

ICT and ITS in road safety

CENTRO DI RICERCA
PER IL
TRASPORTO E LA LOGISTICA



SAPIENZA
UNIVERSITÀ DI ROMA

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***Final Conference of the
SmaLog Project***



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Kharkiv – 4th October 2021

Contents

- **Vehicle/User:** Autonomous Vehicles
- **Infrastructure:** Automated Enforcement
- **Infrastructure:** Automated Road Assessment Programmes
- **Road Safety Management:** Data Collection and Management
 - ITS for Data Collection
 - ITS (DSS) for policies and measures planning
 - ITS for *crowdsourcing*

Vehicle/Users: Autonomous Vehicles

An idyllic scenario



Source: Victoria Transport Policy Institute

An optimistic view

- Happy well-dressed passengers, lounging and working in self driving cars that look like space ships
- Panacea for everything: Independent mobility for non-drivers, reduced stress, less congestion and pollution, safety at highest level
- *Since human errors contribute approximately to 90% of accidents, autonomous vehicles will reduce accidents by 90%!*
- They are behind the corner!

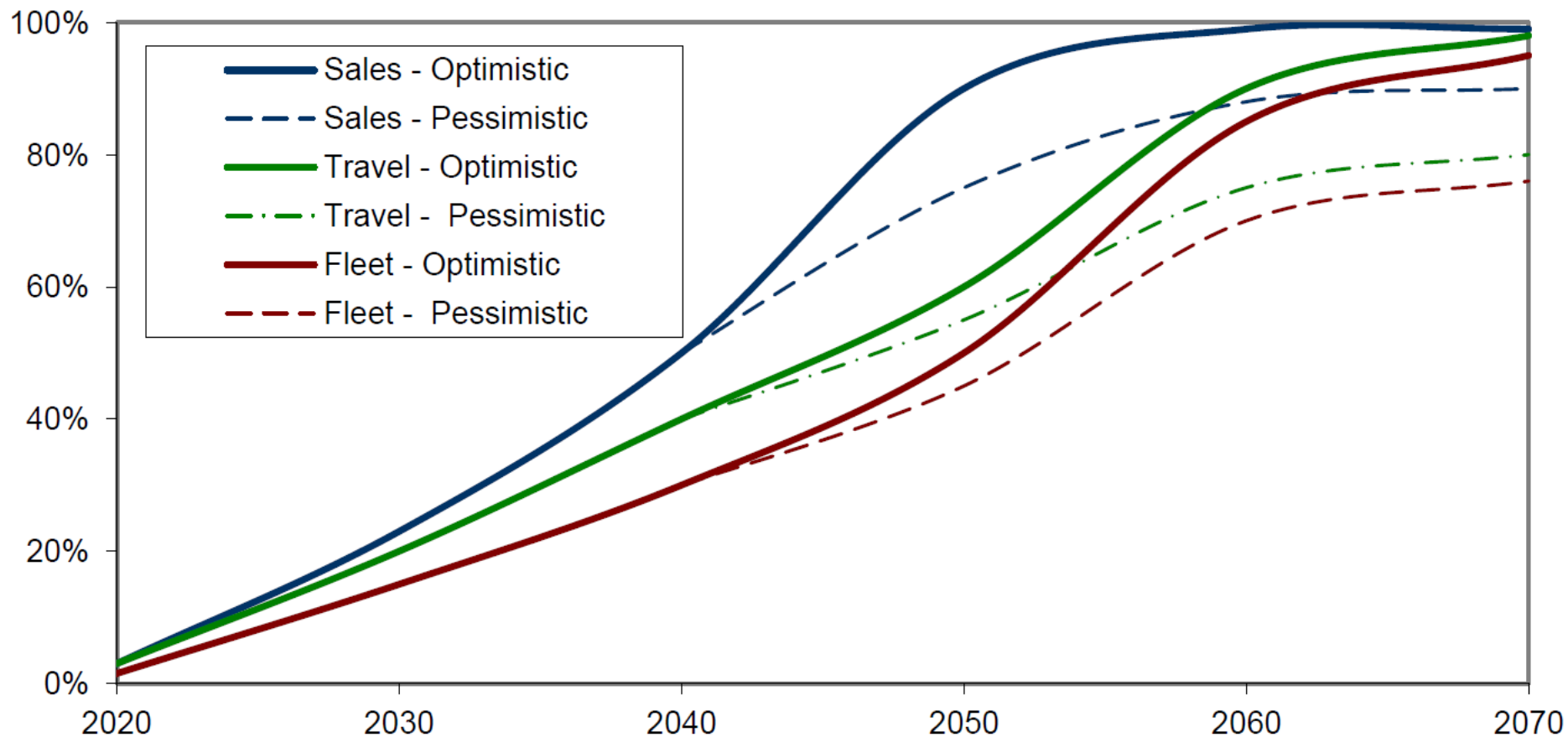
A more complex reality

- **Financial interests** and **difference** with other important electronic innovations like digital cameras, smartphones, Internet
- Significant **investments** to be done by Public Authorities (eg dedicate lanes for platooning)
- Community vs User **objectives** (speed, risks for whom)
- Higher **anxiety** for users
- Risk of **vandalism** and **crimes** for shared vehicles
- **Slow** and unreliable in mixed traffic, difficult to operate in **extreme** weather or pavement conditions
- Lower **costs** for shared use, higher costs for private use

What about additional risks

- Hardware and Software **failures** can lead to fatal results. Reliability to be assessed
- Software systems could be **hacked** for amusement or crime
- Increased **risk-taking** (risk compensation theory). More aggressive and distracted driving for automation levels 1-3, less cautions (eg safety belts) for levels 4-5
- **Human drivers** joining species for autonomous vehicles (eg lanes for platooning)
- Increased **amount** of travel and, thus, higher exposure

AV sales, fleet and travel projections



Source: Victoria Transport Policy Institute

An intermediate steps: ADAS

Advanced Driver Assistance Systems include a large number of new technologies, e.g.:

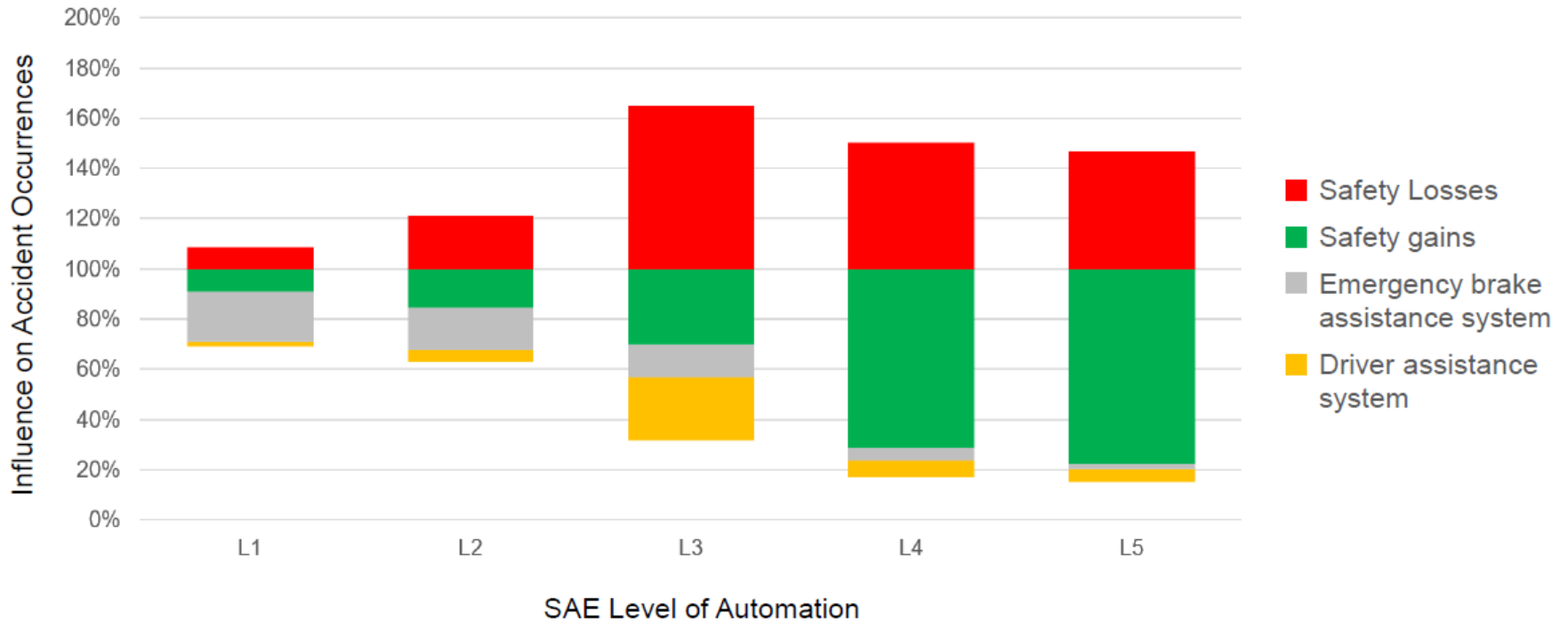
- **Automated emergency braking systems (AEBS)**
- **Lane Departure Warning system (LDWS)**
- **Automatic Cruise Control (ACC)**
- **Lane Keeping Systems**
- **Intelligent Speed Adaptation (ISA)**
- **Traffic sign recognition**
- **Pre-crash seat-belt tensioners**
- **Safety of children in hot cars**
- **Light and heavy duty fuel systems**
- **Driver distraction and drowsiness recognition**
-

Are they cost-effective?

