1 The users estimation of the impact on traffic efficiency

Depending on the company policies, the traffic is organised to respect time schedule or to respect time intervals between trains.

They failed to respect these rules only very few times a year. Usually, the causes are accidents, technical failures or suicides.

They add trains only according to expected events (football matches, concert, etc).

Since no one of these events or situations is supposed to be detected by ADVISOR, TMB and STIB are not convinced that it could have a real impact on traffic efficiency for their networks.

3.8.3.2 Partial conclusion about the impact on traffic efficiency

In line of principle, one could expect that ADVISOR should improve traffic efficiency as far as the companies adapt the train frequency and number according to current and unexpected situations. It seems to be very rarely the case.

The other way to improve traffic efficiency would be to avoid such situations that disturb traffic regularity. However, the situations that ADVISOR is able to detect should not directly influence the traffic.

It is however likely that two of the situations that had originally been foreseen to detect, i.e. rapid increase of crowding level and unbalanced crowding occupancy on platform, could have a positive impact on traffic management. Unfortunately, since we were not able to demonstrate it (and consequently, the users were not able to evaluate it), one can not conclude anything based on the evaluation performed.

3.8.4 Impact on personnel motivation

As mentioned in above section 3.4.2 and in relevant section 3.5.3.2 of the Evaluation Plan (reference 5 according to 1.1), it was impossible to support the evaluation of the potential impact of personnel motivation by available data.

Motivation of the personnel of any company is a difficult matter to manage. For sure, motivation is related to work environment, to personal satisfaction, to personal agreement with companies activities, to personal perception of own utility, and many other issues.

As far as we can judge, people met during the evaluation days acknowledged that ADVISOR could influence the motivation of the personnel of the metro companies in various ways :

- operators would be satisfied to receive such a powerful advanced tool that could make them able to demonstrate their efficiency
- security patrols would be interested to receive information allowing them to be at the right place at the right time instead of “walking around” in the network
- cleaning and technical teams would be pleased to see that their company takes actions to avoid their work remaining somehow useless (or at least endless)
- commercial agents (ticket reselling people, advertising people, marketing people, etc.) would be happy to see their actions not systematically counterbalanced by various security problems having a very bad impact on the passengers feelings
- traffic operators and managers would be pleased to remain focussed on their core business, i.e. passengers transportation, instead of being forced to managed peripheral constraints related to security
- and many other people, from the personnel in charge of the maintenance of the trains to the general management, would be glad for a lot of different, but convergent, reasons

During the User Acceptance Evaluation (section 3.7 above) sessions and the intermediate and final presentations of the results, we have had the opportunity to meet a lot of people at various levels of the metro company organisations.

Every time, we received very positive feedback and really enthusiastic reactions. This has been true from people involved in the project since the very beginning but also from people who have discovered the project only at the very end.

We took care to systematically mention two very important points :

- ADVISOR is a system to help security operators and is not a system to replace them
- security operators keep control of ADVISOR and remain the final decision makers in case of detection.

In particular, the opinion of the potential users of the system about these points is very interesting to note. Within the operating criteria evaluated (section 3.7.2 above), there was a sub-criteria on “Human Control” which received a score of 75%.

Much more globally, the user acceptance evaluation (section 3.7 above) revealed scores most of the time around 80% which proved that the ADVISOR system should be very well accepted by its potential users.

In conclusion, based on the above considerations, one certainly can say that ADVISOR should have a very positive impact on personnel motivation if it was really implemented in the metro networks and control rooms.

3.8.5 Impact on passenger behaviour

The impact of the ADVISOR system on the passenger behaviour for what concerns their travel attitude may be threefold :

- ADVISOR might influence the total number of passengers
- ADVISOR might influence the passenger travelling hours (especially it might lead the passengers to travel later in the night)
- ADVISOR might influence the usage of currently “dangerous” metro stations

3.8.5.1 The users estimation of the impact on passenger behaviour

Using Form 14. to Form 16. presented in section 3.5.2.2 above, we tried to capture the opinion of the metro concerned managers about this potential impact.

Since ADVISOR is not able to detect all the interesting or suspicious situations, we tried to focus the estimation of the metro managers according to the five different scenarios considered at the final stage of development and described in section 3.2.1 above.

a) ***To what extent could the number of passengers be extended if the ADVISOR system was implemented and succeeded in reaching the following situations ?***

LESS OVERCROWDING

Abnormal overcrowding situations are interesting to detect for safety and/or security reasons. However, in both Brussels and Barcelona metros, abnormal overcrowding is quite rare. Usual overcrowding situations are very short in duration and mainly due to normal passengers movements.

For both metros, detection of overcrowding situations would not imply such a special reaction that could cause at the end a significant increase of the number of passengers.

LESS BLOCKING

If the passengers see a reaction from the metro company in case of blocking situations (unwanted and wanted), their feeling of security would increase.

On long term, this could have an impact on the number of passengers.

LESS VIOLENCE

Both metros agree to consider that detection of violence situations and adequate reaction from their relevant teams will have a strong impact on the feeling of security of the normal passengers.

At the same time, detection and reaction would have a deterrent effect on the potentially violent people, which should cause less violence in the metro in the long term.

LESS PEOPLE WITHOUT TICKETS

For STIB, this detection is not relevant since they do not use barriers to control access to the platforms.

For TMB, detection and reaction should have a deterrent impact. However, they do not see a direct impact on the number of passengers.

LESS VANDALISM

For both companies, dirty and/or damaged infrastructures prevent people from using the metro. Consequently, detection and quick reaction should also improve the feeling of normal passengers which should increase their potential number in the long term.

As well as for the detection of violence, detection of vandalism could have a deterrent impact too. Even if it is not possible to arrest the vandals, it is well known that a quick repair or cleaning is the best way to avoid additional damage. In this framework, it is necessary to react very quickly to break the vicious circle of the vandalism. Indeed, an already vandalised environment is usually vandalised again and again. On the contrary, a clean environment is less of a target for vandals.

b) ***To what extent could the passengers travel later than currently if the ADVISOR system was implemented and succeeded in reaching the following situations ?***

It has first to be noted that for what concerns TMB (Barcelona), stations are usually very populated till late in the evening. Since the metro stops its service and closes its stations quite early, the difference between normal traffic hours and “late” hours is certainly less remarkable than in Brussels.

LESS OVERCROWDING

There is even less overcrowding during the very early and very late hours of the day. It is not relevant to increase the number of passengers.

LESS BLOCKING

There is probably less unwanted blocking during the considered hours. However, wanted blocking in such an almost empty environment, should cause stronger bad impact on the blocked people.

As well as during “normal” hours, if the passengers see a reaction from the metro company in case of such blocking situations, their feeling of security would increase.

In the long term, this could encourage them to continue to travel with the metro during these early and late hours.

LESS VIOLENCE

Even more than during the normal traffic hour, the detection of violence situations and adequate reaction will have a strong positive impact on the feeling of security of the passengers.

At the same time, detection and reaction would have a deterrent effect on the potentially violent people which should cause less violence in the metro in the long term.

