

Measure title: **Monitoring Centre for Road Safety and Accident Prevention in Genoa**

City: **Genoa**

Project: **Civitas Caravel** *Measure number:* **11.14**

A Introduction

A1 Objectives

The general objective was the implementation of a monitoring centre to analyse and prevent road accidents with a specific target of the Genoa Municipal Territory. In particular:

- **Objective 1** - To gather data about accidents, injuries, road and traffic characteristics, etc. from different sources by different actors operating with different roles in this field (Municipal Police, 118-First Aid, Regional Health Office, COA - Automated Operational Centre of the Municipality of Genoa, ARPAL - Regional Environment Agency, etc). This unitary framework has been activated trying to define minimal common procedures for the data collection, supported by proper information technology systems, which gives the possibility to have a unique database and to properly process the data.
- **Objective 2** - To analyse these data in order to elaborate an analysis model for the interested area.
- **Objective 3** - To improve the capacity to analyse critical situations in terms of safety and road accidents by the implementation of an exhaustive multi-source data warehouse system, a set of elaboration and representation methods, and new methodologies of data gathering from the field.
- **Objective 4** - To validate the system through the development of specific and significant test cases.
- **Objective 5** - To improve traffic safety to everyone's attention.

A2 Description

Following the Directives of the European Commission, in particular the Programme named "European road safety Action Programme – halving the number of road accident victims in the European Union by 2010: a shared responsibility" COM(2003), and the Italian indications coming from the National Road Safety Plan (Italian Law nr. 44/1999), the Municipality of Genoa's goal is to reduce the number of deaths on the roads by at least 50% by 2010, through actions that promote road safety: in fact the human, social and economic costs of unsafe are extremely high in comparison to the costs to improve road safety. Road traffic accidents in the Member States of the European Union annually claim about 43.000 lives and leave more than 1.8 million injured people, representing estimated costs of 160 billion euros. In Italy it has been calculated (by CENSIS data) that each year it happen 225.000 road accidents that cause 5.400 deaths and 310.000 injured people with a social cost (direct costs + indirect costs) of 18,6 thousand millions of euros. In Genoa (620 thousands of inhabitants; 243,60 km² of land area; 73,53 km² as populated urban centre; 30 million of km per year as traffic volume; 1.266,40 km as total urban road lengths) each year we have 7.500 road accidents that cause 34 deaths and 4.500 injured people with a social cost of 400 millions of euros. Then it's easy to understand as it is very important to undertake general and specific actions of intervention and strategies to improve the road safety, to prevent and decrease the incident risk.

A fundamental part of this strategy is to achieve a better capacity of road accidents analysis as a start point to develop appropriate monitoring actions able to solve and prevent the

“black points” of accidents. Methodological analysis and assessment of the most critical areas and factors are prerequisites for these improvement actions.

This task has been carried out by the implementation of a Monitoring Centre to analyse and prevent road accidents with a specific target of the Genoa Municipal Territory.

In particular, the measure wanted to improve the capacity to analyse critical situations in terms of safety and road accidents by the implementation of an exhaustive multi-source data warehouse system, a set of elaboration and representation methods, and new methodologies of data gathering from the field. In the B3 paragraph are described all these aspects.

Moreover another goal was relating to improve traffic safety to everyone’s attention and to point out the low-cost, high-benefit outcomes from improvements that reduce traffic crashes and their consequences.

In order to achieve these objectives, the system has been able to: gather data about all accidents, injuries, road and traffic characteristics, etc. from different actors operating with different roles in this field; analyse these data with an innovative methodology able to study the road safety for the interested areas, starting from specific indicators. The measure also foreseen the planning of two pilot and test strategies to improve the black points, considering that the results can be verified only on a long period.

An important action was the promotion of the road safety culture towards citizens, politicians, institutional entities involved in the problem, also with the target to include safety as a key planning factor in all transportation plans and programs.

At this point we would like to specify that the results coming from the Caravel project about the possible decrease of road accidents in the urban area of Genoa will be appraisable only after the application of the mobility interventions that can be suggested by the analysis of the Monitoring Centre. On the contrary the campaigns about the road safety can provide positive results in a short time, but it is very difficult to understand how much they have contributed to decreased the accidents.

For these reasons the measure evaluation (see the C section) is centred not on the accidents trend in the Caravel period but on two “society” indicators, the “Awareness level” and the “Acceptance level” of the main stakeholder of the project (the Municipal Police).

In conclusion, the Monitoring Centre (MC) of Genoa has been created as a new system able:

- to integrate the existing system (named GestInc), based only on accidents information, that is updated in order to maintain the alignment between the two DB (GestInc DB and MC DB) and expanded (for example, to manage geographic data to describe the place of accidents);
- to improve and computerize the collection methods so that it is possible to perform data entry directly in digital format on site by agent patrols with the use of PDAs and Tablet PCs;
- to interface the GIS system of the Municipal Territorial Information Office using its functionalities to present data on thematic maps;
- to use WEB technologies for client accesses;
- to be an open system connected to the other ones to become an exhaustive multi-source data warehouse system of road accident and safety.

The main functionalities of the MC system concern:

- the import procedures from external DB and systems (118-First Aid, Regional Health Office, ARPAL - Regional Environment Agency, Traffic DB of COA, etc.) and their merge in the MC DB;

- the presentation on thematic WEB pages of historical accident data selected and sorted by specific keys (location, time, seriousness of injuries, age of the involved people, etc.);
- the direct calculation by MC DB of some performance indicators characterising the safety level.

See the graphics below about the structure of the MC and his functionalities.

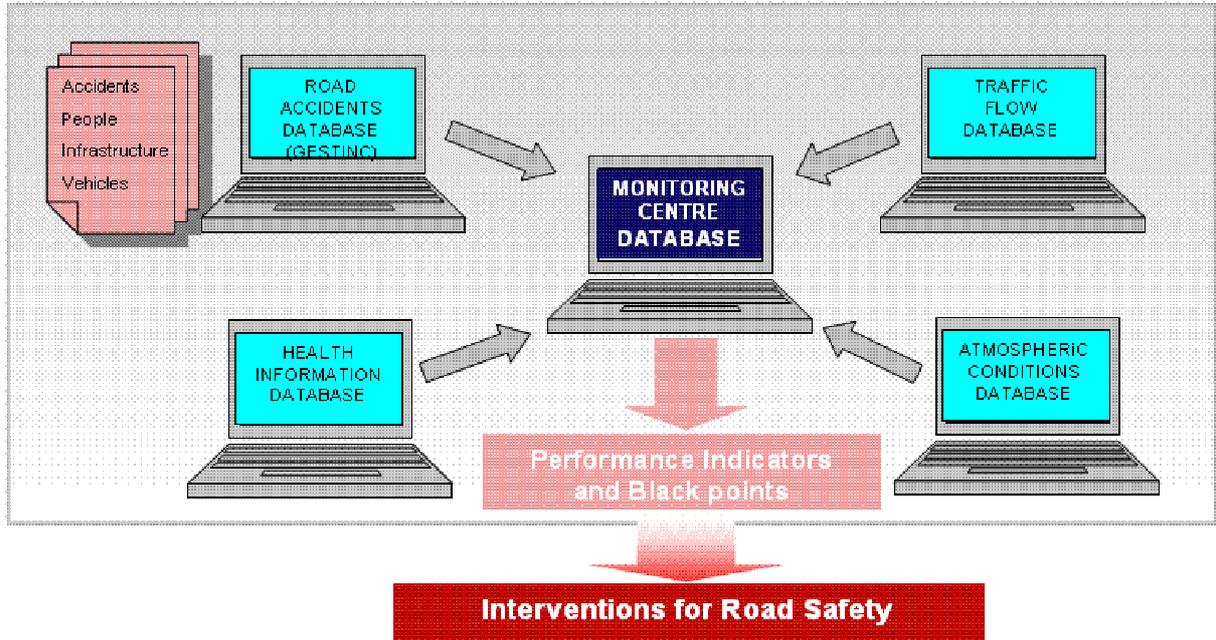


Figure 1: The structure of the MC of Genoa and his functionalities.

B Measure implementation

B1 Innovative aspects

The measure represents a new conceptual approach to face the problem of road accidents. In particular it foresees new organisational arrangements and the use of new technologies.

The innovative aspects of the measure are:

- **New organisational arrangements and relationships:** the collection of data comes from different actors involved in the project and different physical and territorial sources.
- **Use of new technology/ITS:** use of innovative data entry devices (PDA, Tablet Pc) and GPS instruments; the conversion of data at first in electronic format and then in into a usable GIS format (creation of thematic maps).
- **Use of new scientific aspects:** A methodology is elaborated to analyse the risk factors and to plan interventions and strategies to reduce the risk; the system foresees the synthesis of indicators for evaluation of accident risk.
- **New physical infrastructure solutions:** a new structure of road safety data base able to collect data and to automatically provide some accident risk indicators.