- **Automated emergency braking systems (AEBS)**
- **Lane Departure Warning system (LDWS)**
- **Automatic Cruise Control (ACC)**
- **Lane Keeping Systems (LKS)**
- **Intelligent Speed Adaptation (ISA)**
- **Traffic sign recognition**
- **Pre-crash seat-belt tensioners**
- **Safety of children in hot cars**
- **Light and heavy duty fuel systems**
- **Driver distraction and drowsiness recognition**

Source: TRL, Benefit and Feasibility of a Range of New Technologies .. (2015)

Estimated effects on road safety: a Swiss study

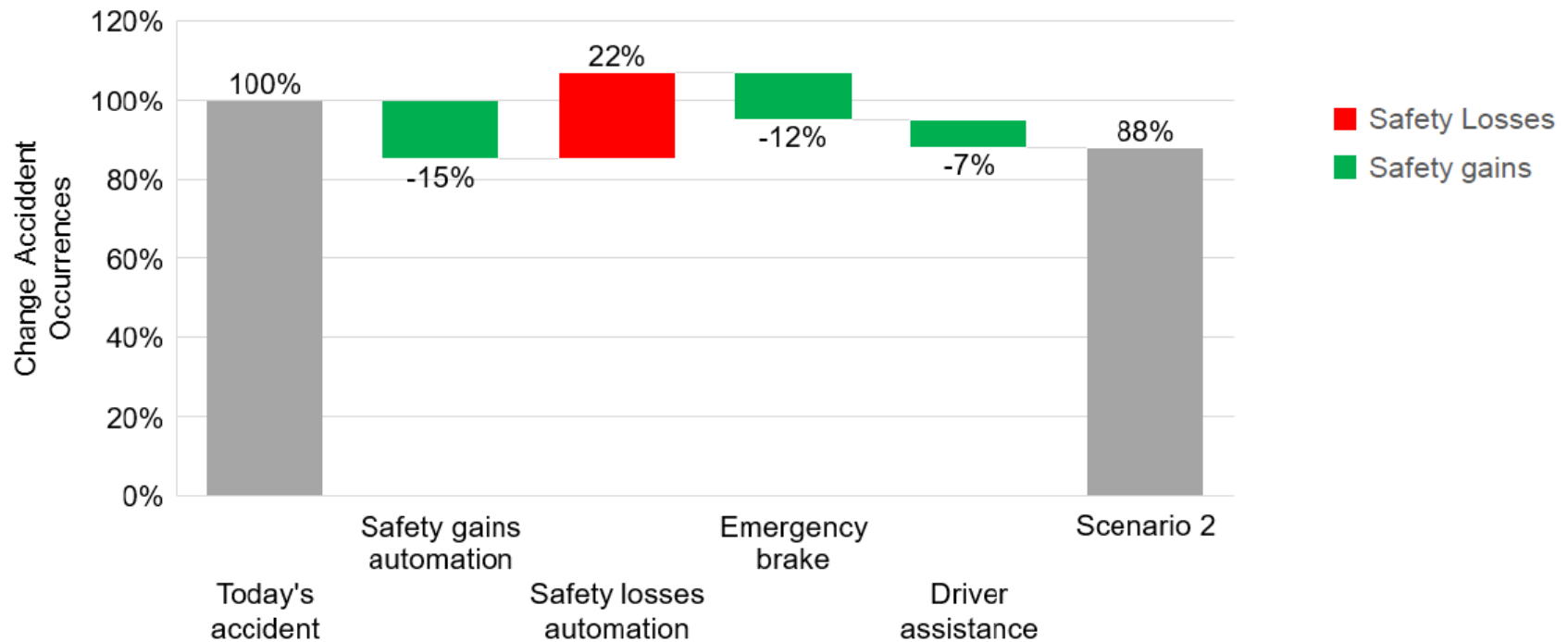


Source: Markus Deublein, EBP Schweiz AG, Zurich, Switzerland

Estimated effects on road safety: a Swiss study

Results: Safety Potential Scenario 2

Levels of Automation	Scenario 1	Scenario 2	Scenario 3	Scenario 4
0 (No Automation)	55%	25%	15%	--
1 (Assistance)	30%	30%	15%	--
2 (Partial Automation)	10%	20%	15%	--
3 (Conditional Automation)	5%	20%	30%	10%
4 (High Automation)	--	5%	20%	30%
5 (Full Automation)	--	--	5%	60%