Both issues should encourage inhabitants of the city to use the metro later in the night than currently.

LESS PEOPLE WITHOUT TICKET

STIB : not relevant - see above

TMB : detection and reaction should have a deterrent impact. However, they do not see a direct impact on the number of paying passengers during the concerned hours.

LESS VANDALISM

Same reasoning as above.

The feeling of insecurity of people is higher in a less populated environment. The positive impact should consequently be proportionally higher outside the “normal” traffic hours.

c) ***To what extent could the most “dangerous” stations be more utilised than currently if the ADVISOR system was implemented and succeeded in reaching the following situations ?***

To this question, TMB answered that they especially control and supervise the stations that could be considered as dangerous and that consequently they do not have dangerous stations.

LESS OVERCROWDING

Not relevant.

LESS BLOCKING

Same feeling as for what concerns the late traffic hours.

LESS VIOLENCE

Same feeling as for what concerns the late traffic hours.

LESS PEOPLE WITHOUT TICKET

Not relevant.

LESS VANDALISM

Same reasoning as above.

The feeling of insecurity of people is higher in more damaged environments. The positive impact should consequently be proportionally higher than in less damaged environments.

3.8.5.2 Partial conclusion about the impact on passengers behaviour

Both metro companies agree that ADVISOR could improve the passenger's behaviour for what concerns their number, and their travel attitude.

However, due to different situations between Brussels and Barcelona[4], STIB seems to believe more than TMB that the impact could be significant.

Unfortunately, nobody wanted to provide any quantitative estimation of the impact.

3.9 Socio-economic Evaluation Results Reporting for the final evaluation

3.9.1 Approach followed

As explained in section 3.4.3 above, socio-economic evaluation aims at estimating the social benefits as the result of implementing the ADVISOR system.

In the ideal approach planned and described in the Evaluation Plan, we expected to get some good estimate of "retrievable" passengers due to the (potential) implementation of our system.

As mentioned in the Evaluation Plan, a qualitative socio-economic evaluation only makes sense if the technical validation, the user acceptance evaluation and the impact evaluation provided good results. Moreover, a quantitative socio-economic evaluation is only possible if the previous evaluation steps provided quantitative data.

The technical validation and the user acceptance evaluation gave quantitative scores, but unfortunately, the impact evaluation results reported above (section 3.8) provide only qualitative outcomes. Indeed, STIB and TMB, the metro companies associated with the project, were not in a position to evaluate quantitatively the impact of a potential implementation of the system.

We anticipated such a situation in the Evaluation Plan where we already mentioned that in the best case, the socio-economic evaluation should be based on assumptions.

Therefore, we will try to provide in the present section, a number of data that could allow further socio-economic evaluation as far as additional and complementary data will be available.

The reasoning followed in the next sections is :

- calculation of the implementation costs
- benefits from the increased number of passengers
- other socio-economic benefits

3.9.2 Calculation of implementation costs

3.9.2.1 Introduction

In order to evaluate the benefit of any implementation, it is necessary to know the gain

[4] in Barcelona, according to the habits of the inhabitants, the metro is very populated till late in the evening and the metro stops its service quite soon; in Brussels, the metro is less populated in the evening and however the metro stops its service later in the night.

and the cost of this implementation. The current section, through a practical example, aims at describing a way to estimate the implementation costs.

There were many possible assumptions, each of them having more or less impact on the costs.

For example, it is very different to consider that the ADVISOR system would be implemented in addition to an existing surveillance system (in which all the necessary cameras and transmission equipment are existing) or to consider a new full implementation.

Some nearly fixed costs, like design, engineering, training and maintenance would represent a smaller percentage of the total cost of a big implementation than of a limited implementation.

Depending on the configuration, the architecture, the company policies, the size of the metro network, the relevant authorities and many other factors, the implementation costs may be very different.

Our example corresponds to a medium-sized metro network and is based on the following data :

- a metro network with 50 “small” (local) stations and 10 “main” stations
- there would be 12 useful cameras in the local stations and 24 in the main stations
- a security operator is present in each main station and manages about 6 stations on the network
- there is no existing useable equipment, but an IP network is available between the different stations and the central control room
- there is only one central control room with 3 operators and 1 supervisor

At each step of the example that will follow, the interested people could adapt the reasoning to their own situation.

In this very simplistic situation, the goal at the end is to have an estimation of the global cost of a complete intelligent video surveillance system. The decision makers could then compare this cost with an evaluation of the social gains expected in terms of number of passengers, in terms of improved quality of life, in terms of traffic improvement, etc.

We will consider different categories of costs. Some are to be supported once, others are to be supported annually. At the end of the reasoning, we will calculate a total cost on a five year basis.

The four different cost categories that we have considered are :

- installation costs (equipment and manpower)
- training costs
- operating costs
- maintenance costs

3.9.2.2 Installation costs

Installation costs of the implementation of a system such as described in the section above, are estimated and presented in the following Form 17. to Form 21.

The cost of the ADVISOR IPU (Image Processing Unit), the ADVISOR SPU (Symbolic Processing Unit) and the ADVISOR HCI (Human Computer Interface) have been estimated on the basis of current knowledge corrected by expected optimisation and progress that should be brought before any real implementation.

INSTALLATION COSTS (part 1)	# (I)	Unit price (II)	Total price (I) x (II)
1 Equipment (part 1)			
Typical equipment in one local metro station			
Cameras + local transmission			
Camera + lens + housing + mounting	12	1.500,00 €	18.000,00 €
Video transmitter (twisted pair)	6	280,00 €	1.680,00 €
Coaxial cable	6	75,00 €	450,00 €
Twisted pair cable	6	30,00 €	180,00 €
Fiber optic cable	0	120,00 €	- €
sub-total (a1)			20.310,00 €
Local station technical room			
Technical cabinet	1	2.800,00 €	2.800,00 €
Electrical facilities	1	2.000,00 €	2.000,00 €
Video receiver (twisted pair)	6	320,00 €	1.920,00 €
Signal correction	6	350,00 €	2.100,00 €
Signal distribution	12	100,00 €	1.200,00 €
Local switcher	1	2.000,00 €	2.000,00 €
Local monitor	2	900,00 €	1.800,00 €
ADVISOR IPU (Image Processing Unit)	3	15.000,00 €	45.000,00 €
ADVISOR SPU (Symbolic Processing Unit)	1	8.500,00 €	8.500,00 €
Station LAN (local area network)	1	1.200,00 €	1.200,00 €
Connection to general IP network	1	1.200,00 €	1.200,00 €
sub-total (b1)			69.720,00 €
Equipment cost of a typical local metro station : (c1) = (a1) + (b1)			90.030,00 €
Number of local metro stations in the considered implementation scale (d1)			50
Total equipment cost for the local metro stations : (e1) = (c1) x (d1)			**4.501.500,00 €**

Form 17. Installation Costs – Equipment (part 1)

INSTALLATION COSTS (part 2)