B2 Situation before CIVITAS

The overall strategy, underlying the actions undertaken by the Municipality of Genoa, is the building of a new road safety culture soliciting safer and sustainable mobility actions towards the local authority, the region, other bodies, schools and citizen association; in addition, the enhancement of technical structures in charge of traffic and safety.

The Municipality of Genoa is working with its staff and resources as far as road safety is concerned and has at disposal studies about traffic and safety among which the Traffic Urban Plan is surely the most important.

Furthermore it has a significant mobility study for the knowledge of the Genoese territory that is represented by the Origin-Destination Flows Matrix built in cooperation with the Province of Genoa started in March and ended in October 2001.

Over the last years, with the implementation of the new urban traffic plan a significant re-organisation and rationalisation have been carried out. The positive outcomes for road safety depend mainly on the frequent use of roundabout in the urban intersections.

As far as the interventions made by the Mobility Department are concerned, in order to enhance road safety conditions (as required by the Road Safety National Plan and at European Level), in the last three years projects and traffic-restraining interventions concerning both safe routes nearby schools and pedestrian-crossing protections have been implemented.

About the way to collect the accident data in the urban area, until now in Genoa the Municipal Police is the only qualified to intervene on urban accident site and the agent patrols collect data using a papery form. Then in the office they insert all information in a specific software tool system named **GestInc** (Verbatel Company). The data are used only to create some statistics without a real methodology of analysis.

The architecture of the system is composed by the GestInc server and 12 clients. The clients are installed in the Municipal Police Districts. When the file "accident event" is completed the software GestInc closes this file and passes it to the central system that inserts the file in the database. Related to the intervention procedure if the 118-First Aid receives a call about an accident, it inform the COA (Automated Operational Centre) of the Municipal Police of Genoa so that provides to send an agent on site. The 118 system is linked by data and call lines to Hospitals and other first aid services.

Now after Caravel the situation is changed. About these changes see the next paragraph.

B3 Actual implementation of the measure

The measure is related to the all territory of Genoa. See the map below.

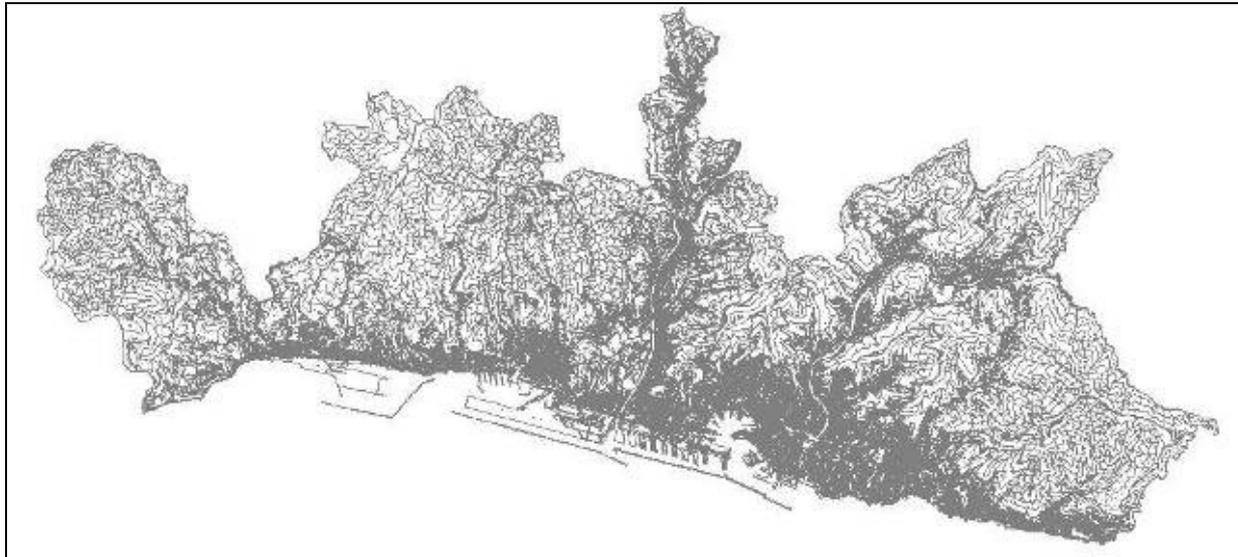


Figure 2: Genoa Municipal Area.

The measure was implemented in the following stages:

Stage 1: Design of the overall architecture of the Monitoring Centre (from February 1st 2005 – to August 1st 2006) – Definition of involved actors and requirements definition by site surveys and working groups participated by different organisations, like municipal administration, police and traffic offices, to face the problem of accident prevention and road safety.

Stage 2: Definition of data collection (from February 1st 2005 – to August 1st 2006) – The stage included the requirements analysis about the data collection, which gives the possibility to have a unique database and to properly process the data. The considered data are those indicated in the figure 1: all data about accidents coming from GestInc DB, the traffic data (flow and speed) of the greater part of roads of Genoa (the flow detecting system isn't in all roads of Genoa), the whether data (mm of rain each 10 minutes), the health information of people involved in the accidents (days of prognosis, arriving date and hour in the hospital, level of urgency, etc.).

Stage 3: Definition of new way to collect accident data on the field (from February 1st 2005 – to February 1st 2006) – The stage included the requirements analysis matched with actors standards procedures. The stage has also been related to the choice of innovative data entry devices (PDA, Tablet Pc or optic pen?) and GPS instruments to collect data by the Municipal Police: the choice has been on 16 PDA and 2 Tablet PC with GPS or GPRS integrated with the aim to automatically collect the latitude and longitude of the accident place.



Figure 3: Tablet PC and PDA to collect accident data on the territory of Genoa.

Stage 4: Methodological analysis (from August 1st 2006 – to August 1st 2008) – Methodological analysis to improve the road safety. In particular, the research elements consist on:

- development of the data analysis method;
- planning and development of indicators (>15) to characterise the level of safety;
- development of an effective data fusion and representation of different kind of data (creation of thematic maps).

About the scientific point of view, the analysis by Road Safety Performance Indicators is divided in **more levels** according to indicator type and to degree of analysis. So the system can systematically monitor the “black points”, analyze the trends with regard to safety levels and address the possible interventions.

The identified Road Safety Performance Indicators, in order to be useful, satisfy the following conditions: they are significant, available, reliable, easy to collect and use qualitative and quantitative information.

The levels are shown in the tables below.

1st level: Statistic Analysis by relative indicators

The first level is the simpler analysis level. It is about several ratio between the number of deaths, injured people and accidents. For example, the Mortality ratio “R_m” is the ratio between the number of death “M” and the number of accidents “I”; the Injured ratio “R_f” is the ratio between the number of injured people “F” and the number of accidents “I” and so on.

2nd level - Macro-territorial Analysis

The indicators consider the relationship among the accident data and some macro – territorial aspects, as the number of kilometres of length for a specific road or homogeneous arc, the number of resident people in a specific zone, the number of moving vehicles in a certain road / zone.

3rd level - Analysis by risk indicators

These types of indicators consider the traffic flow besides the geometric parameter of the road length. At this level we can obtain a classification of the arcs / roads in accordance with the accident risk and so it’s possible individualize the “black points”. In particular, the MC DB provides:

1) three ratio respectively between accidents / dead people / injured people and one million of vehicles-km (T_i , T_m , T_f);

2) a “**weigh**” rate (T_p) that is the addition of the three (T_i , T_m , T_f) weighed ratio:

$$T_p = (T_i \cdot 20 + T_m \cdot 50 + T_f \cdot 30) / 100$$

3) a “**local risk**” indicator (M.G. Vignolo, A. Nordio, “Urban Transport system monitoring: the black points problem”, International Conference “Urban Transport 2004”, book edited by C. A. BREBBIA, Wessex Institute of Technology (UK), ISBN 1-

85312-716-7, Series: Advances in Transport, Vol 16, WITPress, 2004) that represents the risk to which is exposed a motorist that crosses a definite arc of the road network; it is calculated as the sum of the probabilities to be involved in an accident (T_i), to be injured (T_f) or killed (T_m) after an accident, multiplied for the relative average costs due to every events (in this moment the possible costs are $d_i = 35.000$ euro, $d_f = 140.000$ euro, $d_m = 1.555.000$ euro):

$$R = T_i d_i + T_f d_f + T_m d_m \quad [\text{euro/km}]$$

4th level: Analysis by risk indicators variations

In this level we examine the variation of the 3 levels in a defined time period (years, months, etc.) and their dispersion in accordance with some variables.

In the table 1 the used road safety performance indicators per level are resumed. We underline that every variable must be defined for a specific time period and on a specific road / arc / zone.

