



**CIVITAS**

Cleaner and better transport in cities

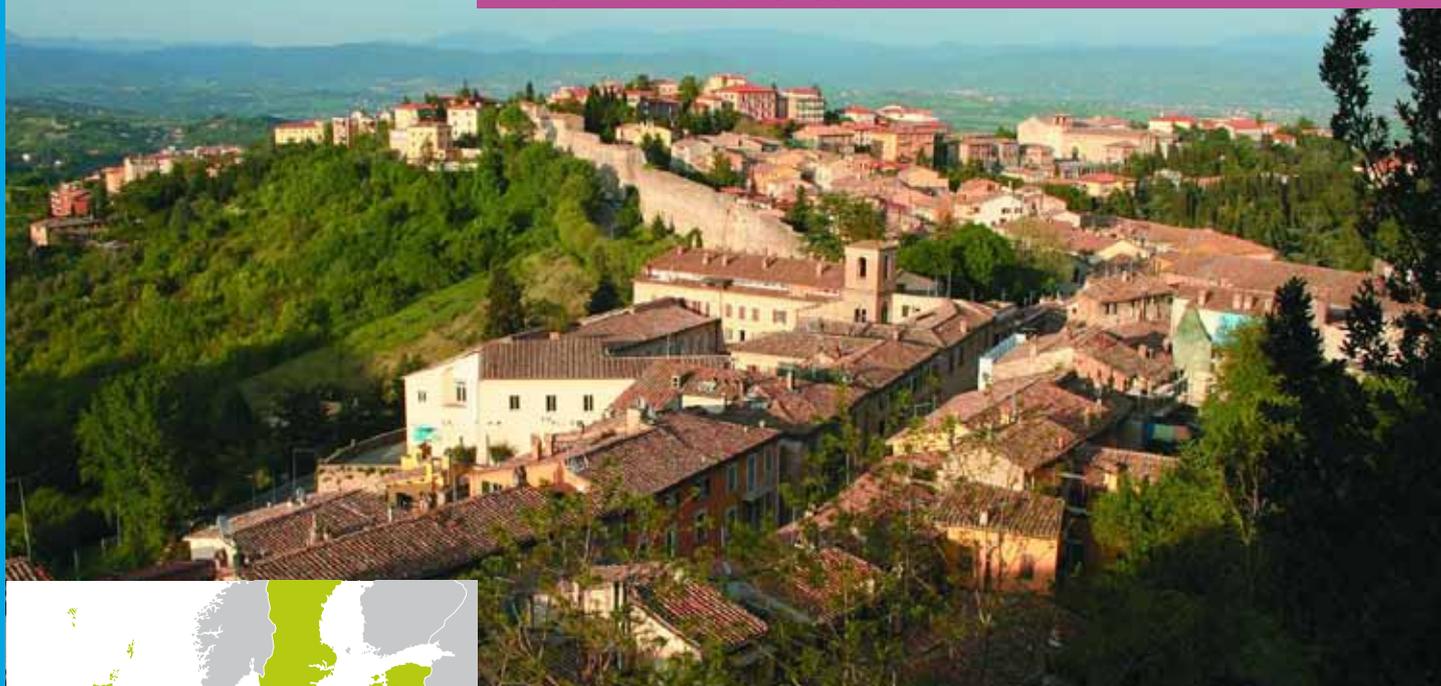
**RENAISSANCE**

# CASE STUDY



## ASSESSING THE OPTIONS FOR MORE EFFICIENT ROAD PAVEMENT MARKINGS

### SAFETY AND SECURITY



Municipalities usually undertake road surface markings maintenance through the combined use of internal staff and outside contractors. The evaluation of the work of external contractors is often done only in a qualitative manner, which does not allow assessing if the budget allocated for road surface markings is spent properly. Within this measure, a tool to verify and judge the quality of road surface markings by means of a scientific and experimental approach was developed. The definition of two new synthetic indicators allows the rating of global efficiency in terms of technical performance and cost of the management system of road surface markings of a municipality road network.

### Municipal context

Perugia is the capital city of the Umbria region in central Italy, a major educational and medical centre and also a host to many famous international festivals.

Perugia is a medium sized city: it is only the 23rd most populated city in Italy (with 167,000 inhabitants) but it is the 11th for land area (about 450 km<sup>2</sup>) [1].

As a consequence of the large surface of its territory, the Municipality of Perugia manages

and maintains a very expansive road network that stretches out for about 1,000 km with the limited budget of a medium size city. The management of the road network also includes the maintenance or installation of new road surface markings.

### Introduction

The road surface marking maintenance measure was mainly focused on developing a procedure for measuring the performance of road markings, taking into account characteristics such as road conditions, weather conditions, etc.