1 Equipment (part 2)

Typical equipment in one main metro station

Cameras + local transmission

	# (I)	Unit price (II)	Total price (I) x (II)
Camera + lens + housing + mounting	24	1.500,00 €	36.000,00 €
Video transmitter (fibre otpic)	12	350,00 €	4.200,00 €
Coaxial cable	12	75,00 €	900,00 €
Twisted pair cable	0	30,00 €	- €
Fiber optic cable	12	120,00 €	1.440,00 €
sub-total (f1)			42.540,00 €

Main station technical room

	# (I)	Unit price (II)	Total price (I) x (II)
Technical cabinet	2	2.800,00 €	5.600,00 €
Electrical facilities	1	3.000,00 €	3.000,00 €
Video receiver (fibre optic)	12	400,00 €	4.800,00 €
Signal correction	12	350,00 €	4.200,00 €
Signal distribution	24	100,00 €	2.400,00 €
Local switcher	1	3.500,00 €	3.500,00 €
Local monitor	4	900,00 €	3.600,00 €
ADVISOR IPU (Image Processing Unit)	6	15.000,00 €	90.000,00 €
ADVISOR SPU (Symbolic Processing Unit)	2	8.500,00 €	17.000,00 €
Station LAN (local area network)	1	2.000,00 €	2.000,00 €
ADVISOR main station Security Operator HCI	1	4.500,00 €	4.500,00 €
Connection to general IP network	1	1.200,00 €	1.200,00 €
sub-total (g1)			141.800,00 €

Equipment cost of a typical main metro station : (h1) = (f1) + (g1)	184.340,00 €
Number of main metro stations in the considered implementation scale (i1)	10
Total equipment cost for the main metro stations : (j1) = (g1) x (i1)	**1.843.400,00 €**

Typical equipment for the metro dispatching

Dispatching technical room

	# (I)	Unit price (II)	Total price (I) x (II)
Technical cabinet	1	2.800,00 €	2.800,00 €
Electrical facilities	1	2.000,00 €	2.000,00 €
Connection to general IP network	1	3.000,00 €	3.000,00 €
ADVISOR maintenance HCI	1	5.000,00 €	5.000,00 €
sub-total (k1)			12.800,00 €

Control room with operators

	# (I)	Unit price (II)	Total price (I) x (II)
Electrical facilities	1	4.000,00 €	4.000,00 €
ADVISOR Security Operator HCI	3	4.500,00 €	13.500,00 €
ADVISOR Security Supervisor HCI	1	5.000,00 €	5.000,00 €
sub-total (l1)			22.500,00 €

Total equipment cost for the metro dispatching : (m1) = (k1) + (l1)	**35.300,00 €**
Total <u>equipment costs</u> for the considered implementation scale (n1) = (e1) + (j1) + (m1)	**6.380.200,00 €**

Form 18. Installation Costs – Equipment (part 2)

INSTALLATION COSTS (part 3)

2 Manpower (part 1)

Study and design

	# Hours (I)	Unit price (II)	Total price (I) x (II)
Overall ADVISOR deployment study and design			
Security Manager	200	80,00 €	16.000,00 €
Security Supervisor	200	65,00 €	13.000,00 €
Senior Design Engineer	400	76,00 €	30.400,00 €
Junior Design Engineer	400	58,00 €	23.200,00 €
sub-total (a2)			82.600,00 €
Dispatching and control room study and design			
Traffic Manager	100	80,00 €	8.000,00 €
Security Manager	100	80,00 €	8.000,00 €
Security Supervisor	150	65,00 €	9.750,00 €
Senior Design Engineer	200	76,00 €	15.200,00 €
Junior Design Engineer	200	58,00 €	11.600,00 €
sub-total (b2)			52.550,00 €
Typical main station deployment study and design			
Security Manager	80	80,00 €	6.400,00 €
Security Supervisor	150	65,00 €	9.750,00 €
Senior Design Engineer	200	76,00 €	15.200,00 €
Junior Design Engineer	400	58,00 €	23.200,00 €
sub-total (c2)			54.550,00 €
Typical local station deployment study and design			
Security Manager	50	80,00 €	4.000,00 €
Security Supervisor	80	65,00 €	5.200,00 €
Senior Design Engineer	120	76,00 €	9.120,00 €
Junior Design Engineer	240	58,00 €	13.920,00 €
sub-total (d2)			32.240,00 €
Detailed main and local stations deployment study and design			
Senior Design Engineer	200	76,00 €	15.200,00 €
Junior Design Engineer	400	58,00 €	23.200,00 €
sub-total (e2)			38.400,00 €
IP network detailed deployment study and design			
Networking System Engineer	120	76,00 €	9.120,00 €
Junior Design Engineer	200	58,00 €	11.600,00 €
sub-total (f2)			20.720,00 €
Electrical facilities study and design			
Senior Design Engineer	120	76,00 €	9.120,00 €
Junior Design Engineer	200	58,00 €	11.600,00 €
sub-total (g2)			20.720,00 €

Manpower cost of study and design : (h2) = (a2) + (b2) + (c2) + (d2) + (e2) + (f2) + (g2) **301.780,00 €**

Form 19. Installation Costs – Manpower (part 1)

INSTALLATION COSTS (part 4)	# Hours (I)	Unit price (II)	Total price (I) x (II)
2 Manpower (part 2)			
Engineering			
Overall ADVISOR engineering			
Senior Project Engineer	150	76,00 €	11.400,00 €
Junior Project Engineer	250	58,00 €	14.500,00 €
sub-total (i2)			25.900,00 €
Dispatching and control room engineering			
Senior Project Engineer	100	76,00 €	7.600,00 €
Junior Project Engineer	150	58,00 €	8.700,00 €
sub-total (j2)			16.300,00 €
Typical main station engineering			
Senior Project Engineer	150	76,00 €	11.400,00 €
Junior Project Engineer	250	58,00 €	14.500,00 €
sub-total (k2)			25.900,00 €
Typical local station engineering			
Senior Project Engineer	100	76,00 €	7.600,00 €
Junior Project Engineer	150	58,00 €	8.700,00 €
sub-total (l2)			16.300,00 €
Detailed main and local stations engineering			
Senior Project Engineer	200	76,00 €	15.200,00 €
Junior Project Engineer	350	58,00 €	20.300,00 €
sub-total (m2)			35.500,00 €
IP network detailed engineering			
Networking System Engineer	150	76,00 €	11.400,00 €
Junior Project Engineer	250	58,00 €	14.500,00 €
sub-total (n2)			25.900,00 €
Electrical facilities engineering			
Senior Project Engineer	250	76,00 €	19.000,00 €
Junior Project Engineer	400	58,00 €	23.200,00 €
sub-total (o2)			42.200,00 €
Manpower cost of engineering : (p2) = (i2) + (j2) + (k2) + (l2) + (m2) + (n2) + (o2)			**188.000,00 €**

Form 20. Installation Costs – Manpower (part 2)

INSTALLATION COSTS (part 5)