<i>1st level - Statistic Analysis by relative indicators</i>	<i>2nd level - Macro-territorial Analysis</i>	<i>3rd level: Analysis by risk indicators</i>
$R_m = (M / l)$	l/km	$T_i = \frac{I}{TGM \cdot 360 \cdot \text{km}} \cdot Y$
$R_{mx} = (M / l) \cdot X$	M/km	$T_m = \frac{M}{TGM \cdot 360 \cdot \text{km}} \cdot Y$
$R_f = F / l$	F/km	$T_f = \frac{F}{TGM \cdot 360 \cdot \text{km}} \cdot Y$
$R_{f\text{serious}} = (F_{\text{serious}} / l)$	$R_{mn} = [(M / l) \cdot n] / N$	$T_p = (T_i \cdot 20 + T_m \cdot 50 + T_f \cdot 30) / 100$
$R_{f\text{slight}} = (F_{\text{slight}} / l)$	$R_{fn} = [(F / l) \cdot n] / N$	$R = T_i d_i + T_m d_m + T_f d_f$
$R_{fx} = (F / l) \cdot X$	$R_{fn} = [(F / l) \cdot n] / N$	
$R_{fx\text{serious}} = (F_{\text{serious}} / l) \cdot X$	$R_{fn} = [(F / l) \cdot n] / N$	
$R_{fx\text{slight}} = (F_{\text{slight}} / l) \cdot X$	$R_{fn} = [(F / l) \cdot n] / N$	
$R_{f2} = (M+F) / l$	$R_{fn} = [(F / l) \cdot n] / N$	
$R_{f2x} = [(M+F) / l] \cdot X$	$R_{fn} = [(F / l) \cdot n] / N$	
$R_p = M / (M + F)$	$R_v = (V/Q) \cdot Z$	

Table 1: Performance indicators per level used in the MC DB

Here is the meaning of every variable used in the equations above:

- "I" is the number of accidents;
- "M" is the number of died people;
- "F" (= $F_{\text{serious}} + F_{\text{slight}}$) is the number of injured people;
- " F_{serious} " is the number of serious injured people (prognosis > 30 days);
- " F_{slight} " is the number of slight injured people (prognosis < 30 days);
- "km" is the number of kilometres of length for a specific road or homogeneous arc;
- "V" is the number of vehicles involved in accidents;
- "Q" is the number of moving vehicles in a defined road / arc / zone;
- "N" is the number of resident people in a specific zone;
- "X" is the baseline related to the number of accidents (i.e. $X = 10^2$);
- "Y" is the baseline related to the number of vehicles per km (i.e. $Y = 10^6$);
- "Z" is the baseline related to the number of moving vehicles in a certain road / arc / zone;
- "n" is the baseline related to the number of resident people in a specific zone (i.e. $n = 10^5$ inhabitants);
- "TGM" is the average daily traffic flow [veic] on a specific road / arc / zone.

About “X”, “Y”, “Z” and “n” the DB user can change the value on web site. By this methodology that use performance indicators the road safety analysis is more structured and considers a lot of aspects related to man – vehicle – environment. Moreover, if some input data are not available the system allows to have at least some results based on the first levels.

About the creation of thematic maps on accident points and “black points indicators”, these are created by selecting a time period filter on MC DB and then by an implemented **hierarchical clustering algorithm** based on:

- the recursive gathering of filtered accidents points (with latitude and longitude) at a defined distance (definition of **clusters** and a distances **matrix**);

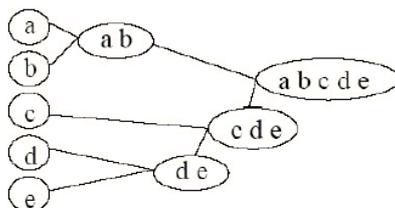


Figure 4: Clustering Algorithm schema

- the characterization of the cluster with its barycentre.

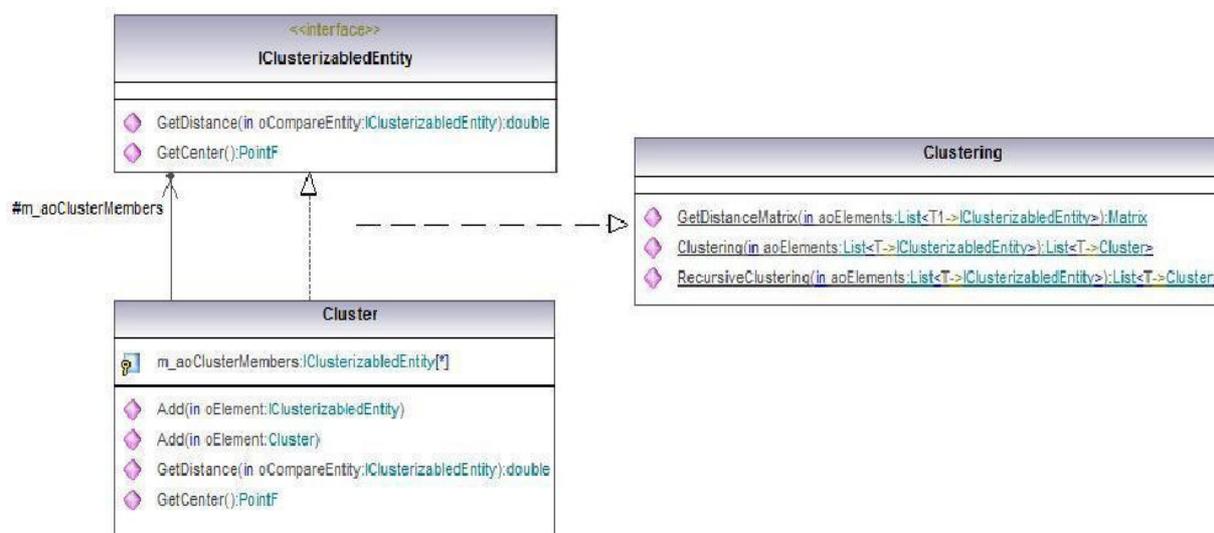


Figure 5: Clustering Algorithm

So each cluster is composed by a lot of information: lat – lon of the barycentre, nr. of accidents, nr. of serious and slight injured people, nr. of died people, nr. and type of involved vehicles, nr. of involved pedestrians, mortality ratio, injured ratio, “weigh” accident rate. Then the MC DB system deletes the “no black” clusters according to a specific calculate severity factor and it can individualize on map 10 types of clusters (or “black points”). The cluster has a different colour in accordance with the type of point and a different dimension in accordance with the severity of black point. Therefore by this clustering the thematic maps have all elements to understand where there are problems and what is the type of problem.

Stage 5: Implementation of the designed hardware architecture (from August 1st 2006 – to August 1st 2007) – The stage included the definition of the informatics

multi-tier architecture of the system. See the architecture in the figure below. This is the advanced scheme of the figure 1.

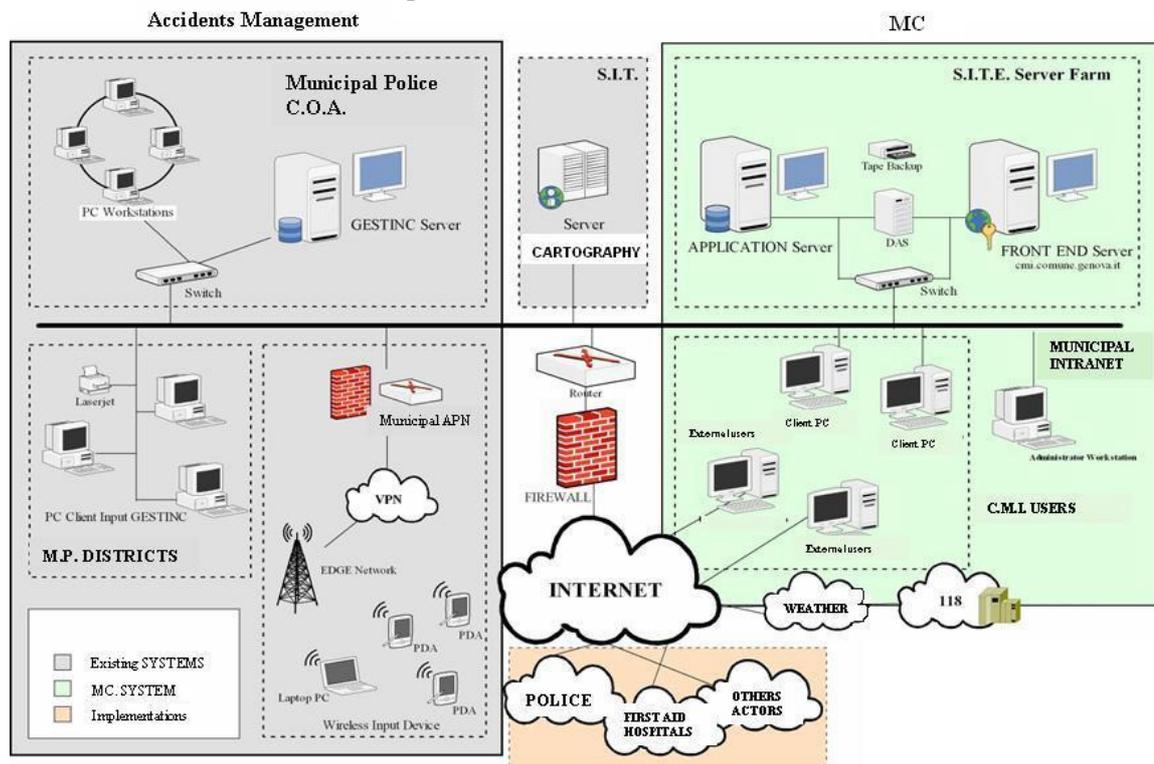


Figure 6: Monitoring Centre Architecture.