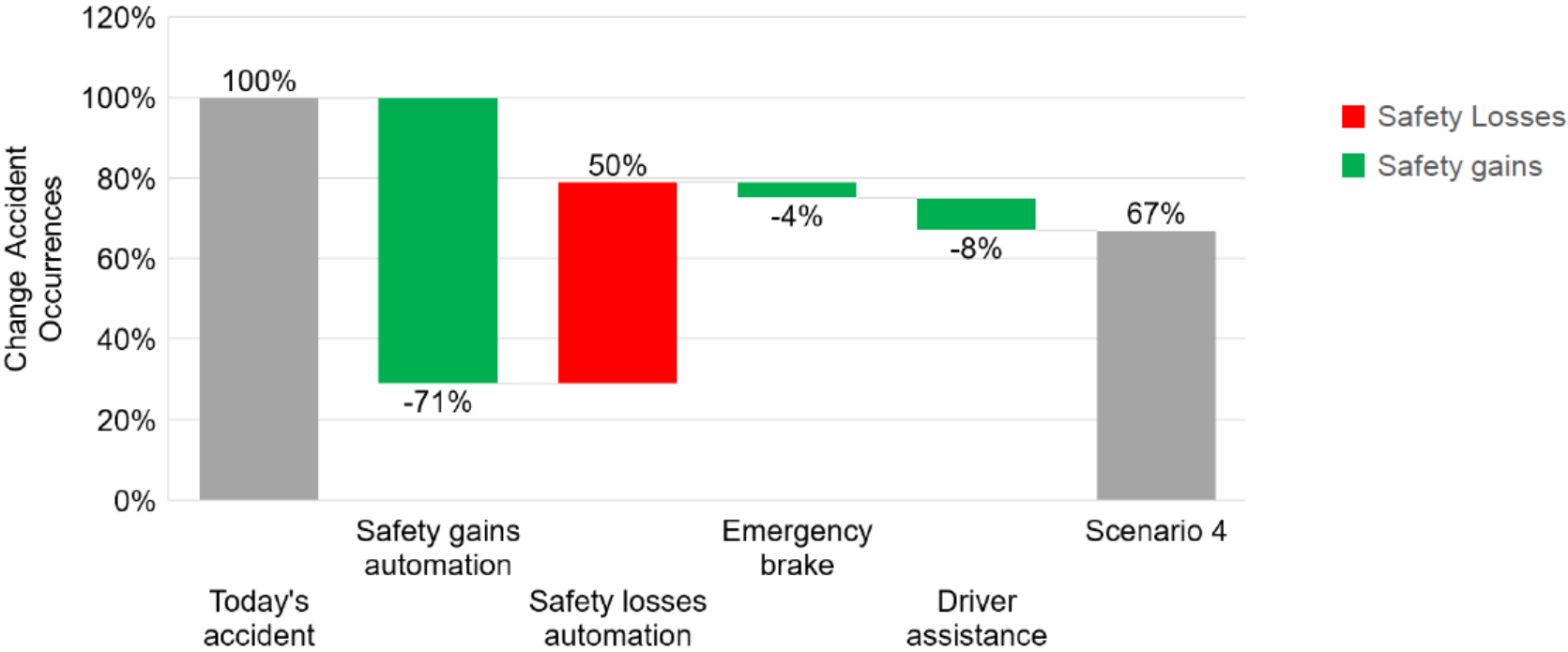


Source: Markus Deublein, EBP Schweiz AG, Zurich, Switzerland

Estimated effects on road safety: a Swiss study

Results: Safety Potential Scenario 4

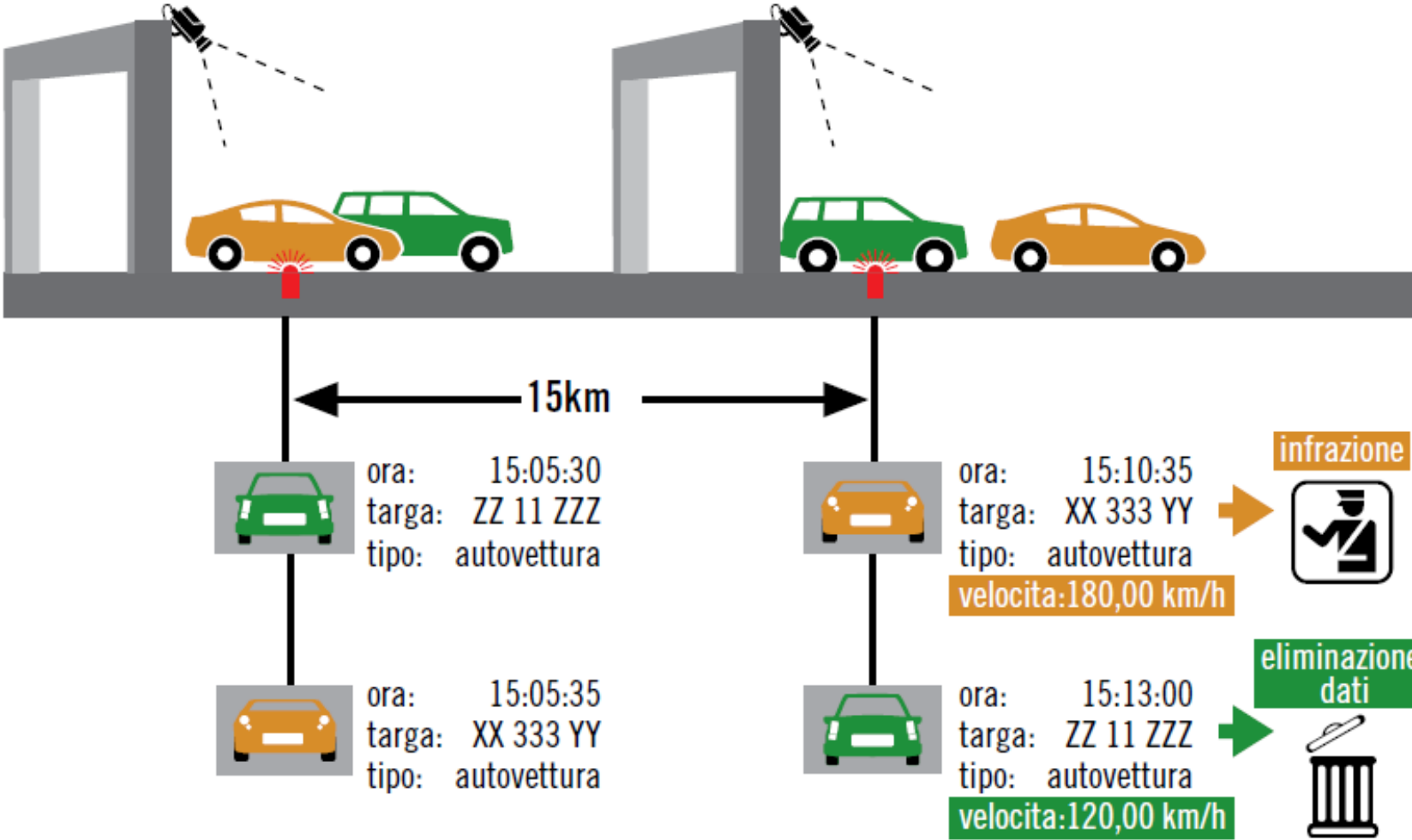
Levels of Automation	Scenario 1	Scenario 2	Scenario 3	Scenario 4
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4 (High Automation)	--	5%	20%	30%
5 (Full Automation)	--	--	5%	60%



Source: Markus Deublein, EBP Schweiz AG, Zurich, Switzerland

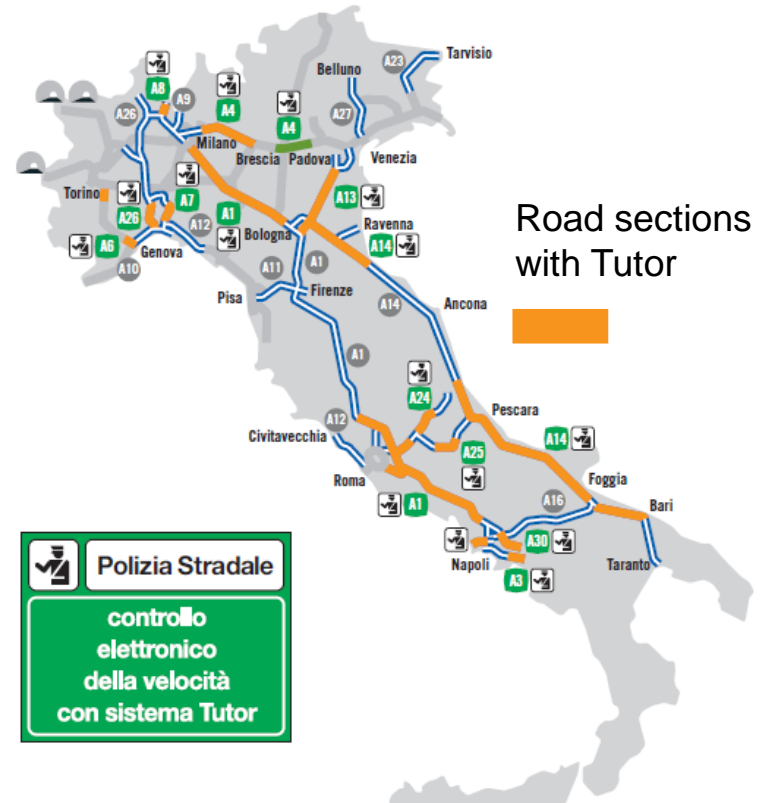
Infrastructure: Automated Enforcement

ITS for Section Control



The Italian case: *Tutor*

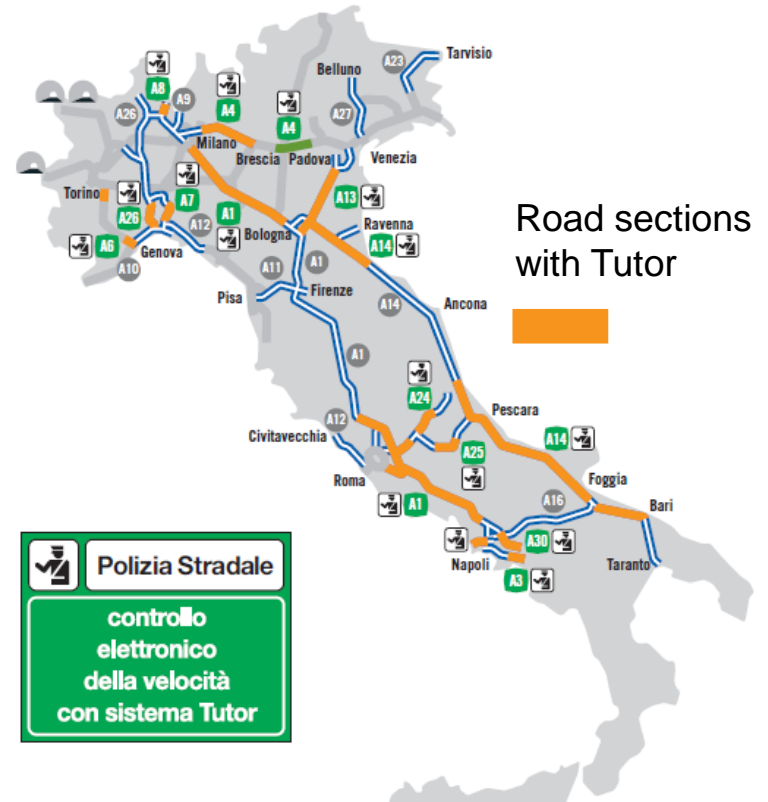
- First activation in 2006 on 460 kms of motorways
- Afterwards Tutor has been gradually implemented on over 2.500 km of Italian motorways network
- It has been recently implemented also to lower level roads



Source: www.autostrade.it

Some results

- - 25% peak speed
- - 15% average speed
- - 51% fatalities, after 1 year
- - 70% fatalities, at present



Source: www.autostrade.it

Infrastructure: Road Assessment Programs

ITS for Road Assessment Programs

- Strong attention paid on Road Infrastructure Safety Management at international level
- Several RISM procedures being introduced/widespread: *Road Safety Audit, Road Safety Inspection, Road Safety Impact Assessment, Network Safety Ranking, **Road Assessment Program***
- RAP can be defined as a protocol to assign ratings to roads based on the **presence or absence of key design features** related to safety
- i-RAP is the most popular program

A simplified tool for RAP


Street Explorer Interactive map Data explorer

SIMPLIFIED TOOL FOR ROAD SAFETY ASSESSMENT USING AUTOMATED IMAGE ANALYSIS

FUNDED BY



THE WORLD BANK
IBRD • IDA



GRSF
Global Road Safety Facility

VIDEO Analyzer

MAP Explorer

Select video to analyze:

Browse... No file selected

Select calibration image:

Browse... No file selected

Select RoadLabPro file:

Browse... No file selected

Street name:

n1

Some application sites

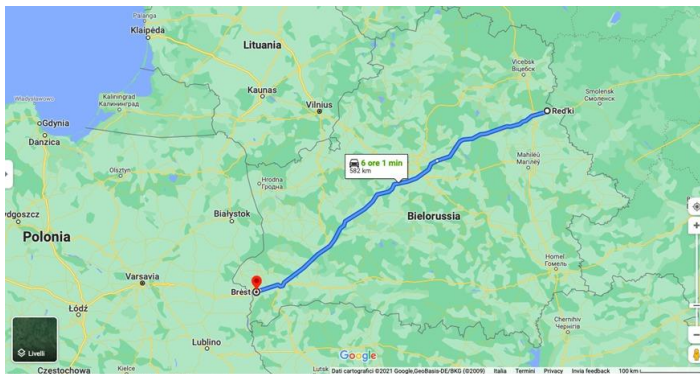
Liberia



Mozambique



Belarus

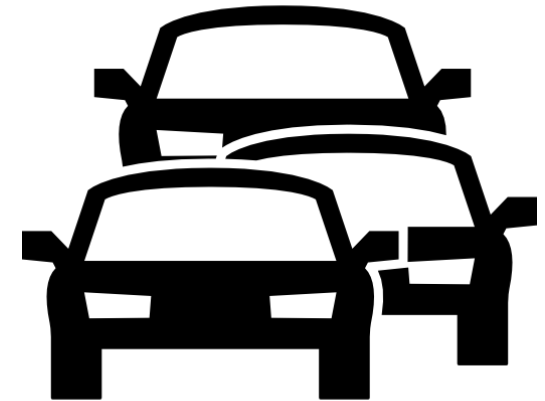


Main features

- Automatically recognise road attributes from video images
- Calculate road users' risks and the GRS according to a simplified methodology;
- Provide outputs on assessed risks (every 100m) both graphically and through table values
- Download all the computed outputs for further analysis

Road user categories for risk assessment

- ❑ Crashes involving only one or more motor-vehicles (MV).
- ❑ Crashes involving at least a cyclist (CYC).
- ❑ Crashes involving at least a pedestrian (PED).