#### MUNICIPAL PROFILE

##### LOCATION

Perugia, Italy

##### POPULATION

167,000

##### LAND AREA

450 km<sup>2</sup>

##### CIVITAS BUDGET

EUR 2,704,508



#### PERUGIA IN CIVITAS

Perugia participated in CIVITAS RENAISSANCE. Under the motto of "Testing Innovative Strategies for Clean Urban Transport for historic European cities", the project connects five cities that face mobility challenges through seasonal tourism: Perugia (Italy), Bath (UK), Gorna Oryhavitsa (Bulgaria), Szczecinek (Poland), and Skopje (Macedonia).

#### PROJECT INFORMATION

CIVITAS RENAISSANCE aims to demonstrate how the legacy of the renaissance can be preserved and developed through innovative and sustainable clean urban transport solutions. The project aims to test and develop a valuable, reliable and integrated package of mobility measures that will make historic cities cleaner and safer.

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The importance of clearly visible pavement markings on foggy roads

This methodology was designed to be a tool for public administrations all over Europe to monitor the quality of road markings and reduce costs through an optimised management of road marking maintenance. In the framework of CIVITAS RENAISSANCE the methodology was developed on the road traffic network of the Municipality of Perugia.

### Taking a closer look

The first step of this measure was the analysis of the state of the art. The current available technologies and standards used to measure the performance of horizontal road markings were analysed and compared in order to acquire the know-how required for the following stages. The equipment required for the measure was then selected and purchased.

A selection of the test sites was made in cooperation with MUPER road marking staff. In order to represent the conditions of road marking for the whole Municipality, 27 test sites were chosen. The following parameters were considered:

- material (paint, thermoplastic, two components paint, tape, others);
- traffic flow (low, medium, high);
- pavement conditions.

Two experimental campaigns on the 27 selected sites were performed during the project. At the same time the methodology for evaluating

the global quality of road markings installed on the road network managed by MUPER was studied and developed. In particular the methodology consists of the following parts:

- selection of test sites in order to represent the conditions of road marking of the whole Municipality;
- definition of the parameters to be measured, procedures and equipment;
- data processing;
- results aggregation in synthetic indexes considering performance and economic aspects.

While the measurements of the second experimental campaign were carried out, the University research centre CIRIAF performed additional activities for the Municipality of Perugia with the aim of testing new products and of verifying the work undertaken by external contractors. This led to the redefinition of public tenders for road marking works containing, among other things, stricter controls on the works performed by the external contractors.

Another aspect that was investigated during the project was the ratio between the budget allocated by the Municipality of Perugia for road markings and the budget needed to guarantee efficient markings in the entire road network. Several scenarios were compared considering the cost, the service life and the performance of the materials currently on the market.

Two indicators were then performed to assess the quality of the road markings. One international event on "International Meeting on Road Safety and Markings" was held in Perugia on 11 May 2012, targeting stakeholders interested in applying the procedures in their territories/road networks. Three papers were published: one was presented at a national conference (CIRIAF 2010 national congress, Perugia, Italy [?]), one at an international conference (2nd International Conference on Road and Rail Infrastructure CETRA 2012, Dubrovnik, Croatia [?]) and one published on a peer reviewed journal (The Open Transportation Journal [?]). An information brochure describing the activities was also published.

Before CIVITAS, no quantitative data have ever been collected to describe the efficiency of road markings in the Municipality of Perugia. Road markings performance is being measured for the first time in the framework of this measure, allowing a rigorous and scientific approach to the topic.

### Results

The measurements carried out in Perugia showed that the quality of road markings installed on its road network is often poorer than the one suggested by the EU reference standard EN 1436. In 2010, the performance indicator CIS-Q (CIVITAS indicator for stripes – quality) was 6.6/10 that dropped at 4.9/10 in 2012. This reduction was expected since in all



## BACKGROUND INFORMATION

Road safety is a major focus of the European Commission policies: in 2011, more than 30,000 people died on the roads of the European Union, i.e. the equivalent of a medium town. For every death on Europe's roads there are an estimated four permanently disabling injuries such as damage to the brain or spinal cord, eight serious injuries and 50 minor injuries [1].

The third European Road Safety Action Programme (2003-2010) proposed a series of measures such as stricter control on road traffic, new road safety technologies, improved road infrastructures and actions to improve users' behaviour. The programme included an ambitious target to halve the number of road deaths by 2010 which was not achieved. Despite that, the fourth European Road Safety Action Programme (2011-2020) maintains the target of halving the overall number of road deaths in the EU between 2010 and 2020.

Quality of road infrastructure is a key point to achieve the goal defined by the EU, together with stricter policies and controls and an improved action of prevention and education. In particular, good quality surface road markings showed to be one of the most effective road safety actions [2]: the importance of pavement markings and their influence on driving safety, especially at night in difficult weather conditions (fog, rain, etc.) is well known.

As far as road surface markings, there are four main typologies of road marking materials: paint, thermoplastic, two components resins and preformed tapes. The retro-reflecting properties of each material, i.e. the ability to reflect light from the vehicle headlights back to the driving position, can be improved using glass beads; they could be mixed with the road marking material before the application on the road pavement or post-sprayed on the signage. In the European Union, the reference standard for the evaluation of road markings is EN 1436. It specifies the performance for the road user of white and yellow road markings, based on luminance (colour), day-time visibility, night-time visibility and skid resistance.

the test sites the markings were not re-laid in this lapse of time (this was not requested by the project).