Stage 6: Design of the specified software (from February 1st 2005 – to August 1st 2006) – The stage included the software definition.

Stage 7: Software implementation (from February 1st 2007 – to February 1st 2008) – The development of the specific software architecture took place.

Stage 8: Implementation of the system (from November 1st 2006 – to May 1st 2008) – The stage included the carrying out the system.

Stage 9: Test and start up of the system (from February 1st 2007 – to August 1st 2008) – The stage included test and start up of the implemented system.

Stage 10: Operational run (from August 1st 2007 – to February 1st 2009) – The stage included the operational testing on the field.

Now it is interesting to describe the several screens of the Monitoring Centre DB. The MC DB is available on the Municipal intranet at the web address “<http://cmi.comune.genova.it>”. The first page on web site is showed below.

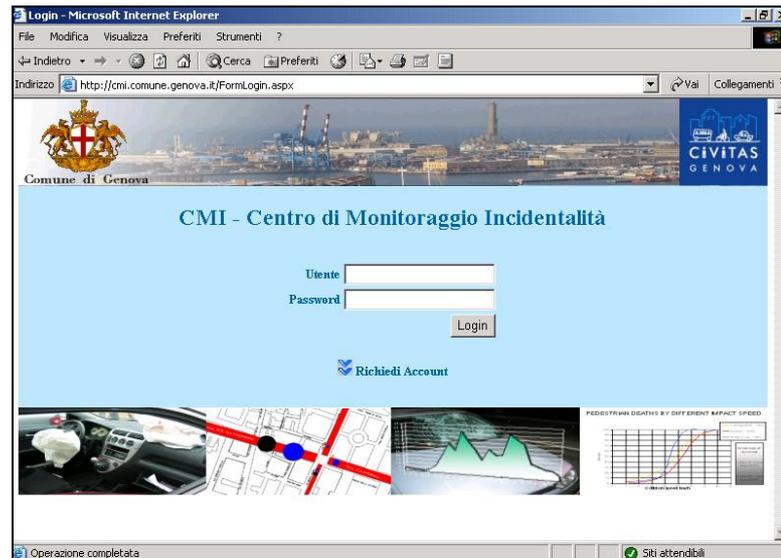


Figure 7: First page on Monitoring Centre web site in the Municipality of Genoa

After the login (username and password) the DB user has several possibilities.



Figure 8: Second web page with several type of output.

In fact, he can choose among several types of output:

- **list of accidents** (for example, it's possible to get all accidents happened with at least one involved pedestrian in a specific road or the accidents caused by rain in a specific time period in Genoa or the accidents with died and injured people and so on) and *accidents details* selecting the specific accident;

Incidenti		Risultati 1 - 10 di 6836 - Pagina 1 di 684				
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 > >>						
Data e Ora Incidente	Luogo	Veicoli Coinvolti	Feriti	PR	Deceduti	
01/10/2007 1.30.00	VIA DELLE CASACCIE	1	1	0	0	
01/10/2007 6.40.00	PIAZZA GIUSTI	1	1	0	0	
01/10/2007 7.30.00	CORSO SARDEGNA	2	1	0	0	
01/10/2007 8.40.00	VIA STURLA	2	1	0	0	
01/10/2007 10.30.00	VIA EUGENIO RUSPOLI	2	0	0	0	
01/10/2007 11.15.00	PIAZZA MANIN	2	1	0	0	
01/10/2007 11.30.00	LARGO DODICI OTTOBRE	2	0	0	0	
01/10/2007 12.25.00	VIA BRIGNOLE DE FERRARI	2	0	0	0	
01/10/2007 12.30.00	VIA CINQUE DICEMBRE	2	0	0	0	
01/10/2007 13.30.00	VIA EVANDRO FERRI	2	0	0	0	
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 > >>						

Figure 9: Example of list of accidents coming from the MC DB.

- **list of road safety performance indicators** divided in more levels according to the indicator type and analysis level;

1 Livello: Analisi statistica ad indicatori relativi	
Rapporto di mortalità	0,01316
Rapporto di mortalità ogni X incidenti	1,31579
Rapporto di lesività Rf	0,77632
Rapporto di lesività stradale grave Rfl serious	0,01316
Rapporto di lesività stradale non grave Rfl slight	0,76316
Rapporto di lesività Rf ogni X incidenti	77,63158
Rapporto di lesività stradale grave Rfl serious ogni X Incidenti	1,31579
Rapporto di lesività stradale non grave Rfl slight ogni X Incidenti	76,31579
Rapporto di lesività stradale REZ	0,78947
Rapporto di lesività stradale REZ ogni X incidenti	78,94737
Indicatore di pericolosità Rp1	0,01667
Numero incidenti di riferimento (Σ)	100

Aggiorna

Figure 10: Example of list of road safety performance indicators (first level) coming from the MC DB.

2 Livello: Analisi aggregata macroterritoriale	
Incidenti per Km	21,43280
Morti a Km	0,28201
Feriti a Km	16,63862
Morti per incidente su N abitanti	0,00212
Feriti per incidente su N abitanti	0,12515
Lesività per incidente su N abitanti	0,12727
Indicatore di pericolosità Rp2	0,00211
Popolazione residente di riferimento (N)	100000
Numero veicoli di riferimento (Z)	100000

Figure 11: Example of list of road safety performance indicators (second level) coming from the MC DB.

3 Livello: indicatori di rischio			
TCM Diurno	<input type="radio"/>	Feriti Gravi	<input type="radio"/>
TCM Notturno	<input type="radio"/>	Feriti Lievi	<input type="radio"/>
TCM Filtri	<input type="radio"/>	Somma Totale Feriti	<input checked="" type="radio"/>
TCM Totale	<input checked="" type="radio"/>		
Numero di veicoli a Km quale valore di riferimento		1000000	Aggiorna
Tasso aggregato annuale di incidentalita'	5,33300		
Tasso aggregato annuale di mortalita'	0,07017		
Tasso aggregato annuale di ferimento	4,14009		
Tasso annuale di incidentalita' pesato	1,92970		
Rischio locale [euro/Km percorso]	0,87602		

Figure 12: Example of list of road safety performance indicators (third level) coming from the MC DB.

We underline that the examples of the figures above concerns one of the two operational test plans foreseen in the measure: the results of the three levels of indicators on Corso Europa during the period October 2007 – September 2008. We can see in the 3rd level that the Local Risk for Corso Europa is 0,88 euro per km covered by each vehicles.

- **data dispersion;**
- **automatic graphics** (about the accidents in general on a road or about the whole territory and about safety performance indicators);

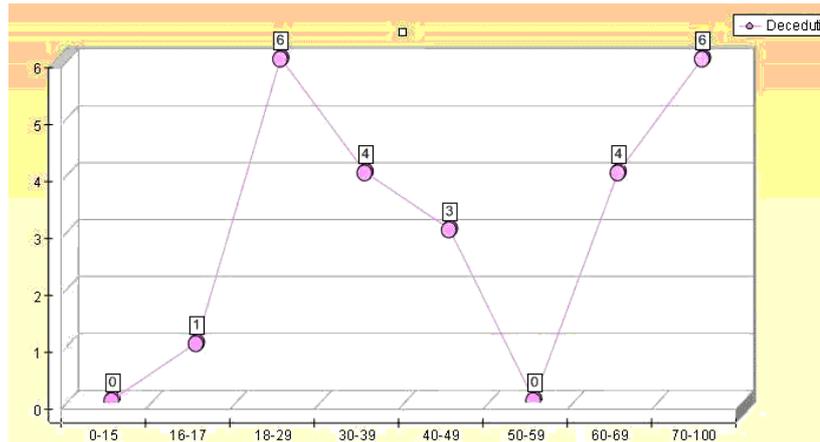


Figure 13: Example of death trend per age brackets about all roads of Genoa coming from the MC DB (from October 2007 to September 2008).

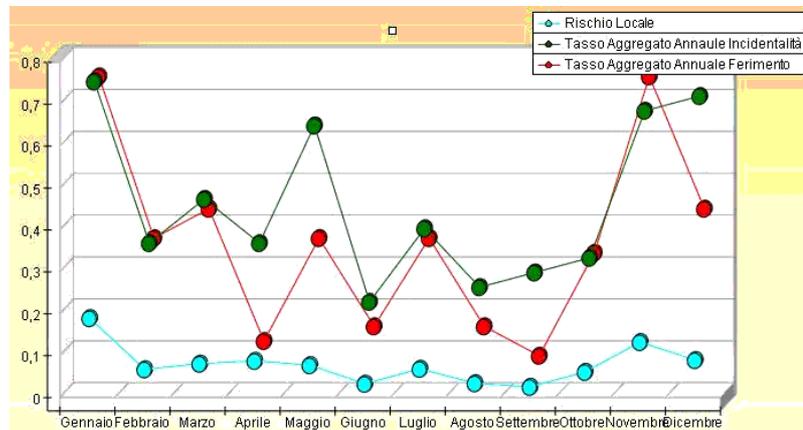


Figure 14: Example of several indicators trends per month about Corso Europa coming from the MC DB (from October 2007 to September 2008).