Road attributes «along road»

MV crashes

- Facilities of bicycling
- Grade
- Curvature
- Median
- Motorcycle dedicated lane
- Shoulder width
- Pedestrian crossing
- Delineation
- Roadside severity
- Sidewalk
- Speed management/ traffic calming
- Lane width
- Number of lanes
- Road surface conditions
- Area Type

Pedestrian crashes

- Pedestrian crossing facility
- Curvature
- Delineation
- Sidewalk
- Speed management/ traffic calming
- Area Type

Red = by video
Blu = by openStreetMap

Cycle crashes

- Facilities of bicycling
- Curvature
- Delineation
- Shoulder width
- Road surface conditions
- Speed management/ traffic calming
- Area Type
- Motorcycle dedicated lane

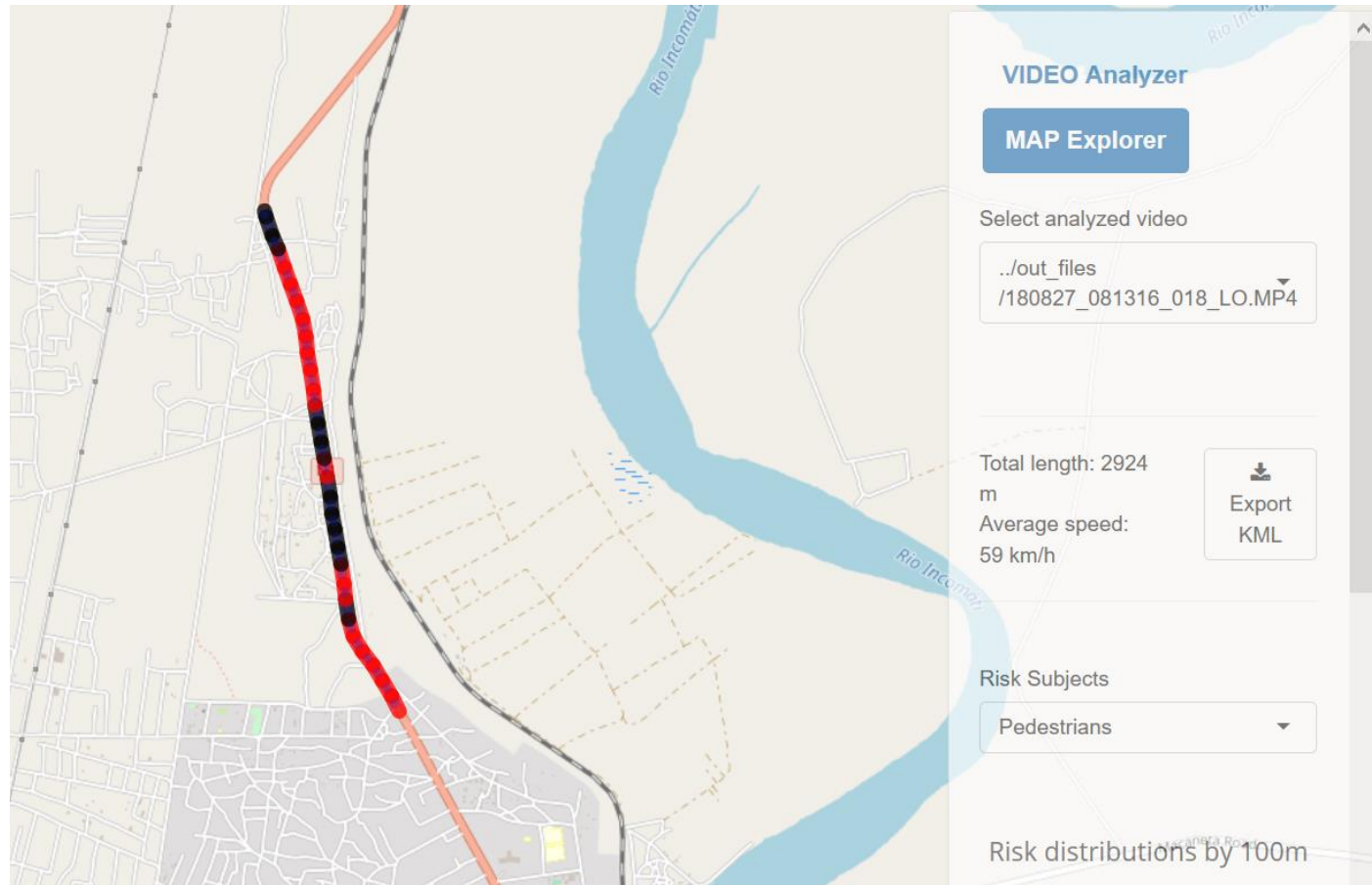
Orange = by App
Black = manually

Equipment for video filming

- ❑ Nextbase 612GW camera (1 unit)
- ❑ Smartphone (1 unit)
- ❑ Mount for the smartphone (1 unit)
- ❑ Power cable for the smartphone (1 unit) (or powerbank)
- ❑ RoadLabPro App for road surface conditions
- ❑ Blank sheet of 2x2 meters (1 unit)
- ❑ Cloth to be put on the vehicle dashboard (1 unit)



Results



Results

Overall Summary

Show entries

[Download](#)

Search:

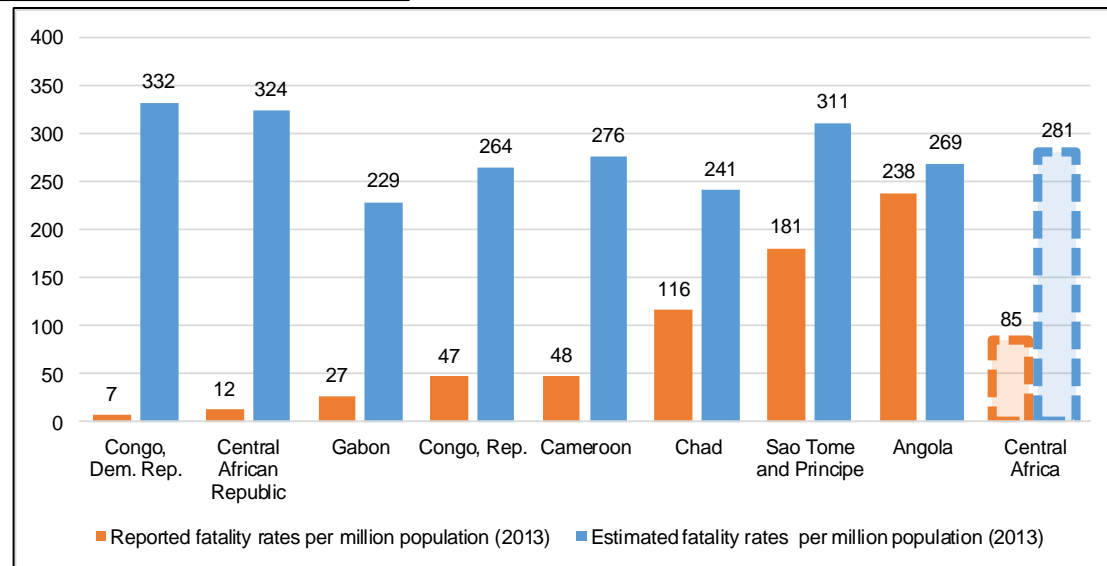
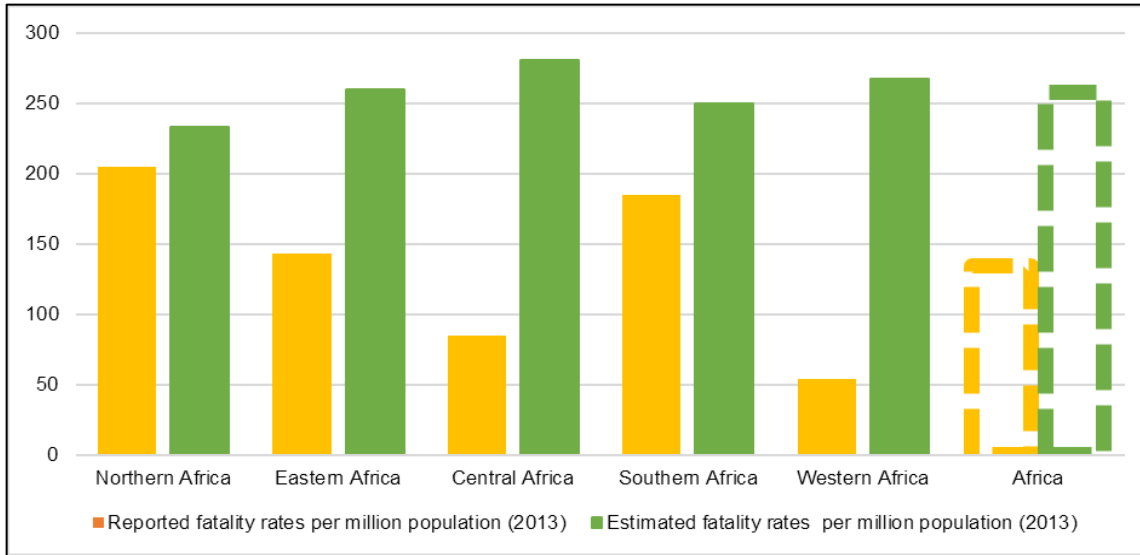
	interval	lanewidth	roadside	speed	curvature	roadconditions	access	intersections	zebra	area	grade	persons	bicycle	cycling	mot
1	100	2.8	0.4	48	1047	very good	0	2	0	rural	0	0	0	no	no
2	200	2.8	0.4	51	1994	very good	0	1	0	rural	0	0	0	no	no
3	300	2.4	0.4	53	611	very good	0	1	0	rural	2	0	0	no	no
4	400	2.8	0.4	56	1717	very good	1	0	0	rural	2	0	0	no	no
5	500	2.8	0.4	59	345	very good	0	0	0	rural	0	0	0	no	no
6	600	2.8	0.4	59	388	very good	0	0	0	rural	-8	0	0	no	no
7	700	2.8	0.4	58	2541	very good	0	1	0	urban	0	0	0	no	no
8	800	3.1	0.4	55	1428	very good	0	1	0	urban	-6	0	0	no	no
9	900	2.9	0.4	56	2121	very good	0	0	0	urban	-8	13	4	no	no
10	1000	2.8	0.4	58	1207	very good	0	1	0	urban	0	0	0	no	no