2 Manpower (part 3)

Installation

	# Hours (I)	Unit price (II)	Total price (I) x (II)
Typical local station			
Project Manager	20	80,00 €	1.600,00 €
Project Engineer	40	76,00 €	3.040,00 €
Technicians	100	55,00 €	5.500,00 €
Electricians	100	50,00 €	5.000,00 €
sub-total (q2/*)			15.140,00 €
Number of local metro stations in the considered implementation scale (q2/**)			50
sub-total (q2) = (q2/*) x (q2/**)			**757.000,00 €**
Typical main station			
Project Manager	50	80,00 €	4.000,00 €
Project Engineer	100	76,00 €	7.600,00 €
Technicians	250	55,00 €	13.750,00 €
Electricians	250	50,00 €	12.500,00 €
sub-total (r2/*)			37.850,00 €
Number of main metro stations in the considered implementation scale (r2/**)			10
sub-total (r2) = (r2/*) x (r2/**)			**378.500,00 €**
Metro dispatching			
Project Manager	60	80,00 €	4.800,00 €
Project Engineer	100	76,00 €	7.600,00 €
Technicians	200	55,00 €	11.000,00 €
Electricians	100	50,00 €	5.000,00 €
sub-total (s2)			28.400,00 €
Manpower cost of installation : (t2) = (q2) + (r2) + (s2)			**1.163.900,00 €**

Testing and commissioning

	# Hours (I)	Unit price (II)	Total price (I) x (II)
Typical local station			
Project Manager	10	80,00 €	800,00 €
Project Engineer	25	76,00 €	1.900,00 €
sub-total (u2/*)			2.700,00 €
Number of local metro stations in the considered implementation scale (u2/**)			50
sub-total (u2) = (u2/*) x (u2/**)			**135.000,00 €**
Typical main station			
Project Manager	20	80,00 €	1.600,00 €
Project Engineer	50	76,00 €	3.800,00 €
sub-total (v2/*)			5.400,00 €
Number of main metro stations in the considered implementation scale (v2/**)			10
sub-total (v2) = (v2/*) x (v2/**)			**54.000,00 €**
Metro dispatching			
Project Manager	20	80,00 €	1.600,00 €
Project Engineer	50	76,00 €	3.800,00 €
sub-total (w2)			5.400,00 €
Manpower cost of testing and commissioning : (x2) = (u2) + (v2) + (w2)			**194.400,00 €**
<u>Manpower for installation</u> of considered implementation (y2) = (h2) + (p2) + (t2) + (x2)			**1.848.080,00 €**

Form 21. Installation Costs – Manpower (part 3)

3.9.2.3 Training costs

The training costs estimated are presented in Form 22. and Form 23. .

To be consistent with the principle adopted since the beginning of the example, we consider that the metro company wants to create a documentation system that will be regularly updated in order to support its training policy.

The training costs taken into consideration in the present section are the initial training costs (to be supported once). Further update of the documentation and related additional training are considered as a section of the maintenance costs in section 3.9.2.5 below.

TRAINING COSTS (part 1)	# - # Hours (I)	Unit price (II)	Total price (I) x (II)
3 Manpower and equipment to prepare and implement the training facilities			
Implementation of the documentation facilities (on-line / CD-Rom / paper)			
Hardware and software for a documentary database			
Computer facilities	1	4.000,00 €	4.000,00 €
Documentary management software	1	5.000,00 €	5.000,00 €
Documentary redaction software	1	3.000,00 €	3.000,00 €
sub-total (a3)			12.000,00 €
Manpower			
Data-base Engineer	100	70,00 €	7.000,00 €
Networking Engineer	50	70,00 €	3.500,00 €
sub-total (b3)			10.500,00 €
Cost of implementing the documentation facilities : (c3) = (a3) + (b3)			**22.500,00 €**
Writing of the documentation			
Manpower			
Project Engineer	150	76,00 €	11.400,00 €
System Engineer	100	76,00 €	7.600,00 €
Security Manager	60	80,00 €	4.800,00 €
Security Supervisor	100	65,00 €	6.500,00 €
Documentation Writer	500	52,00 €	26.000,00 €
sub-total (d3)			56.300,00 €
Cost of preparing the training : (e3) = (c3) + (d3)			**78.800,00 €**

Form 22. Training Costs – Preparation of the training

TRAINING COSTS (part 2)

	# - # Hours (I)	Unit price (II)	Total price (I) x (II)
4 Manpower of the trainees and cost of the trainers			
Technical training for maintenance personnel			
Hardware and software of a typical local station			
Maintenance Engineer	2	1.440,00 €	2.880,00 €
Maintenance Technician	5	1.300,00 €	6.500,00 €
sub-total (a4)			9.380,00 €
Hardware and software of a typical main station			
Maintenance Engineer	2	720,00 €	1.440,00 €
Maintenance Technician	5	650,00 €	3.250,00 €
sub-total (b4)			4.690,00 €
Hardware and software of the dispatching and control room			
Maintenance Engineer	2	1.440,00 €	2.880,00 €
Maintenance Technician	5	1.300,00 €	6.500,00 €
sub-total (c4)			9.380,00 €
Hardware and software of the telecommunication network			
Network Engineer	2	2.280,00 €	4.560,00 €
Maintenance Engineer	2	2.160,00 €	4.320,00 €
Maintenance Technician	5	1.950,00 €	9.750,00 €
sub-total (d4)			18.630,00 €
Cost training the maintenance personnel : (e4) = (a4) + (b4) + (c4) + (d4)			**42.080,00 €**
Operation training for security personnel			
Operating a typical main station HCI			
Security Supervisor	4	1.500,00 €	6.000,00 €
Security Operator	20	1.240,00 €	24.800,00 €
sub-total (f4)			30.800,00 €
Operating a control room HCI			
Security Manager	2	3.600,00 €	7.200,00 €
Security Supervisor	4	3.000,00 €	12.000,00 €
Security Operator	10	2.480,00 €	24.800,00 €
Traffic Manager	4	3.600,00 €	14.400,00 €
sub-total (g4)			58.400,00 €
Operating a dispatching technical room HCI			
System Manager	2	1.720,00 €	3.440,00 €
Security Supervisor	4	1.500,00 €	6.000,00 €
sub-total (h4)			9.440,00 €
Cost training the operation personnel : (i4) = (f4) + (g4) + (h4)			**98.640,00 €**
<u>Total manpower of the trainees</u> : (j4) = (e4) + (i4)			**140.720,00 €**

Form 23. Training Costs – Manpower of the Trainees and Costs of the Trainers

3.9.2.4 Operating costs

The operating costs are the ones which are to be supported every year.

We have included here mainly the manpower necessary to operate the ADVISOR system within the architecture described in section 3.9.2.1 above, but also other expenditures like electrical consumption.

Operating costs are presented in Form 24. below.

The maintenance costs are described in next section.