- maps (about the accident points and “black points indicators”).

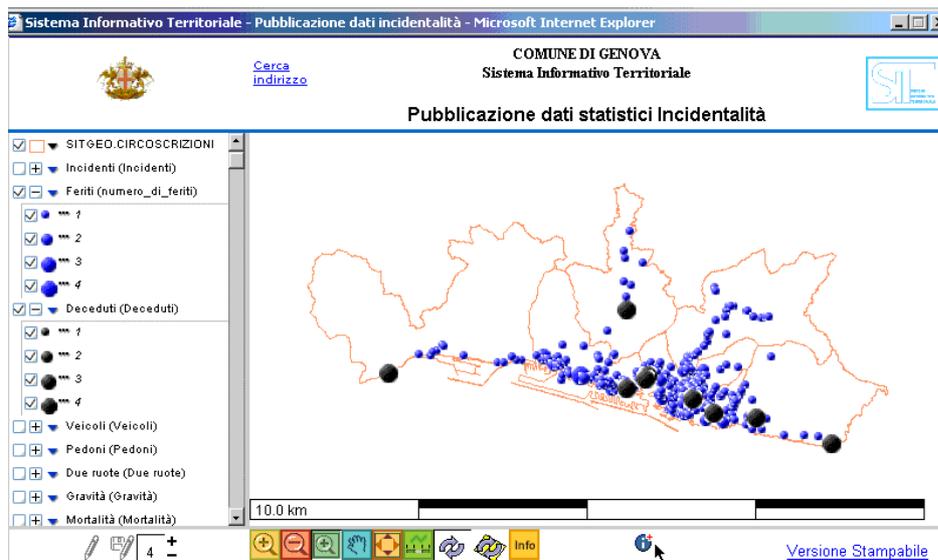


Figure 15: Example of maps with the “black points” about injured people (blu points) and deaths (black pints) about the whole teeritory coming from the MC DB (from April 2008 to September 2008).

It's also possible to see the specific road where is the black point. See the figure below.

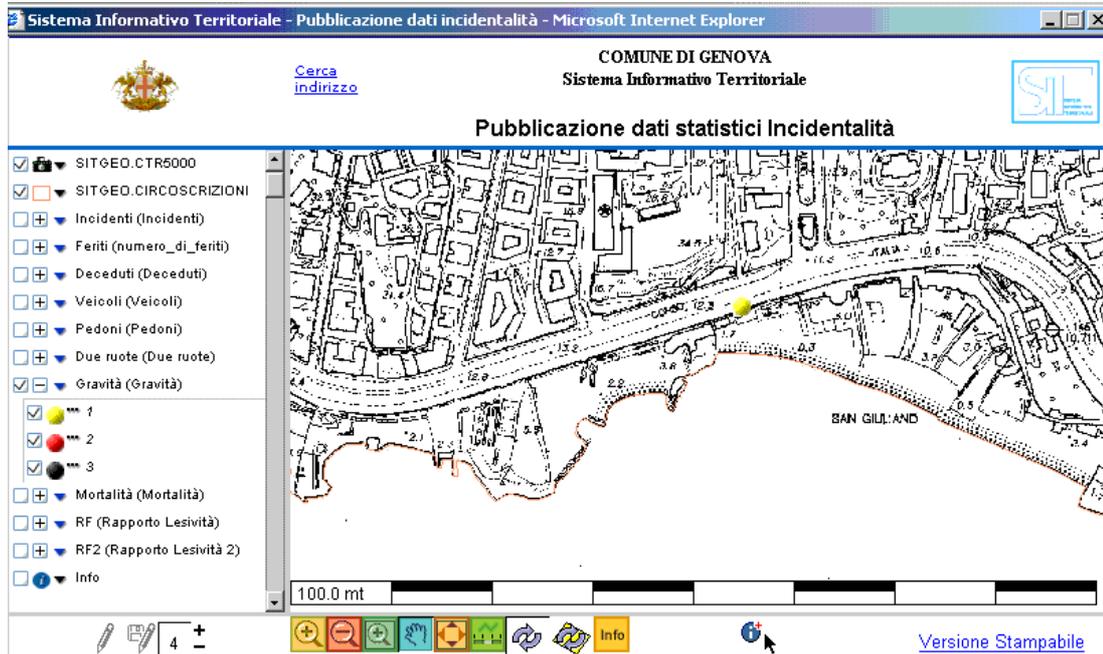


Figure 16: Example of cartography with the “black point” coming from the MC DB.

- **the excel files** with all information about the clusters and the accidents belonging to each cluster.

The MC DB is able to filter the input data to the system by different external DBs (Accidents DB, Weather Conditions DB, First Aid DB, Hospital DB, Traffic Flow DB). In particular, the filters are divided in more sections:

- **accident** (with all information related to the accidents in general, as the type of vehicles, the type of crash, etc.);
- **period of time** (years, months, days of the week, hour of the accidents);
- **man** (with all information related to the people involved in the accidents, as age, sex, driver – passenger – pedestrian, etc.);
- **environment** (for example, weather conditions);
- **traffic flow** (for example, traffic intensity);
- **road infrastructure** (for example, road lighting degree, state of road pavement, system of signs, etc.).

In the figure below there is an example of possible filters in the “accident” section.

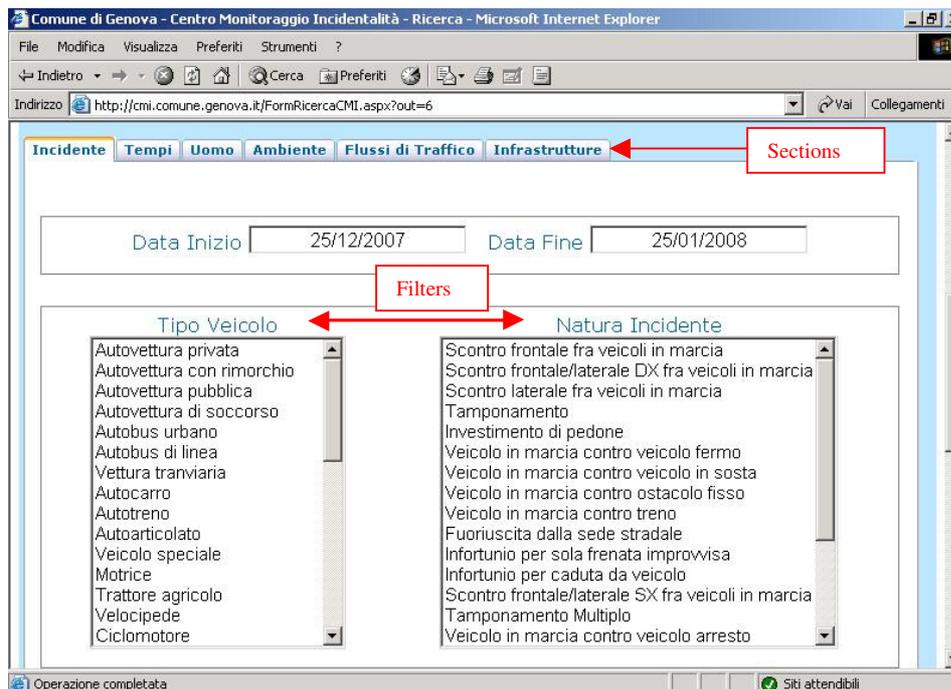


Figure 17: Some filters in the “accident” section of the MC DB.

So the DB user chooses the type of output, inserts the start date and the end date of the data research and selects some filters by the different sections.

Stage 11: Development of operational test plans (from November 1st 2005 – to February 1st 2009) – The core of the stage is the operative application in two existing “black points” on Genoa territory. Particularly, the statistic analyses related to the historical data (from 1993 to 2005), with more attention to the situation between 2001 and 2005, have shown that in Genoa the two roads with the highest number of death and serious wounded are Corso Europa and Corso Sardegna. So the two operational test plans to improve safety have been done in two black points of these roads. The specific black points have been chosen in collaboration with the Municipal Police.

The test plans have shown that to improve the road safety for Corso Europa it is necessary to change the semaphore timing. See the intersection more dangerous on Corso Europa.