Road Safety Management: Data Collection and Management

The problem of accident data

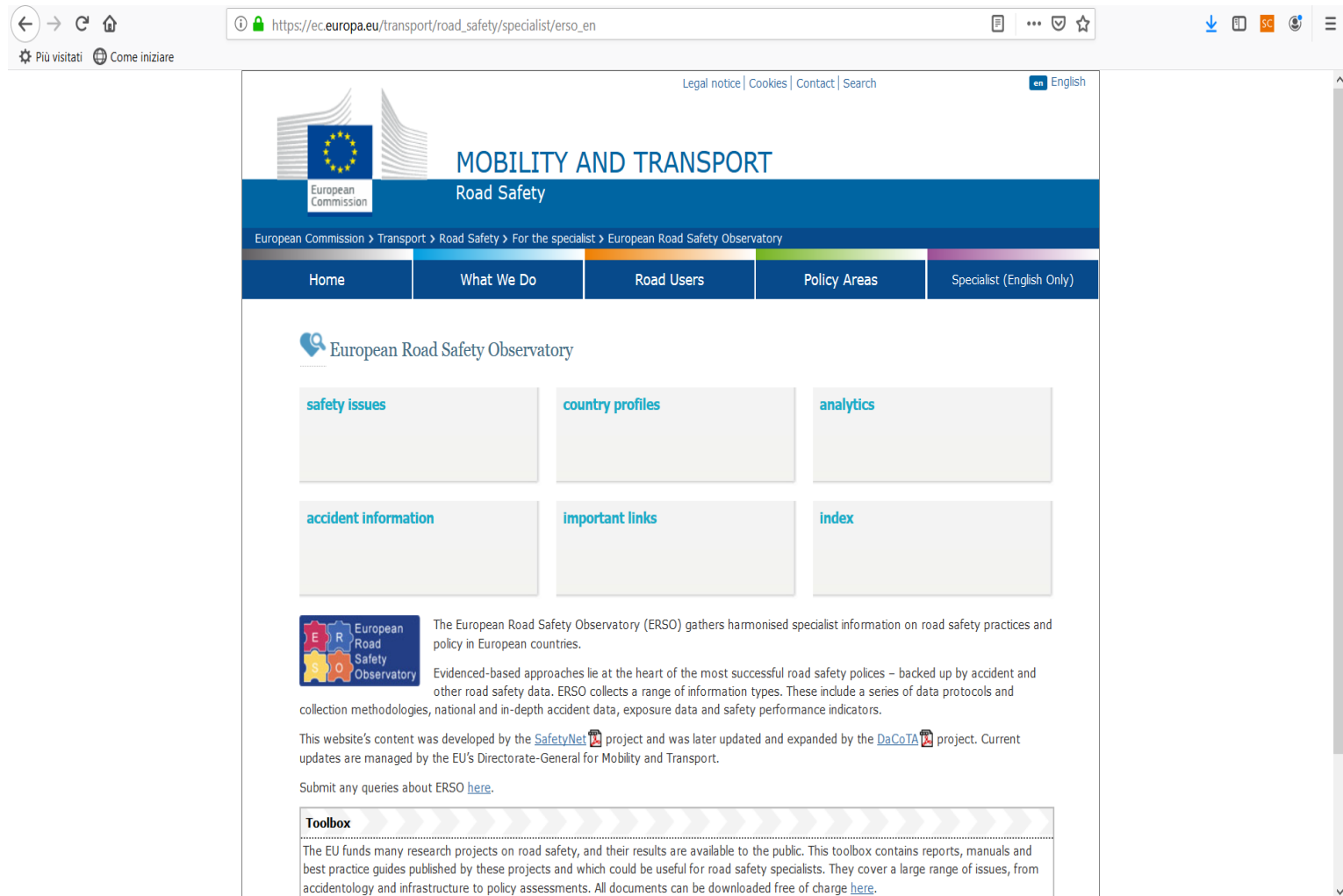
- Reliable and harmonised road accident data are crucial for defining **evidence-based road safety policies** and to **monitor** performances and assess **results**
- Data on **infrastructures, traffic** (exposure), accident **costs, Safety Performance Indicators** are also needed
- Also **road users** must be involved in the information collection and planning process
- European Union invested a lot of resources in improving quality and availability of accident data, mainly through dedicated **research projects**
- **Observatories** of different levels (Continental, National, Regional, Urban) are fundamental tools

Reliability of data



Source: WHO, SAFERAFRICA Project

The European Road Safety Observatory



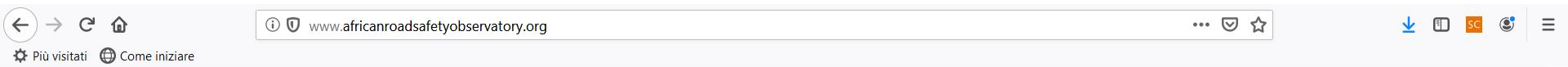
The screenshot shows the website for the European Road Safety Observatory (ERSO) on the European Commission's Mobility and Transport portal. The browser address bar shows the URL: https://ec.europa.eu/transport/road_safety/specialist/erso_en. The page header includes the European Commission logo and the text "MOBILITY AND TRANSPORT Road Safety". A navigation menu contains links for "Home", "What We Do", "Road Users", "Policy Areas", and "Specialist (English Only)".

The main content area features a search icon and the text "European Road Safety Observatory". Below this are six interactive tiles: "safety issues", "country profiles", "analytics", "accident information", "important links", and "index".

A descriptive paragraph states: "The European Road Safety Observatory (ERSO) gathers harmonised specialist information on road safety practices and policy in European countries." It further explains that "Evidenced-based approaches lie at the heart of the most successful road safety polices – backed up by accident and other road safety data. ERSO collects a range of information types. These include a series of data protocols and collection methodologies, national and in-depth accident data, exposure data and safety performance indicators." It also notes that the website's content was developed by the [SafetyNet](#) project and updated by the [DaCoTA](#) project, managed by the EU's Directorate-General for Mobility and Transport. A link is provided to "Submit any queries about ERSO [here](#)."

A "Toolbox" section is highlighted with a chevron graphic and contains the text: "The EU funds many research projects on road safety, and their results are available to the public. This toolbox contains reports, manuals and best practice guides published by these projects and which could be useful for road safety specialists. They cover a large range of issues, from accidentology and infrastructure to policy assessments. All documents can be downloaded free of charge [here](#)."