OPERATING COSTS - annual basis	# - # Hours (I)	Unit price (II)	Total price (I) x (II)
5 Manpower			
Security Management			
Organisation of the HCI Operations			
Security Manager	0,5	128.000,00 €	64.000,00 €
Security Supervisor	1	104.000,00 €	104.000,00 €
sub-total (a5)			168.000,00 €
Control and tracking of the Security Activities			
Security Manager	0,5	128.000,00 €	64.000,00 €
System Engineer	0,5	121.600,00 €	60.800,00 €
sub-total (b5)			124.800,00 €
HCI Operation			
Operation of the control room			
Security Supervisor	1	104.000,00 €	104.000,00 €
Security Operator	3	83.200,00 €	249.600,00 €
sub-total (c5)			353.600,00 €
Operation of a main metro station			
Security Operator sub-total (d5/*)	1	83.200,00 €	83.200,00 €
Number of main metro stations in the considered implementation scale (d5/**)			10
sub-total (d5) = (d5/*) x (d5/**)			**832.000,00 €**
Cost manpower of operating the system : (e5) = (a5) + (b5) + (c5) + (d5)			**1.478.400,00 €**
6 Other operation expenditures			
Electrical consumption			
Typical local station			
Cameras and local transmitter	12	88,00 €	1.056,00 €
Technical cabinet and integrated equipment	1	900,00 €	900,00 €
sub-total (a6/*)			1.956,00 €
Number of local metro stations in the considered implementation scale (a6/**)			50
sub-total (a6) = (a6/*) x (a6/**)			**97.800,00 €**
Typical main station			
Cameras and local transmitter	24	88,00 €	2.112,00 €
Technical cabinet and integrated equipment	2	900,00 €	1.800,00 €
Main station HCI	1	150,00 €	150,00 €
sub-total (b6/*)			4.062,00 €
Number of main metro stations in the considered implementation scale (b6/**)			10
sub-total (b6) = (b6/*) x (b6/**)			**40.620,00 €**
Dispatching and control room			
Technical room and integrated equipment	1	500,00 €	500,00 €
Control room HCI	4	150,00 €	600,00 €
sub-total (c6)			1.100,00 €
Cost electrical consumption of operating the system : (d6) = (a6) + (b6) + (c6)			**139.520,00 €**
Consummables			
Estimated budget of the consummables (e6)	12	1.000,00 €	12.000,00 €
Cost other expendidures for operating the system : (f6) = (d6) + (e6)			**151.520,00 €**

Form 24. Operating Costs – annual basis

3.9.2.5 Maintenance costs

Maintenance costs are also to be supported on an annual basis. They include consumption of spares, manpower and updating of the documentation of the system.

These costs are presented in Form 25. to Form 27. below.

MAINTENANCE COSTS (part 1) - annual basis	# (I)	Unit price (II)	Total price (I) x (II)
7 Equipment and spare parts for :			
Local and main metro stations			
Camera + lens + housing + mounting	16	1.500,00 €	24.000,00 €
Video transmitter (twisted pair)	10	280,00 €	2.800,00 €
Video transmitter (fibre otpic)	8	350,00 €	2.800,00 €
Video receiver (twisted pair)	10	320,00 €	3.200,00 €
Video receiver (fibre optic)	8	400,00 €	3.200,00 €
Signal correction	16	350,00 €	5.600,00 €
Signal distribution	16	100,00 €	1.600,00 €
Local switcher (small)	2	2.000,00 €	4.000,00 €
Local switcher (big)	1	3.500,00 €	3.500,00 €
Local monitor	8	900,00 €	7.200,00 €
ADVISOR IPU (Image Processing Unit)	6	15.000,00 €	90.000,00 €
ADVISOR SPU (Symbolic Processing Unit)	4	8.500,00 €	34.000,00 €
Networking equipment	2	2.000,00 €	4.000,00 €
Connection to MAN (metropolitan area network)	2	1.200,00 €	2.400,00 €
ADVISOR Operator HCI	2	4.500,00 €	9.000,00 €
Misceanellous	1	5.000,00 €	5.000,00 €
sub-total (a7)			202.300,00 €
Metro dispatching and control room			
Networking equipment	1	2.000,00 €	2.000,00 €
ADVISOR maintenance HCI	1	5.000,00 €	5.000,00 €
ADVISOR Security Operator HCI	1	4.500,00 €	4.500,00 €
sub-total (b7)			11.500,00 €
Cost spare parts for the maintenace of the system : (c7) = (a7) + (b7)			**213.800,00 €**

Form 25. Maintenance Costs - Spares

MAINTENANCE COSTS (part 2) - annual basis

	# Hours (I)	Unit price (II)	Total price (I) x (II)
8 Manpower for the maintenance of the equipment (hardware and software), i.e. :			
Hardware and software of a typical local metro station			
Cameras + local transmission			
Maintenance Engineer	6	62,00 €	372,00 €
Maintenance Technician	24	55,00 €	1.320,00 €
sub-total (a8)			1.692,00 €
Local station technical room			
Network Engineer	10	66,00 €	660,00 €
Maintenance Engineer	12	62,00 €	744,00 €
Maintenance Technician	48	55,00 €	2.640,00 €
sub-total (b8)			4.044,00 €
Manpower for the maintenance of one local metro station (c8/*) = (a8) + (b8)			5.736,00 €
Number of local metro stations in the considered implementation scale (c8/**)			50
sub-total (c8) = (c8/*) x (c8/**)			**286.800,00 €**
Hardware and software of a typical main metro station			
Cameras + local transmission			
Maintenance Engineer	10	62,00 €	620,00 €
Maintenance Technician	40	55,00 €	2.200,00 €
sub-total (d8)			2.820,00 €
Main station technical room			
Maintenance Engineer	16	66,00 €	1.056,00 €
Maintenance Technician	20	62,00 €	1.240,00 €
Networking Technician	48	55,00 €	2.640,00 €
sub-total (e8)			4.936,00 €
Manpower for the maintenance of one main metro station (f8/*) = (d8) + (e8)			7.756,00 €
Number of main metro stations in the considered implementation scale (f8/**)			10
sub-total (f8) = (f8/*) x (f8/**)			**77.560,00 €**
Hardware and software of the dispatching and control room			
Dispatching technical room			
Maintenance Engineer	40	66,00 €	2.640,00 €
Maintenance Technician	80	62,00 €	4.960,00 €
Networking Technician	80	55,00 €	4.400,00 €
sub-total (g8)			12.000,00 €
Control room with operators			
Maintenance Engineer	20	62,00 €	1.240,00 €
Maintenance Technician	40	55,00 €	2.200,00 €
sub-total (h8)			3.440,00 €
Manpower for the maintenance of the dispatching and control room (i8) = (g8) + (h8)			15.440,00 €
Cost manpower for the maintenace of the equipment : (j8) = (c8) + (f8) + (i8)			**379.800,00 €**

Form 26. Maintenance Costs – Manpower for the maintenance of the equipment

MAINTENANCE COSTS (part 3) - annual basis

9 Manpower for the updating of documentation and further training

Maintenance of the hardware and software of the documentation facilities

	# Hours (I)	Unit price (II)	Total price (I) x (II)
Data-base Engineer	80	70,00 €	5.600,00 €
Networking Engineer	40	70,00 €	2.800,00 €
sub-total (a9)			8.400,00 €