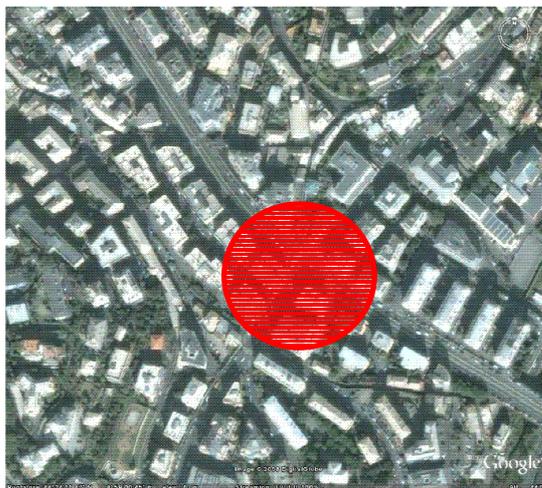


Figure 18: Black point in Corso Europa, Genoa.

Relating to Corso Sardegna it is necessary to change the semaphore timing and to hinder a direction to the traffic flow with the aim to reduce the conflict points between the traffic lanes. See the figure below with the solution able to eliminate all conflict points.

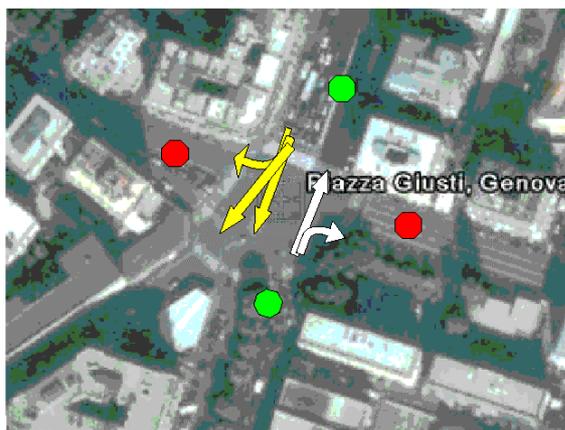


Figure 19: Black point in Corso Sardegna (intersection with Piazza Giusti), Genoa

Stage 12: Educational campaign (from May 1st 2008 – to February 1st 2009) – The stage included the educational campaign (for example, educational activities in schools provided by the Municipal Police; the organization of the bicycle day; lessons on road safety about a scientific point of view in the Faculty of Engineering of Genoa; the real simulation by the Municipal Police of an accident during the “Festival della Scienza” (Science Festival) of Genoa, a national annual important event to show all innovations within all scientific aspects to the citizen; and so on).

Stage 13: Evaluation (from February 1st 2006 – February 1st 2009) – The stage included the evaluation and monitoring campaign. In particular, some questionnaires have been submitted to police agents with the aim to understand the awareness and acceptance level.

Stage 14: Dissemination toward citizens (from February 1st 2006 – February 1st 2009) – The stage included activities related to the dissemination of the results of the measure to the citizens. For example, on May 2008 the presentation of the Monitoring Centre of Genoa during the International Conference on Probabilistic Safety Assessment and Management of Hong Kong (China); on the 31st of October has been presented the Monitoring Centre during the “Festival della Scienza” (Science

Festival) of Genoa; a specific session devoted to road safety has taken place in the Mobility Forum that represents an important event for discussion and dissemination; and so on.

B4 Deviations from the original plan

The technical contents of the measure and its objectives are coherent with the ones originally foreseen.

There has only been an initial delay of some months due to difficulties in involving the Municipal Police in the development of the project. After this delay, all the activities have been regularly developed and are substantially in line with the forecast duration. The initial delay has been recovered partly with the parallel execution of some activities and partly reducing the originally forecast experimental trial which was very long.

So no real impact on the development of the measure has occurred.

B5 Inter-relationships with other measures

The measure is related to other measures as follows:

- **Measure 11.5 - Mobility Forum** – The Mobility Forum represents an important event for discussion and dissemination. A specific session devoted to road safety has taken place.
 - **Measure 12.1 - Intermodal infomobility platform in Genoa** – Information related to road safety and the monitoring centre are included in the platform.
-

C Evaluation – methodology and results

C1 Measurement methodology

C1.1 Impacts and Indicators

As just specify in A2 paragraph it's possible to evaluate only two "society" indicators, because the accident trend will give us appreciable information only on a long period, after the applications of the interventions suggested by the Monitoring Centre.

However, it is necessary to underline that by the Measure 11.14 of the Caravel project Genoa has a new tool able to impact on the urban mobility with the possibilities to compare many types of information, not concerning only the road accidents (as the existing system) but also the traffic flow, the atmospheric conditions, the health data and so on. This comparing work, by specific performance indicators, allows to understand the strategies and the priorities to improve the road safety with the aim to decrease the social and economic costs coming from the accidents.

See the table below about the analyzed indicators.

Evaluation Category	N°	Indicator	Units	Source of data	Methodology for indicator construction (survey, modelling, etc)	Details about the date for indicator construction
Society	13	Awareness level	Survey	CdG- Municipal Police	Survey	Monitoring of the indicator on February 2008 (as baseline) and October 2008
Society	14	Acceptance level	Survey	CdG- Municipal Police	Survey	Monitoring of the indicator on February 2008 (as baseline) and October 2008

Table 2: Indicators of the measure 11.14 and methodology for indicators construction.

The detailed description of the indicator methodologies follows:

- **Indicator 1 - Awareness level** – Survey through interviews of the level of attention by the Municipal Police to the problem of safety.
- **Indicator 2 - Acceptance level** – Survey through interviews of the degree of acceptance of the measure by the Municipal Police.

Each time it has been surveyed about 50 police officers.

We specify that the baseline date for the survey has been chosen on February 2008 because it's the time immediately preceding the experiment of collecting accident data with PDA and Tablet PC. In this way it has been possible to survey the same police officers after their participation in the experiment.

C1.2 Establishing a baseline

For the two indicators, "Awareness level" and "Acceptance level", the baseline is February 2008. This date has been fixed during the period of the project because it was important to understand the state of the indicators before and after the test (October 2008) about the new work organization of the Monitoring Centre.

In particular, on February 2008 a first questionnaire has been submitted to Police agents.

About the first indicator the questionnaire includes three questions:

- 1) According to your point of view is it possible to act for concretely improving the Road Safety?
- 2) Do you think that the future use in Genoa of PDA and Tablet PC to collect road accident data could be useful?
- 3) If “Yes”, according to your point of view, considering a scale from 1 to 5, what is the degree of utility?

About the second indicator the questionnaire includes six questions:

- 1) Would you use PDA and Tablet PC to collect data about serious accidents?
- 2) Would you use PDA and Tablet PC to collect data about slight accidents?
- 3) Do you think that the use of PDA and Tablet PC represent an increase / improvement of the Police work?
- 4) According to your point of view, considering a scale from 1 to 5, what is the degree of increase / improvement of the Police work?
- 5) Do you think that the use of PDA and Tablet PC to directly collect data on accident place could cause some consequential problems?
- 6) If “Yes”, which problems could it create?

See the results of the questionnaire in C2.

On October 2008, after the experiment with the new input devices, a second questionnaire has been submitted to the same Police agents.

About the first indicator the questionnaire includes two questions:

- 1) After your participation in the experiment with the new input devices (PDA and Tablet PC) to collect road accidents data, do you think that is useful?
- 2) If “Yes”, according to your point of view, considering a scale from 1 to 5, what is the degree of utility?

About the second indicator the questionnaire includes six questions:

- 1) After your participation in the experiment, would you keep on using PDA and Tablet PC to collect data about serious accidents?
- 2) After your participation in the experiment, would you keep on using PDA and Tablet PC to collect data about slight accidents?
- 3) After your participation in the experiment, do you think that the use of PDA and Tablet PC represent an increase / improvement of the Police work?
- 4) According to your point of view, considering a scale from 1 to 5, what is the degree of increase / improvement of the Police work?
- 5) After your participation in the experiment, have you relieved some problems about the use of PDA and Tablet PC in the collecting data directly on accident site?
- 6) If “Yes”, which problems have you relieved?

See the results of the second questionnaire in C2.

C1.3 Building the business-as-usual scenario

As business-as-usual scenario we can image the Municipal Police with the same organization and tools existing before the Caravel project, so without the Monitoring Centre and his DB for accident prevention and without the PDAs / Tablet PCs to collect data.

In particular, without the MC the Police officers would have only the existing “Gestic” system able to collect data only about the accidents: so it would not be possible to do all the analysis with different types of information coming from the performance indicators. Moreover without the PDAs and Tablet PCs, with the integrated GPS and GPRS, we wouldn’t have data about latitude and longitude of the places where the accidents happen and, consequently, it would be impossible to build digitalized thematic maps on “black points”.

In conclusion, in the business-as-usual scenario there isn’t a concrete dialogue among the several parts involved in the “accidents” problem, as the Police, the Mobility and Traffic Local

Offices, the technical scientific experts: so without this interrelation of persons and data it's no possible to program and plan the mobility in order to improve the road safety.

C2 Measure results

This paragraph is dedicated to the results about the "Evaluation". In this measure two indicators are presented and they are related to the "Society" area.