The SAFERAFRICA Observatory



- Home
- Dialogue ▾
- Participate ▾
- Knowledge ▾
- Data ▾
- SaferAfrica ▾
- Contacts
- About
- English

LEARN ABOUT ROAD SAFETY

MORE

Welcome to the African Road Safety Observatory

The African Road Safety Observatory is a space for interaction to highlight the relevant road safety needs in African countries

ITS for accident data collection and analysis

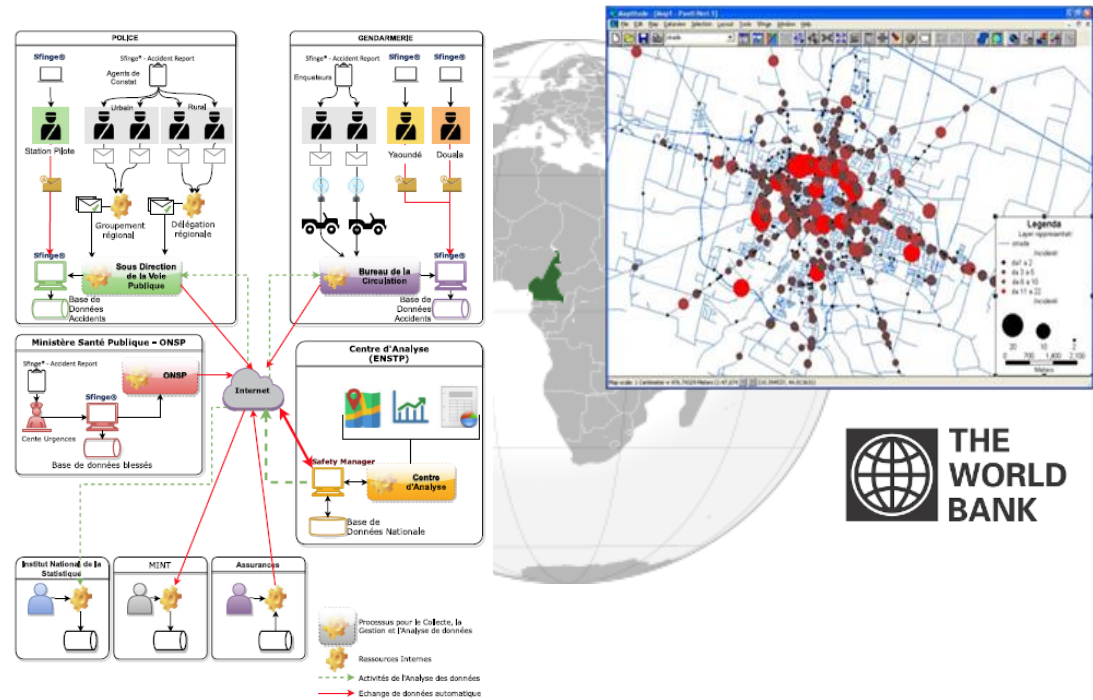
- The creation/improvement of reliable and harmonised road accident databases can/must be supported by appropriate tools
- The use of dedicated information systems can significantly reduce the level of **underreporting**, improve the **quality** and **quantity** of collected data, help **police officers** and **decision makers**, **speed up** the whole process, allow the use of **efficiency assessment tools** (CBA), monitor the **results**
- Software tools can be used to support:
 - **Data collection process**
 - **Policies and measures planning**
 - **Involvement of citizens (*crowdsourcing*)**

ITS for Data Collection

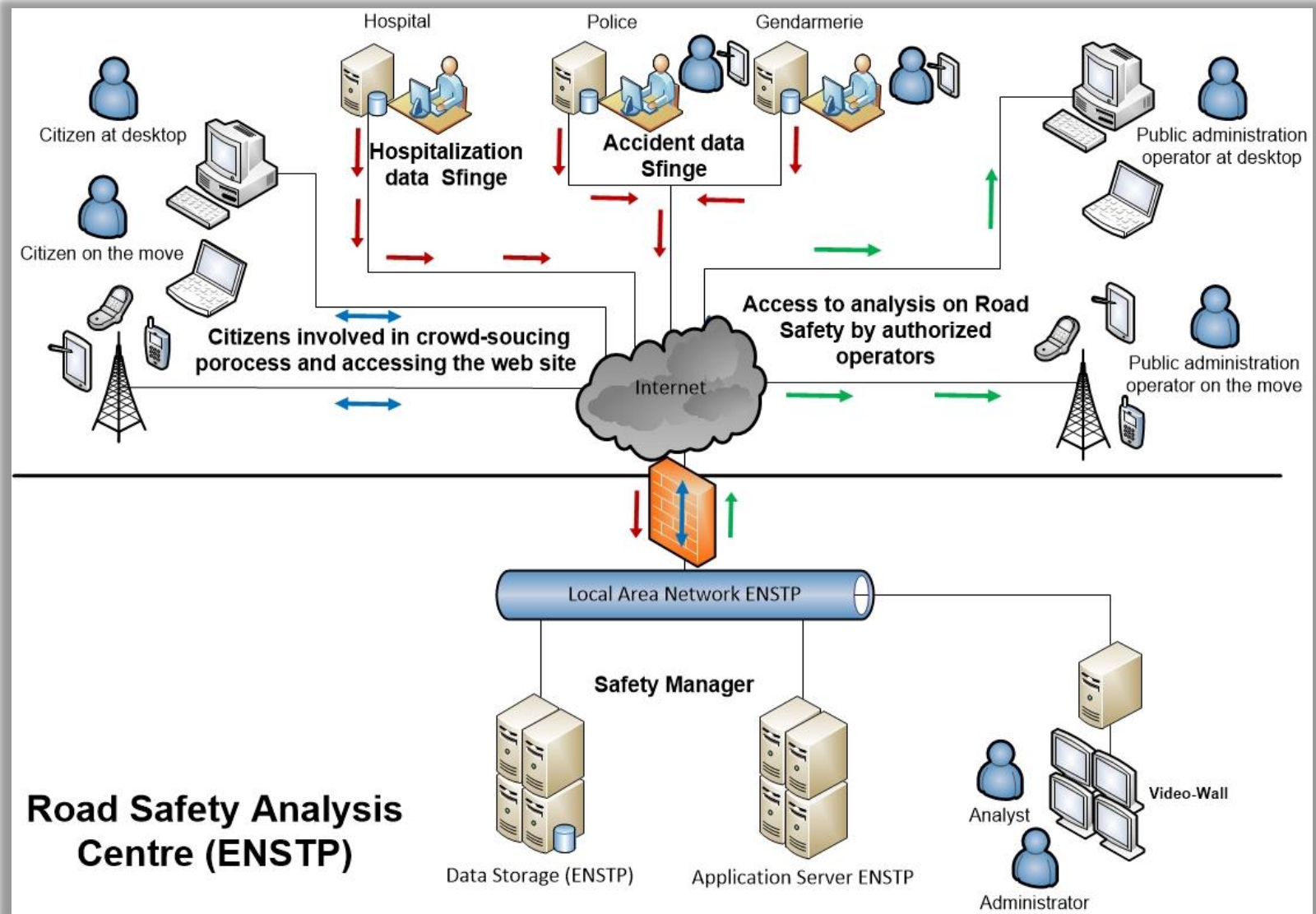
Example of good practices: Cameroon

- Creation and implementation of traffic accident databases and of an information system for road safety at national level
- Creation of the National Centre for Analysis of Traffic Accidents

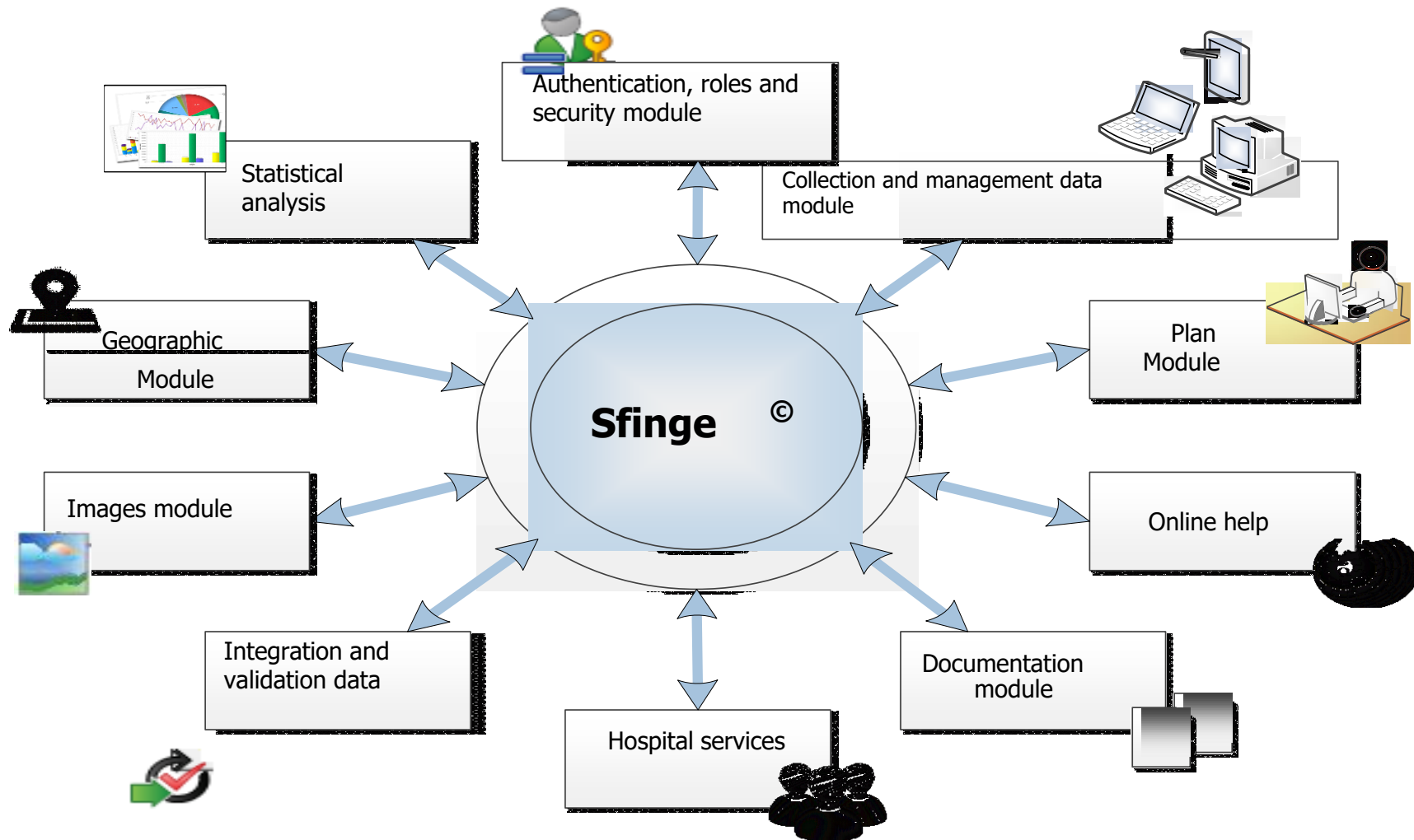
Coordinated by CTL
Main partners: IBSR,
IT, SWOV