Documentation and further training

Update and further training on local and main station hw and sw

	# Hours (I)	Unit price (II)	Total price (I) x (II)
Networking Engineer	40	70,00 €	2.800,00 €
Project Engineer	40	76,00 €	3.040,00 €
System Engineer	40	76,00 €	3.040,00 €
Security Manager	30	80,00 €	2.400,00 €
Security Supervisor	40	65,00 €	2.600,00 €
Security Operator	30	52,00 €	1.560,00 €
sub-total (b9)			15.440,00 €

Update and further training on dispatching and control room hw and sw

	# Hours (I)	Unit price (II)	Total price (I) x (II)
Networking Engineer	30	70,00 €	2.100,00 €
Project Engineer	30	76,00 €	2.280,00 €
System Engineer	40	76,00 €	3.040,00 €
Security Manager	60	80,00 €	4.800,00 €
Security Supervisor	60	65,00 €	3.900,00 €
Security Operator	40	52,00 €	2.080,00 €
sub-total (c9)			18.200,00 €

Costs for the maintenance of the documentation system (d9) = (a9) + (b9) + (c9) **42.040,00 €**

Form 27. Maintenance Costs – Update of the Documentation and further Training

3.9.2.6 Summary of the implementation costs

The table below collect all the costs calculated before.

At the end, we consider the global cost on a five year basis which is acceptable for such a technology and such an environment.

SUMMARISING TABLE OF COSTS

	Costs to be reported from		
INSTALLATION COSTS			
Total equipment costs for the considered implementation scale	Form 18	(n1)	6.380.200,00 €
Manpower for installation of considered implementation	Form 21	(y2)	1.848.080,00 €
Total Installation Costs	(n1) + (y2) =	IC	8.228.280,00 €
TRAINING COSTS			
Cost of preparing the training	Form 22	(e3)	78.800,00 €
Total manpower of the trainees	Form 23	(j4)	140.720,00 €
Total Training Costs	(e3) + (j4) =	TC	219.520,00 €
OPERATING COSTS (annual basis)			
Cost manpower for operating the system	Form 24	(e5)	1.478.400,00 €
Cost other expendidures for operating the system	Form 24	(f6)	151.520,00 €
Total Annual Operating Costs	(e5) + (f6) =	OP	1.629.920,00 €
MAINTENANCE COSTS (annual basis)			
Cost spare parts for the maintenace of the system	Form 25	(c7)	213.800,00 €
Cost manpower for the maintenace of the equipment	Form 26	(j8)	379.800,00 €
Costs for the maintenance of the documentation system	Form 27	(d9)	42.040,00 €
Total Annual Maintenance Costs	(c7) + (j8) + (d9)	MC	635.640,00 €

CALCULATION OF THE IMPLEMENTATION COSTS ON A FIVE YEARS PERIOD

IPC = 1 x (IC + TC) + 5 x (OP + MC)	**IPC**	**19.775.600,00 €**

Form 28. Summarising Table of Costs

This final global cost of about 20 millions EURO would be taken into account when comparing with the potential social benefits on the same five years period of time.

3.9.3 Benefits from the expected increased number of passengers

As mentioned above, the impact evaluation did not provide quantitative data that could allow us to evaluate the potential increase of passengers resulting from an implementation of the ADVISOR system.

The calculation below aims at encouraging possible decision makers to consider the industrialisation (from manufacturer point of view) and the implementation (from metro companies point of view) of ADVISOR.

The example on which we have based the estimation of implementation costs, corresponds to a medium-sized metro network (60 stations) covering adequately the territory of a medium-sized city (around 1 million inhabitants).

It is reasonable to consider that such a metro network transports daily 300.000 people. According to usual metro calculation, it does not mean that the metro transports 300.000 different people every day, but that the metro realises 300.000 travels of people every day.

On a year basis : 300.000 x 365 = 109.500.000 travels. Let's round this number to 100.000.000 to take less busy periods into account.

In the framework of previous projects (PASSWORDS and AVS-PV) which dealt with increasing security in metro environment (see references in section 1.2), it has been learned from studies achieved by some European public transportation companies, that one of the main reasons why people who could take the metro do not take it, is the feeling of insecurity.

According to these studies, between 2 and 10% of additional passengers could be gained if this feeling of insecurity could disappear.

For the purpose of the present reasoning, let's suppose that the full implementation of the ADVISOR system that has been envisaged to illustrate our costs estimation, should generate 2% of additional travels.

As repeated many times in the document and in the evaluation plan, we have to be very cautious with figures when trying to evaluate the benefits expected from a system that does not exist, that has not been implemented and that has only be seen by a very limited number of responsible people. Keeping this idea in mind, the 2% of potential increasing of travels seem sufficiently low to be accepted as a calculation basis.

On this basis, the ADVISOR system should generate an increase of 100.000.000 x 2% = 2.000.000 additional travels on a year.

Let's consider that the mean price of a ticket is 1 EURO. This should generate 2.000.000 EURO of additional revenue each year.

If the existing infrastructure is able to sustain these additional travels without additional costs, we could roughly consider that the implementation of the ADVISOR system could potentially generate 10.000.000 EURO of additional revenues in five years from the increase of the number of passengers.

We are well aware that all the figures used above and that the reasoning followed may be discussed, but we believe that they are sufficiently cautious to take their result into consideration.

If we compare the results from the present and the previous sections, we find :

- Implementation costs on a five year basis : 20.000.000 EURO
- Financial benefits from the increased number of travels : 10.000.000 EURO

Taking all the assumptions made into account, we could consider that 50% of the implementation costs could be supported financially by the increase of the number of passengers.

This is very impressive and should encourage the decision makers to go further in the analysis.

3.9.4 Other socio-economic benefits

Socio-economic benefits, at large, include many more than economic benefits. It is relevant to consider :

- efficiency of public transport systems
- influence on the automotive traffic
- possible improved mobility
- reduction of time lost in traffic jams
- influence on environmental conditions
- possible improved access to cultural and other social activities of the city
- improvement of the citizen quality of life
- and probably many other related issues

Those matters have been addressed and analysed in greater detail in the PRISMATICA project (seen reference in section 1.2 above) and relevant outcomes should be taken into account together with the present ADVISOR evaluation. A number of PRISMATICA Deliverables are dealing with various aspects of socio-economic benefits. By courtesy of the PRISMATICA project, we have copied below some key extracts of the relevant documents to give the interested reader a first view on the subjects handled in the full deliverables.

Additional information can be found or requested via the PRISMATICA web site : http://www.prismatica.com

Extracts from PRISMATICA Deliverable D2 : "State of the Art – Passenger actual and perceived security in Public Transports – theoretical and empirical elements"

PRISMATICA is part of the efforts to make public transport systems more attractive to passengers and staff by decreasing the feelings of insecurity as well as by raising the actual level of security. This is within the framework of making public transport security more cost-effective.

This report, the State of the Art, is dedicated to the review and analysis of existing reports and articles in the field of public transport security (e.g. indicators, statistics, processes, perceived security, theories) as well as PRISMATICA-research already implemented. The results of the PRISMATICA-general questionnaire and Juvenile delinquency questionnaire as well as initial insights regarding operational requirement analysis and perceptions of key stakeholders are used for the content of this report.