Now it is necessary to underline that the indicators mentioned in C3 ("...The definition of a set of indicators (>15) and of a risk analysis model") are not related to "Evaluation" field but to the technical results of the Measure: the pointed out indicators are "scientific indicators" of the project which have been introduced in the software of the system.

So in C2.5 there is the description of the "Evaluation" results about the baseline (February 2008) and the period after the test (October 2008).

Besides even if any indicators about the economy and transport field have been foreseen in this measure however it is possible to do some comments.

C2.1 Economy

As described in A2 paragraph in the Municipality of Genoa each year it happen 7.500 road accidents that cause 34 deaths and 4.500 injured people (of which 102 serious injuries). An interesting European project named "Costs-Benefit Analysis of Road Safety Improvements Project" (Final Report - 12 June 2003) has estimated the costs per fatality, serious injury and slight injury concerning the road accidents. See the results in the table below.

Crash Severity	Lost Output	Human Costs	Medical Costs	Share of cost per fatality or injury			
				Property Damage	Insurance Admin.	Police Cost	Total, all costs
Fatal	520 355	1 016 917	7 005	9 714	273	1 738	1 555 002
Serious Injury	19 687	116 347	11 803	3 905	144	201	152 087
Slight Injury	2 263	9 670	965	2 291	87	43	15 320

Table 3: Costs estimated per fatality, serious injury and slight injury concerning the road accidents.

The Report doesn't consider the costs of an accident with only damages to vehicles. In the scientific paper entitled "Urban Transport system monitoring: the black points problem" (M.G. Vignolo, A. Nordio, International Conference "Urban Transport 2004", book edited by C. A. BREBBIA, Wessex Institute of Technology - UK, ISBN 1-85312-716-7, Series: Advances in Transport, Vol 16, WITPress, 2004), it has been estimated this type of costs (35.119 euros) considering the costs indicated in the Italian P.I.L. (the balance of the National internal production).

So now we have all the elements to calculate the economic costs coming from the accidents in the territory of Genoa: 400 millions of euros.

If the Municipality of Genoa, through the several actions on road safety in progress and the Monitoring Centre, succeeded in observing the targets indicated in the "European road safety Action Programme – halving the number of road accident victims in the European Union by 2010: a shared responsibility" COM(2003) and in the Italian Road Safety Plan (a reduction of 40% of death and 20% of injured people), the local economic cost of road accidents would decrease of 38 millions of euros within the 2010.

C2.2 Energy

There aren't indicators in this area.

C2.3 Environment

There aren't indicators in this area.

C2.4 Transport

Through the potentialities of the Monitoring Centre it's possible to monitor all the elements that can influence the accident trend. Then we can understand the specific aspects that caused or can cause a "black point". For example, the knowledge that a black point in a certain road is caused by an high level of traffic flow gives us an indication about the possible strategies to solve the point (as an alternative route). So the strategies set can gives some addresses to plan the urban mobility in order to improve the transports safety.

C2.5 Society

About the baseline data in the tables below there are the results related to the questionnaires provided to the Police agents.

Awareness level

N°	Questions	Baseline Results	
		Yes	No
1	According to your point of view it is possible to act for concretely improving the Road Safety?	51	5
2	Do you think that the future use in Genoa of PDA and Tablet PC to collect road accident data could be useful?	33	19
3	If "Yes", according to your point of view, considering a scale from 1 to 5, what is the degree of utility?	Average 3,3	

Summarizing the results, all agents think it's possible improving the road safety (51 positive answers against 5 negative ones). Half of interviewed people said that the use of technological devices to collect road accident data can be useful. Moreover, considering a scale from 1 to 5, the average degree of utility is 3,3. So, at the end, the level of attention by the Municipal Police to the problem of safety is good.

About the results see the diagram below.

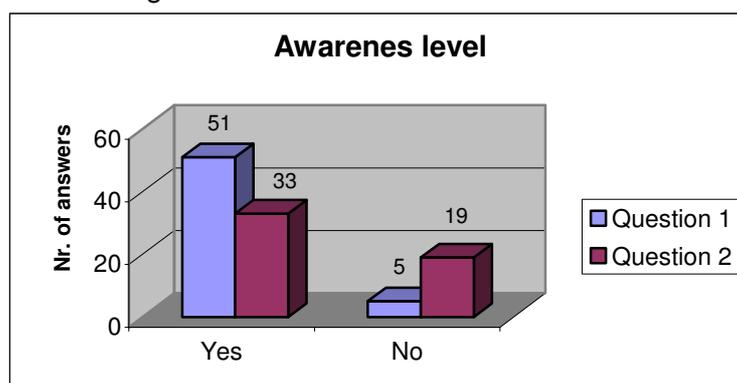


Figure 20: Diagram about the awareness level (baseline date).

Acceptance level

N°	Questions	Baseline Results	
		Yes	No
1	Would you use PDA and Tablet PC to collect data about serious accidents?	38	16
2	Would you use PDA and Tablet PC to collect data about slight accidents?	36	13
3	Do you think that the use of PDA and Tablet PC represent an increase / improvement of the Police	Inc 25	Imp 27

	represent an increase / improvement of the Police work?		
4	According to your point of view, considering a scale from 1 to 5, what is the degree of increase / improvement of the Police work?	Inc (average) 2,8	Imp (average) 3,7
5	Do you think that the use of PDA and Tablet PC to directly collect data on accident place could cause some consequential problems?	Yes 38	No 13
6	If "Yes", which problems could it create?	In particular: time loss, difficulties during bad weather, possibility to lose data.	

Summarizing the results, around 60% of interviewed agents would use PDA and Tablet PC to collect data about serious and slight accidents. So there isn't any differences according to the accident severity. The answers about increase / improvement of the Police work by the use of technological devices let understand that agents aren't convinced on the positive aspects coming from the project and the 66% of them think that the direct data collection on accident place could cause some consequential problems, as time loss, difficulties during bad weather, possibility to lose data. In particular, considering a scale from 1 to 5, the average degree of increasing of the work is 2,8 and the degree of improving of the work is 3,7. This conclusion confirms some difficulties to accept the measure by Police agents. About the results see the diagram below.

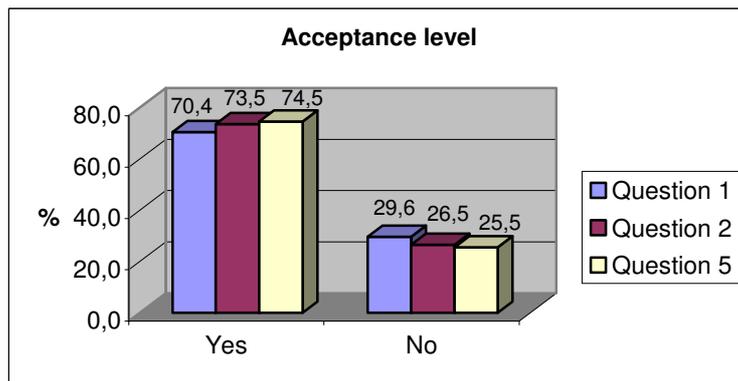


Figure 21: Diagram about the acceptance level (baseline date).

About the survey held on October 2008, after the experiment on the collection of accidents data by PDAs and Tablet PCs, the tables below there are the results related to the questionnaires provided to the Police agents.

Awareness level

N°	Questions	Baseline Results	
		Yes	No
1	After your participation in the experiment with the new input devices (PDA and Tablet PC) to collect road accidents data, do you think that is useful?	65%	35%
2	If "Yes", according to your point of view, considering a scale from 1 to 5, what is the degree of utility?	Average 3,3	

Summarizing the results, 65% of interviewed Police agents thinks that the use of PDAs and Tablet PCs to collect road accident data is useful. So in comparison with the previous results, before the experiment, the awareness level is improved a little bit. Moreover, considering a scale from 1 to 5, the average degree of utility is the same: 3,3.

About the results see the diagram below.

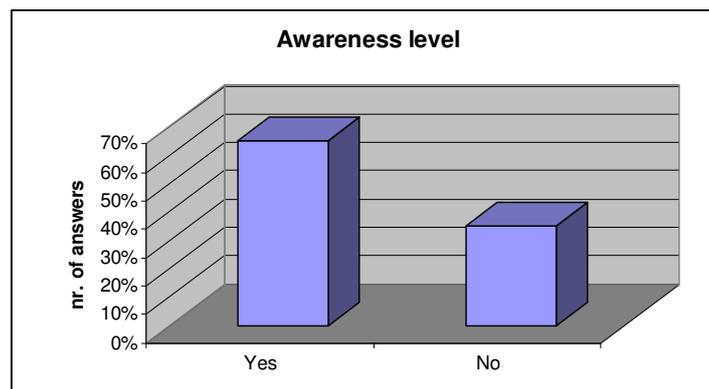


Figure 22: Diagram about the awareness level (October 2008).