The network architecture



The modules



Automatic location

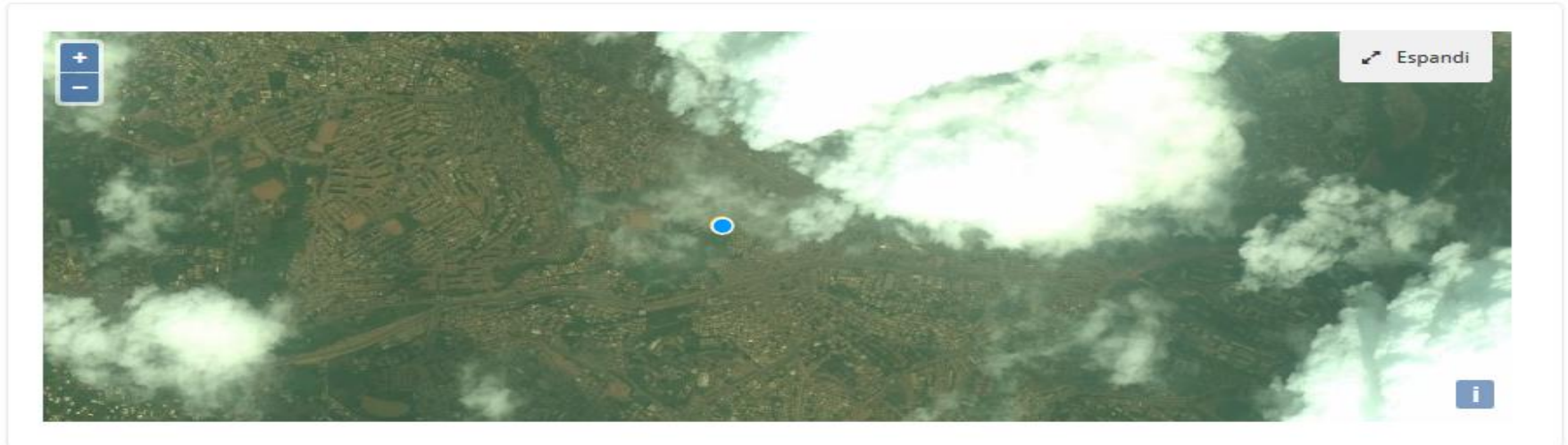
 [Locate on cartography](#)

Latitude *(R-1)*

3.874162591133853

Longitude *(R-2)*

11.496645212173464



Hospital Data Collection screenshot

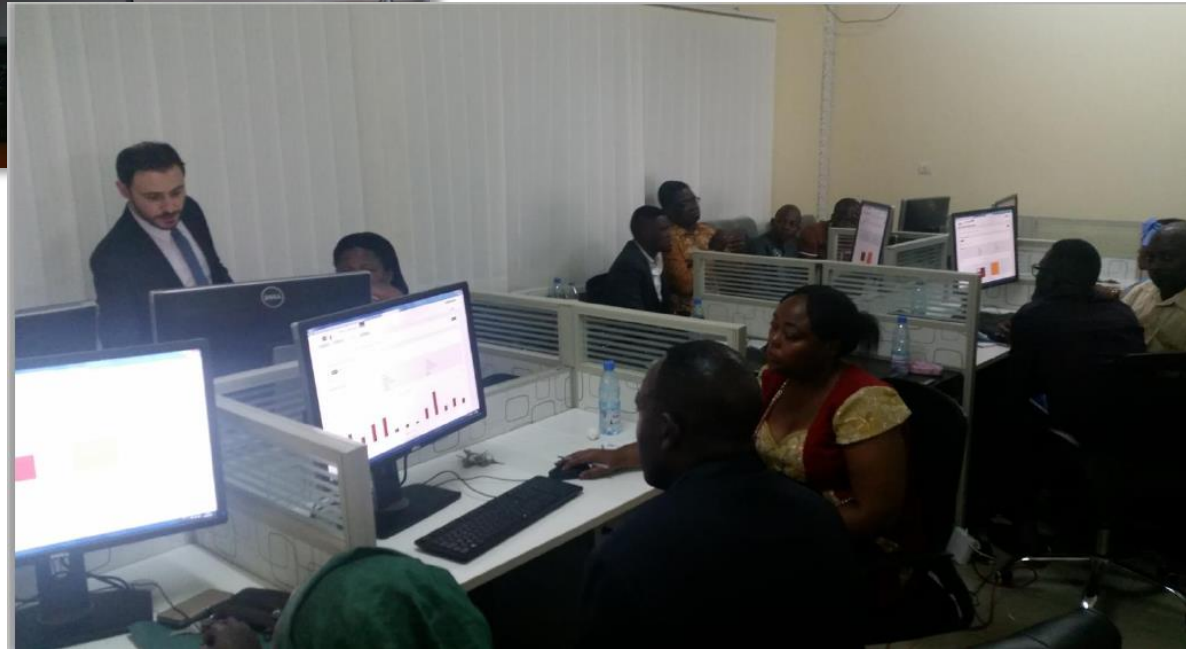
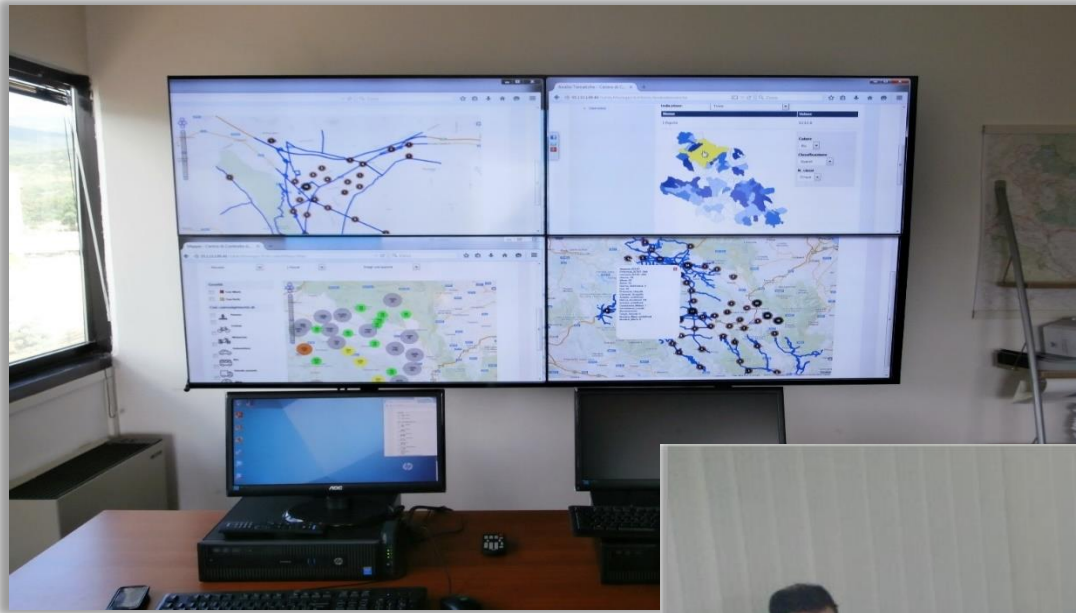
The screenshot displays the SFINGE Hospital Data Collection interface. At the top, there is a navigation bar with the SFINGE logo and several menu items: Administration, Hospitalized people, Documents, and Data exchange. The user is logged in as 'andrea caruso' and the language is set to 'en'. Below the navigation bar, the page title is 'List patients'. A blue button labeled '+ Add new person' is located on the left. The main content is a table with the following columns: Last name, First name, Event date time, Date/Time admission, Death date/time, Discharge date/time, MAIS Code, and Actions. The table contains three rows of patient data. The first row is for Giuseppe Verdi, admitted on 1/25/2016 at 3:30 AM and discharged on 1/26/2016 at 10:52 AM. The second row is for Mario Rossi, admitted on 1/23/2016 at 10:00 AM and discharged on 1/26/2016 at 9:23 AM. The third row is empty. Each row has 'Edit' and 'Delete' buttons. At the bottom of the page, there is a footer with the text 'Sfinge - © 2017 - IT Roma' and 'v.1.2.6171.22538'. The INFINGENIERIA DEL TRASPORTO logo is also visible in the bottom right corner.