…

Eleven operators (the PRISMATICA-operators) replied on a questionnaire on security issues, supplying interesting and useful information for this State of the Art report. The eleven is by all means big in size and active in major cities.

…

Security not so long ago was a big issue for the transport operators. In 1980 three out of 10 PRISMATICA-operators had a security policy. Today, due to increasing crime rates, all these operators have a security policy and are spending on average about 16,7 million Euro per year of security in their network. If their network would be more secure the use of the network might increase by over 10%, especially in off-peak hours. A very substantial extra benefit. Vandalism, violence against staff and cost of fraud encourage the operators to introduce the policy. These three are the most important factors still today and in the near future as well, with a substantial increase in the importance of violence against staff and passengers.

…

To improve the level of security in the USA with a certain level it might be seven times more expensive to arrive at the same level of national security when the investment is moved from improving informal social control to increasing law enforcement.

…

Service quality evaluation. Asking staff and passengers about how they perceive the quality of public transport might as well be the starting point of evaluating security measures taken by the public transport operators. Security is seen as a part of the quality of the service that is provided by public transport operators, together with availability, accessibility, information, time, customer care, comfort and environment. If they do not feel secure and therefore stop using the public transport it is time for the operator to take action.

Extracts from PRISMATICA Deliverable D3 : "Common set of security statistics and indicators for public transport"

… we find a rough indication about the security costs in comparison with the total annual budget. They vary from 3,2% to 0,013%. Although when STIB[5] has to pay all the security costs it would end up with a percentage of 0,92%. This would make PPT[6] the network with the lowest security costs. They however have not included the police surveillance. This is a responsibility of the police for which PPT does not pay anything. If they would have to pay it, they would end up with a much higher percentage. It is the same for RATP[7], which does not pay for making police watch its system. Consequently, it becomes clear why for example for LUL[8] and ML[9] the costs for police and security personnel is the highest of all security costs. This taken into consideration we can maybe draw the conclusion that a metro network spends a higher percentage of its budget on security than mixed (including bus or tram networks). At the same time we can conclude that for major European cities, the security costs will invariably be about 1% or more of the annual budget.

…

The results of the research on perceived (but also registered) security might be used to improve the situation in stations, on lines or even on the whole network. These improvements should be communicated to the people using or willing to use public transport if they feel more secure. Earlier research indicated that use of public transport might be increased by 10% or even 38%, depending on the research done if people felt more secure using public transport. However, those results coming from mainly American surveys should be considered with all reserves due to peculiarities.

Extracts from PRISMATICA Deliverable D4 : "Report on requirements for project tools and processes"

The results presented … provide a framework of requirements for the definition and development of innovative processes and the design and development of innovative tools.

…

The … study informs the rest of the project by providing a social inclusion perspective from which to examine systems (existing or new designs) dealing with personal security in public transport systems.

… the study [is based] upon extensive field work and interviews which have been undertaken in the transport operator networks and the community.

…

One important aim of environmental policies is to effect significant shifts in travelling patterns from private to public modes. At the same time, governmental

[5] STIB : metro of Brussels (was member of the PRISMATICA consortium and a the same time, was associated to ADVISOR)
[6] PPT : metro of Prague
[7] RATP : metro of Paris
[8] LUL : metro of London
[9] ML : metro of Lisbon

social policies aim to improve the quality of life/health of all citizens and make societies more socially inclusive. Public transport can be more attractive if fears for personal security are reduced.

Part two of this Deliverable presents the results of field studies on perceptions of personal security of key stakeholders, such as passengers, citizen groups and personnel, having regard to implications that these perceptions may have for social inclusion or exclusion and for processes and tools.

The objective is to get an insight into their opinions on the expectations that stakeholders have of a computer-supported surveillance system, factors that affect perceived and reported personal security and effects on accessibility.

To achieve such an objective, the needs and views of people have been gathered to inform the rest of the project (especially the developments of processes and tools) through:

An understanding of the difference between reported (i.e. registered and therefore documented) personal security and perceived personal security (i.e. people's perception of risks to their personal security) and how this might improve social inclusion through public transport use.

Understanding people's concerns when using (or choosing not to use) public transport and their suggestions for improvements in those areas, with emphasis on socially excluded groups.

Gathering a 'wish-list' from people regarding their personal security in public transport to help in defining longer-term aims in the area.

…

Information from conventional survey-type sources (from available published reports) was combined with qualitative empirical methods, in the general form of face-to-face interviews and small meetings with key stakeholders. This was done to address some of the limitations of the former (including the fact that surveys do not tend to cover people who have been excluded, or have excluded themselves, from the public transport system, PTS, for social or physical reasons).

Each partner in the Consortium was asked to contribute literature and liase with suitable stakeholders in order for the research to have a broad base on which conclusions at a European level could be drawn. Reports on experiences from other parts of the world were also sought.

…

Apart from the legal aspects, … privacy is the issue that needs to be balanced with the apparent advantages of CCTV surveillance. People seem to accept cameras in public spaces if they believe they are part of legitimate public security operations. In particular, most people belonging to disadvantaged groups believe that help could be reached through CCTV in case of trouble. This attitude of acceptance may change in the future if misuse is discovered or if people's expectations of benefit from the systems are not met. This means that tools and processes must be developed in ways that retain public acceptance of the relevant technology and avoid generating expectations that cannot be met.

Extracts from PRISMATICA Deliverable D5/6 : "Identification and development of innovative processes"

… the level of security of a transport network mirrors that of a city. At times, the feeling of insecurity is less significant in underground transport networks than on the street. Operators emphasise the fact that the number of recorded acts of delinquency on the transport network is low in relation to the number of passengers.

Despite the low volume of delinquency, mass transport network generate specific fears, which vary according to the transport mode (metro, tramway, bus or train). These fears are so prevalent in some cases that some people choose to use private cars as a transit alternative. As for insecurity in cities, fear is both subjective and/or objective. In other words, it is more or less founded on the risk of an actual hazard.

People's awareness with respect to this problem is a true cultural metamorphosis in itself. The operators understood that the concept of insecurity significantly exceeds that of the crime, (in the purely legal sense of the word) due to the impact of offences that did not result in legal action taken by the courts, as well as to purely psychological factors. They also admitted that they should be responsible for the prevention of delinquency as much as they could. In contrast, public authorities have gone the opposite route and acknowledged that they do not have a monopoly over security, and that society must develop its own resources.

…

The image of the public transport network and the general public's perception of the company's image must be first and foremost improved. Indeed, it is not enough to improve actual security conditions for customers to travel safely; this kind of improvement may remain unnoticed by the public as certain failures may remain concealed, thereby having no direct impact on rider ship levels. Other measures, conversely, will have positive impacts on the travel experience resulting in a soothing effect on the feelings and thoughts of customers.

…

To have a better understanding of facts, the operator must exchange data with the police and constabulary forces. In fact, it would be ideal to have the ability to supplement existing data with additional data from other departments where the complaints had originally been recorded. Many offences remain unknown by the operator due to the fact that most victims report thefts and violence directly to the police. From a strictly operational angle, it is also important to collect and map out data on more minor infringements.