The results of the two measurement campaign have shown that the actual system of road marking management in the Municipality of Perugia does not allow both fulfilling the requirements of its own tenders and achieving adequate performance (in terms of CIS-Q) because of:

- Lack of technical/instrumental control: before CIVITAS, the road marking staff of the Municipality of Perugia did not foresee an instrumental control on the horizontal markings.
- Intensive use of pre-mixed paint: the measurement carried out during the project demonstrated that this kind of material, even if freshly applied, cannot reach sufficient levels of performance in terms of night visibility.

Night visibility is the most important parameter especially for roads without illumination. Moreover the performance of paint drops quickly.

These negative results are mainly due to budget limitations: CIRIAF calculated that the budget yearly allocated by the Municipality of Perugia could allow maintaining in good conditions only 6 percent of its road network.

An economic analysis was carried out to suggest which materials should be used to reduce the costs of maintenance. Some useful information was found:

- The most economic material for stripes is solvent based paint, that is now being replaced by water based paints that is more expensive but not toxic at all;
- The most economic material in the long term (after 12 years) is sprayed thermoplastic.

In addition to the scheduled campaigns, CIRIAF performed activities for the Municipality of Perugia in order to verify the work undertaken by external contractors. This led to the redefinition of the requirements contained in public tenders works, containing stricter controls. As a result, in 2012, for the first time in Perugia, controls were performed with technical equipment on the works made by the winning contractors of the public tender. The results showed that the tender requirements were not fulfilled in almost all the investigated sites. As a consequence the company was obliged to re-install the markings. Similar results were also found in the two experimental campaigns.

## Lessons learned

This measure made it possible for the Municipality of Perugia to assess the real situation of road marking in its territory. Furthermore, it showed how stricter and instrumental controls can easily and quickly lead to concrete results. For instance, a simple check can show if the quality of marking installed by the contractors is adequate (in terms of the requirements given in the public tender) and, if not, the administration can act accordingly. This guarantees that the allocated budget is spent in an efficient way.

However there is still work to do. The requirements specified in international standards (in Europe EN 1436) for road markings performance (retroreflection under headlamp lighting, reflection in daylight or under road lighting, colour, skid resistance) derive from studies conducted on visibility of markings on highways. These requirements should be revised in order to be applied on urban roads. New requirements in terms of visibility should be lower than the actual ones for several reasons, such as lower speed limits, lower annual average daily traffic (AADT), more diffuse presence of road lighting, etc. New studies should be conducted in order to define how the performance of markings varies with time on urban roads. In this way it could be possible to select the appropriate material for each scenario (based on pavement, AADT, presence of lighting, etc.).

However, even defining lower requirements, it will be hard for many municipalities to keep a high quality of markings on the entire territory because of the restricted budget. Better results



could be achieved through the combined use of the following approaches:

- Stricter controls by the public administrations on the quality of works performed by contractors with adequate instrumentation using the methodology developed within this measure, which proved to be reliable and accurate.
- A smarter management system aiming at optimising the budget allocated for road markings. In particular a scale of priorities should be defined in order to understand where road markings should be applied first. Some factors that could be used to define the priorities are: number of accidents per year on the considered stretch of road, presence/absence of road lighting, presence/absence of schools, hospitals of other crowded places, speed limit, presence/absence of curb, AADT, etc.). Furthermore the periodic monitoring of the performance of road markings and the integration of the collected data in a GIS-based system could help the public administration to monitor the global state of the road markings in its territory.

### Upscaling and transferability

The indicators were developed in order to represent the global characteristics of the entire road network of the considered municipality: for this reason the choice of measurement locations has been guided by the necessity to guarantee upscaling throughout the road network managed by the Municipality. In other terms the chosen sites are representative of the road conditions in the whole territory of Perugia (different road surfaces, marking materials, traffic flows).

Moreover, the methodology was expressly designed to be easily transferred to other cities in Europe.

An experimental campaign was carried out in Bath (25-26 July 2011), in order to evaluate the transferability of the procedure. The measurements were performed in five test sites, one of which (St James Rampire) is the demonstration site of one of CIVITAS measures in Bath (for more information, click here). During the tests CIRIAF's staff held a short practical training course to the staff of the City of Bath explaining the measurement procedures developed within this measure and showing how the instruments work.

The methodology proved to be reliable and transferable in other European countries: in particular the results obtained in Bath showed that the use of thermoplastic markings results in higher and more enduring performance. As demonstrated by the economic analysis performed for the Municipality of Perugia, initially the cost of this type of material is higher than that of traditional paints, but in the long term its high durability and its good technical performance make it one of the most economical materials for road markings.

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International meeting on road Safety and markings