Last name	First name	Event date time	Date/Time admission	Death date/time	Discharge date/time	MAIS Code	Actions
Verdi	Giuseppe	1/25/2016 3:30 AM	1/25/2016 7:45 AM	-	1/26/2016 10:52 AM	-	Edit Delete
Mario	Rossi	1/23/2016 10:00 AM	1/23/2016 10:45 AM	-	1/26/2016 9:23 AM	-	Edit Delete
		-	-	-	-	-	Edit Delete
		-	-	-	-	-	Edit Delete

Sfinge - © 2017 - IT Roma
v.1.2.6171.22538

ITS (DSS) for policies and measures planning

Cameroon: The National Control Centre



Activities of the Control Center

- **Data acquisition and management** → receiving data from: Police, Gendarmerie, Hospitals, mobility manager, people responsible for the design and implementation of interventions, etc.
- **Road Safety Planning** → *criticality analysis*, development and updating of the Road Safety Plan, *economics evaluations*, monitoring of Road Safety Interventions, etc.
- **Communication** → *dissemination* of information on the status of Road Safety, *involvement of citizens and other stakeholders*

The DSS Safety Manager

- **Web based information system** supporting the activities of the Control Center
- Based on the experience developed in European **research** projects
- Organized in:
 - "public area" which is available to all citizens (website), to support the activities of "**Communication**" of the Monitoring Center and to support citizen participation (crowd-sourcing)
 - "reserved area" with the tools available to the staff of the Center for the activities of **Acquisition and Data Management** and **Road Safety Planning**

Data matching dashboard

The dashboard features a header with the national flag of Benin and the coat of arms of the Research Centre for Transport and Logistics (CTL). A navigation bar includes 'Home', 'Data', 'Analysis', and 'Planning', with 'PLANNING' highlighted in a blue box. The main content area is titled 'Matching between accident data and hospital data' and contains three interactive cards:


- Matching on going**: Shows an icon of two documents with arrows indicating a process. The text below reads: 'Matching on going between data collected by Police Forces (Police and Gendarmerie) and data on people involved in traffic accidents provided by sanitary structures'. A 'Continue ->' button is at the bottom.
- Archive Accepted Matching**: Shows an icon of a document with a green checkmark and a police hat. The text below reads: 'Archive accepted matching between data collected by Police Forces (Police and Gendarmerie) and data on people involved in traffic accidents provided by sanitary structures'. A 'Continue ->' button is at the bottom.
- Archive Rejected Matching**: Shows an icon of a document with a red 'X' and a police hat. The text below reads: 'Archive rejected matching between data collected by Police Forces (Police and Gendarmerie) and data on people involved in traffic accidents provided by sanitary structures'. A 'Continue ->' button is at the bottom.

Planning dashboard

Planning

Create New Processing Projects List


Interventions Choice



Interventions Choice

+ Add new


Maps



This section allows to show on map the traffic accident data included in the database and to look at their information.

+ Add new


Graphs



This section allows to realise statistical analysis on the traffic accident data included in the database and to show them graphically.


+ Add new

Tables




This section allows to realise statistical analysis on the traffic accident data included in the database and to

Critical Elements



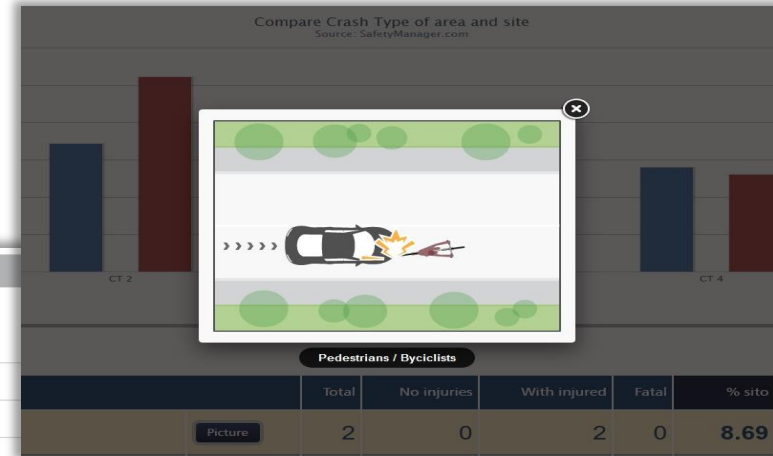
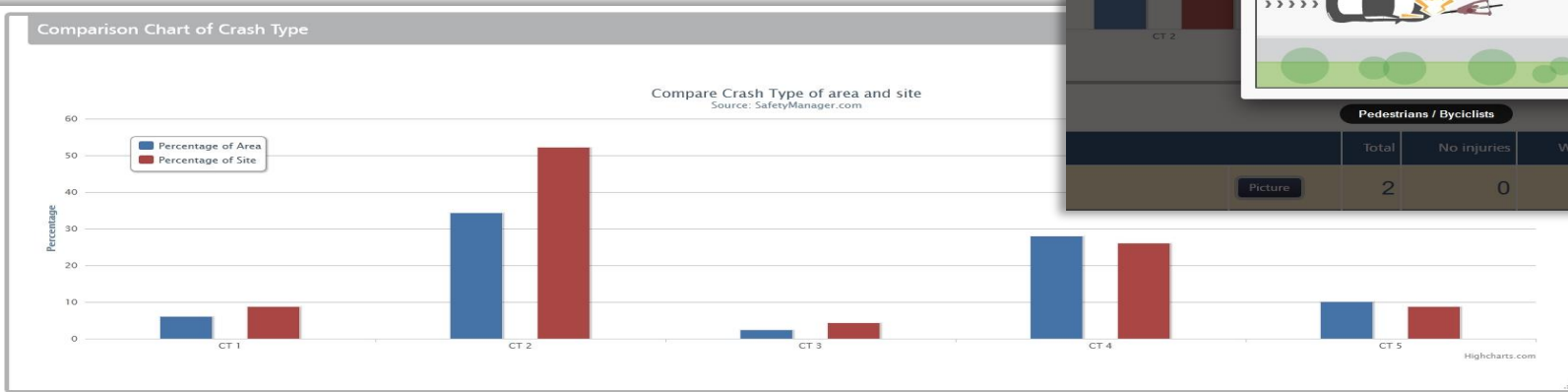
Choice of interventions – Classification of existing network safety

Causes and countermeasures



Choice of interventions – Causes and countermeasures

Significant Crash Type



Significant Crash Types

Choice	Id	Crash Type	Total	No injuries	With injured	Fatal	% sito	% Media area	SW	OOD	PPI
<input checked="" type="radio"/>	10	Pedestrians / Bicyclists	2	0	2	0	8.69	6.06	1.00	1.43	6.99
<input type="radio"/>	2	Head-on Left Turn / Rear end Left Turn crashes	12	8	4	0	52.17	34.36	0.33	1.52	19.94
<input type="radio"/>	12	Running off road	1	1	0	0	4.34	2.39	0.10	1.82	54.95

NON significant Crash Types

Benefit-cost (ABC) or Cost-Effectiveness analysis

Interventions Choice Settings Identifying Critical Crash Type Choice Causes Determination Countermeasures Choice Creating packages Compare packages

Compare packages Step 6 di 6

Compare packages of countermeasures on the economic attractiveness.

154317 | Via Campo di Marte

Settings for the economic evaluation

Indicator

Costs / Benefits

Cost / Effectiveness

Interest rate

20 %

Compare packages

Packages

Package title	Countermeasures	Costs of realization	Maintenance costs	Benefits	Costs / Benefits	Details
Test Package 1	MS03Remove/relocate obstacles close to road PE02Use crossing guards near schools	75000.00	40000.00	185594.18	2.20	Report
Test Package 2	MS03Remove/relocate obstacles close to road MS08Add/improve lighting	35000.00	40000.00	160143.86	1.90	Report

Print report (PDF)

ITS for *crowdsourcing*

Involving citizens

The screenshot shows the website www.africanroadsafetyobservatory.org/partecipate/crowdsourcing/. The page features a navigation menu with links for Home, Dialogue, Partecipate, Knowledge, Data, SaferAfrica, Contacts, and About. A language selector is set to English. The main heading reads "SHARE, EXPLORE, DISCUSS ROAD SAFETY ISSUES". Below this, there are tabs for "Report or Propose a solution", "Explore", "Proposals", and "Reports". A large map of Africa is displayed with a red location pin in Sudan. A green text box over the map says "REPORT a road safety related problem in your country or PROPOSE a solution" with examples like "No crossing facilities for pedestrians" and "Poor rescue system in rural area". A red text box says "Please LOGIN to submit a report or a proposal". At the bottom left of the map area, there are "SIGN IN" and "REGISTER" buttons. The browser's address bar and various icons are visible at the top.

The crowdsourcing

www.africanroadsafetyobservatory.org/partecipate/crowdsourcing/#nav-explore

Select a point on the map to view details

Filters

Proposals

- Road Safety Management 9
- Unsafe Roads 10
- Unsafe vehicles 2
- Risk behaviour of road users 8
- Poor post-crash care 1

Report

- Road Safety Management 11
- Unsafe Roads 13
- Unsafe vehicles 1
- Risk behaviour of road users 20

Municipal level

The screenshot shows the PUMS website interface. At the top, the logo for PUMS (Piano Urbano della Mobilità Sostenibile) is visible, along with the word 'ROMA' and the city's coat of arms. The navigation menu includes 'Il Piano', 'Partecipa', 'Chi Siamo', and 'Diario'. The main heading is 'Proposte dei cittadini'. Below this, there is a sidebar with 'Partecipa' and 'Interventi' sections. The main content area shows 'Proposte pervenute nella fase di ascolto conclusa' and a map of Rome with various colored markers representing different proposals.

This screenshot provides a more detailed view of the map and the 'Interventi' section. The map shows various colored markers (red, blue, yellow, green) across the city of Rome, indicating the locations of different proposals. The 'Interventi' section on the left lists the following categories and their counts:

Interventi	Count
Trasporto pubblico	881
Traffico privato	391
Logistica urbana	341
Sistema della ciclabilità	551
Isole ambientali	125
Sicurezza stradale	255

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