…

Some feelings of anxiety appear and grow in the absence of any serious danger. Fears are induced by damages, even committed in the absence of witnesses. Passengers have no objective reasons to feel anxious, since in this case the victim is the company itself. Yet, the same sense of discomfort is felt when passing through stinking corridors. The stench of urine triggers an olfactive reaction, which *makes people feel uncomfortable. Passengers often feel they enter hostile territory sensing that their space is not truly controlled by the operator, the owner. They discover areas taken over by force and then marked by urine and tags.*

In regard to passenger feelings of insecurity, the golden rule of transport operators must be to ensure cleanliness of the premises.

…

The need for a human presence is difficult to comply with due to the costs involved. The general public do not expect employees to be particularly efficient in fighting insecurity. Passengers are also reassured by the presence of other passengers and even by homeless people so long as they are decent and do not have a threatening behaviour.

…

The operator must use a logo, a style, and signs to mark its territory. Upon entering the operator's premises certain rituals have to be performed for a successful journey. The relationship between insecurity and fraud is neither immediate nor obvious. Many operators and security professionals are anxious to clearly separate these two issues.

Fare evasion leaves no one indifferent. When it is openly committed in the presence of an employee who neither protests nor attempts to react, it gives witnesses the feeling that the operator abandons its space and renounces to have its rights enforced. Paying one's fare is the first and foremost show of respect upon entering the operator's space.

Less than for the economic part of the socio-economic evaluation, is it possible here to evaluate the social benefits in financial terms. It seems from the previous part of this evaluation that the investment to be supported is reasonable compared with the social benefits, but this remains essentially a political decision.

3.9.5 Partial conclusion on the socio-economic evaluation

At this stage of the socio-economic evaluation, we believe that we have to remain very modest and cautious when the time comes to attempt some conclusions. Indeed, the ADVISOR ambition should not extend beyond **participation** in initiating the "virtuous circle of security" which is :

> *ADVISOR improves (a little bit) the real security which increases slightly the number of passengers whilst decreasing the feeling of insecurity hence encouraging more people to use public transport, etc.*

From that point of view, this should clearly be a business case for the deployment of ADVISOR, especially if the costs of dealing with the effects of crime (like paying the victims, going to court, repairing vandalised equipment, removing graffiti, etc.) are taken into account.

Since a proven reason why people do not use the metro is the subjective feeling of insecurity, one could think that making the existing and potential passengers aware of the ADVISOR system should decrease this feeling. It is possible, but once again, it has to be discussed with the concerned authorities.

Anyway, considering the state-of-the-art and the limited efficiency of the current systems, it may be a very dangerous approach to let the passengers and/or the Public Authorities believe that ADVISOR alone (or any other technological system) would make the metro definitely safer.

4 CONCLUSIONS

The successful installation of the ADVISOR Processing Unit in the Sagrada Familia station and the ADVISOR Human Computer Interface in the Sagrera Main control room of the metro of Barcelona (TMB), allowed us to conduct the final step of End-users evaluation in a realistic environment.

At this final level of development of the project, most of the functionality had been implemented, which allowed complete demonstration and credible evaluation. The final evaluation has been both quantitative and qualitative.

According to the Evaluation Plan previously set up, three different aspects of the system have been evaluated by the End-users, i.e. the "user acceptance", the "impact" and the "socio-economic consequences", each of the aspects being divided into several criteria.

In summary, the results were as follows :

<u>User acceptance evaluation</u>

- Usefulness: the ADVISOR system has strongly confirmed its usefulness. According to the evaluation system used, the evaluators scored this criteria at 81%. A number of possible points to be improved have been identified and discussed which should allow the system to better meet the users needs better in further development.
- Operating of the system : this criteria received an overall score of 65%. From the discussions held with the evaluators, the general feeling was, however, very positive. The 65% score obtained reflects that the system could be improved to allow much more efficient operation.
- Using the system: the evaluators gave an overall score of 81% to this criteria which is very satisfying. Desirable improvements have been identified and suggestions received, in particular to make the system much easier to use.

<u>Impact evaluation</u>

- Impact on safety: according to STIB (metro of Brussels), ADVISOR should currently have very little impact on safety. According to TMB (metro of Barcelona), it could allow the avoidance of 10 to 20 accidents each year. However, it is relevant to note that the number of safety problems increases according to the size of the metro network and that, from this point of view, Brussels and Barcelona metro networks are of medium size.
- Impact on security: ADVISOR's potential impact on security has been evaluated as much higher than impact on safety, because security is, most of the time, related to human behaviours. These are by their nature less predictable, and therefore, any help received from a system that could allow security improvement is perceived as having a high impact.
- Impact on traffic efficiency: according to the traffic management of both STIB and TMB, the impact of ADVISOR should be very limited. There might possibly be a

more positive impact in networks where situations of unbalanced crowd occupancy and rapid increase of crowding level are quite common.

- Impact on personnel motivation: motivation is related to work environment, to personal satisfaction, to personal agreement with companies activities, to personal perception of own utility, and many other issues. During the evaluation sessions, all the people met at various levels of the metro company organisations gave very positive feed-back and really enthusiastic reactions. One certainly can say that ADVISOR should have a very positive impact on personnel motivation if it was fully implemented in the metro networks and control rooms.
- Impact on passengers behaviour: the evaluators did not want to risk quantitative estimation of this impact, but both STIB and TMB agreed that the ADVISOR system could improve the passengers behaviour for what concerns their number and their travel attitude.

Socio-economic evaluation

- Approach: the socio-economic evaluation aims at estimating the "social" gains or losses (the global economic gains and losses, for all members of society) as the result of implementing the system in comparison with an existing situation. We provide in the relevant sections, a calculation of implementation costs and we compare these costs with the potential benefits.
- Benefit gained from the increased number of passengers: we attempt to show that a significant part of the implementation costs could be sustained by the additional revenues generated from the additional passengers, gained as a result of the ADVISOR implementation.
- Other social benefits: we identified a number of other "non-monetary" benefits that could be considered in the evaluation. These other social benefits should be a consequence from the previous one, i.e. the increase of the number of passengers but also from the better feeling of current passengers (comfort, feeling of security, etc).
- Even if we know that we should remain very modest and cautious, we believe that ADVISOR could participate in the "virtuous circle of security"[10]. This should encourage the decision makers[11] to go further in the analysis.

The final evaluation reported in the present document describes how the ADVISOR system has been very well appreciated by the relevant potential users, i.e. the metro companies.

They have acknowledged the efficiency of the ADVISOR system and confirmed that it could help them to increase the efficiency of their work. They recognised that many of its functions could not be provided by any other existing system which demonstrates its innovative and advanced nature. This definitely confirms the success of the ADVISOR project.

[10] ADVISOR improves (a little bit) the real security which increases slightly the number of passengers whilst decreasing the feeling of insecurity hence encouraging more people to use public transport, etc.

[11] The decision makers are both the public transportation companies for what concerns the decision to implement the system and the industrial companies for what concerns the decision to move forward from a prototype to a commercial equipment.