Acceptance level

N°	Questions	Baseline Results	
		Yes	No
1	After your participation in the experiment, would you keep on using PDA and Tablet PC to collect data about serious accidents?	65%	35%
2	After your participation in the experiment, would you keep on using PDA and Tablet PC to collect data about slight accidents?	70%	30%
3	After your participation in the experiment, do you think that the use of PDA and Tablet PC represent an increase / improvement of the Police work?	Inc 47%	Imp 53%
4	According to your point of view, considering a scale from 1 to 5, what is the degree of increase / improvement of the Police work?	Inc (average) 3,5	Imp (average) 3,7
5	After your participation in the experiment, have you relieved some problems about the use of PDA and Tablet PC in the collecting data directly on accident site?	76%	24%
6	If "Yes", which problems have you relieved?	In particular: PDA too much small, no practical, time loss, difficulties during bad weather, possibility to lose data.	

Summarizing the results, the 65% of interviewed agents keeps on using the PDA and Tablet PC to collect data about serious and the 70% about slight accidents. So the percentage is increased after the experiment. The answers about increase / improvement of the Police work by the use of technological devices let understand that 53% of agents are convinced on the positive aspects coming from the project but the 76% of them has relieved some problems in the collecting data on accident place, as time loss, difficulties during bad weather, possibility to lose data, PDA too much small and no practical (they prefer the Tablet PC). In particular, considering a scale from 1 to 5, the average degree of increasing of the work is 3,5 and the degree of improving of the work is 3,7. This conclusion confirms some difficulties to accept the measure by Police agents even after the experiment: they keeps on using the technologic devices but for half of them it is an increase of the work. About the results see the diagram below.

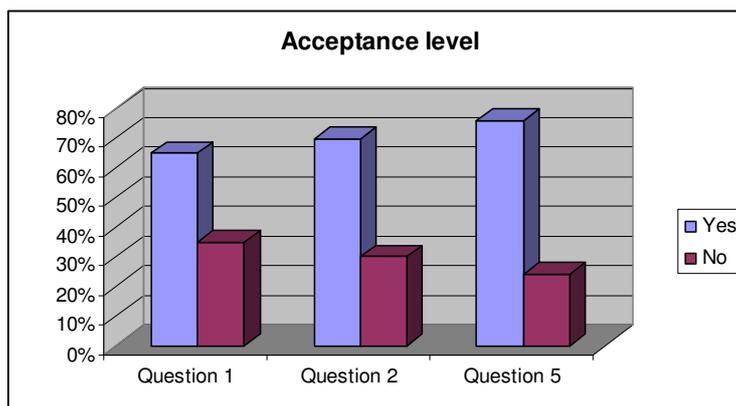


Figure 23: Diagram about the acceptance level (October 2008).

C3 Achievement of quantifiable targets

No.	Target	Rating
1	Implementation of an exhaustive multi-source data warehouse system to improve the capacity to analyse critical situations in terms of safety and road accident.	**
2	Improve traffic safety	NA
3	Raise acceptance level	**
NA = Not Assessed * = Not achieved ** = Achieved in full *** = Exceeded		

The results are verifiable by:

- the availability of a powerful analysis tool for the Monitoring Centre;
- the definition of a set of indicators (>15) and of a risk analysis model;
- the development of two operational plans to improve safety and reduce accidents risks in two critical points of the target area;
- the improvement of cooperation between all actors involved.

The targets above have been achieved as demonstrated in the B3 paragraph.

The target "Improve traffic safety" will be verifiable between some years, when we will have the statistical analysis of road accidents.

C4 Up-scaling of results

This measure doesn't foresee the up-scaling of results, because the Monitoring Centre for Road Safety and Accident Prevention is already built with the aim to collect and analyse accident data related to all territory of Genoa.

C5 Appraisal of evaluation approach

The evaluation approach worked well. About the society indicators there has been the precious help of the vice-chief of the Municipal Police that has organized the surveys between his police agents.

C6 Summary of evaluation results

The Monitoring Centre of the Municipality of Genoa is built with the characteristics shown in A2 and B3 paragraphs with the aim to help the public territorial planner in achieving the road safety objectives.

In particular the key results are as follows:

- **Key result 1** – The MC is an exhaustive multi-source data warehouse system able to gather data about accidents, injuries, road and traffic characteristics, etc. from different sources by different actors operating with different roles in this field (Municipal Police, 118-First Aid, Regional Health Office, COA - Automated Operational Centre of the Municipality of Genoa, ARPAL - Regional Environment Agency, etc).
- **Key result 2** – The MC is able to analyse these data in order to provide many results about “black points” and their causes about a road or the whole territory of Genoa with the aim to understand the interventions and priority for the improvement of road safety.
- **Key result 3** - The MC provides several thematic maps useful to analyse the critical situations. The PDAs and Tablet PCs are necessary to collect the lat / lon for the thematic maps.
- **Key result 4** – The safety performance indicators are an important tool to analyse the road safety and its trend.
- **Key result 5** – Using the “Local Risk” coming from the DB it’s possible to know the costs per km of the accidents for each road of Genoa.
- **Key result 6** – The measure works well if there is the direct involvement of the Municipal Police Top Management in the Project.

D Lessons learned

D1 Barriers and drivers

D1.1 Barriers

- **Barrier 1** – The resistance on behalf of the Municipal Police personnel in using new equipment (PDA and Tablet PC) to collect data. The risk that the measure failed due to the barrier has been low, because the experiment about the use of innovative data entry devices by Municipal Police was only a part of the project. Besides the acceptance level has shown that agents keep on using the technologic devices even if they consider it an increase of the work.

With the aim to overcome the barrier it has been necessary the direct involvement of the Municipal Police Top Management in the Project, the political support to it and the early training to key-personnel.

- **Barrier 2** – The lack of resources to sustain the Centre in the future time and to get into day-by-day operational practice of the developed procedures. The risk that the measure fails due to the barrier has been moderate.

To overcome the barrier it will be necessary to consider the operational management of the Monitoring Centre as a crucial part of the municipal mobility by the end of the project.

D1.2 Drivers

- **Driver 1** – The use of innovative data entry devices (PDA, Tablet PC) and GPS instruments in the road safety field. This have the aim to collect the accidents data directly on site in a digitalized way and it allows to have the lat / lon of the accident place for the building of thematic maps about the "black points".
- **Driver 2** – The elaboration of an innovative methodology to analyze the road safety beginning from the indicators for the evaluation of the "black points" and to plan territorial interventions and strategies. The Monitoring Centre is an important tool based on the statistics and performance indicators, which makes it possible to monitor the progress made in implementing the action programme and to analyse the trends with regard to safety levels. The collection and analysis of data on accidents and physical injuries is essential to be able to make an objective evaluation of road safety problems and to identify the priority fields of action. Simply counting crashes or injuries is an imperfect indicator of the level of road safety. A Safety Performance Indicator is any variable, which is used in addition to the figures of crashes or injuries to measure changes in the operational conditions. So an uniform methodology for measuring a coherent set of safety performance indicators can give a more complete picture of the level of road safety and can detect the emergence of problems at an early stage, before these problems result in crashes.

D2 Participation of stakeholders

The stakeholders have been involved through periodical meetings and continuous consultations. In particular, the main stakeholders involved are:

- **Stakeholder 1** – The Municipal Police has been the main stakeholder of the measure; it used the technological devices to collect accidents data for the monitoring experiment.

- **Stakeholder 2 & 3** – The Liguria Region (Regional Health Office) and 118 (First Aid) have been a strong support in the health data implementation in the Data Base of road safety. They are interested in DB results.
- **Stakeholder 4** – The University of Engineering - Department of Transports - has given a lot of support in the methodology to analyse the road safety.
- **Stakeholder 5** - COA (Automated Operational Centre of the Municipality of Genoa) has been available to provide traffic data about Genoa territory.
- **Stakeholder 6** - ARPAL (a Regional Agency) and the Municipal Office for the Environmental Emergency have been available to provide data about weather conditions.
- **Stakeholder 7** – SITE (Cartographic Office of the Municipality of Genoa) has provided to implement the digital maps about the local territory in the DB of the MC.

D3 Recommendations

- **Recommendation 1** - The Monitoring Centre is an important structure with the aim to collect road accident data, to study data and to individualize solutions to improve road safety. So the EU should employ resources to create the Monitoring Centre in the main European cities with the purpose to have a common collecting centre at European level.
- **Recommendation 2** – The scientific performance indicators used in this measure could be a good base to analyze the road safety at European level. So every Monitoring Centre in Europe could use the same indicators and methodology to analyze accidents problem.

D4 Future activities relating to the measure

- The Data Base of the Monitoring Centre and the analysis methodology will also be used after the end of the project. The positive impacts of the application of the strategies individualized in the Monitoring Centre will be visible only in some years, when it will be possible to compare the future accident statistic of the two operational test road with the actual data.
- In accordance with the Italian Road Safety Plan in the next future it will be created the Regional Monitoring Centre to which the Municipal MC will have to give all local data. Then a National MC will collect all local and regional information with the aim to plan the mobility improving the road safety at national level .

