Deliverable D3.10b:

Safety Performance Indicators for Speed: Pilots in Belgium and Spain

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Executive Summary

In the deliverable D3.8 of the SafetyNet project, "Road Safety Performance Indicators: Manual", the practical procedure recommended in order to produce speed SPIs was described. In this deliverable, two pilot studies are presented that aim to apply the recommendations of the SafetyNet manual and evaluate their pertinence.

The first pilot concerns Belgium where an annual survey focussing on speed behaviours over the Belgian road network has been implemented in 2003. It is carried out by the Belgian Road Safety Institute (IBSR) and its aim is to produce safety performance indicators. The methodology of the Belgian survey follows quite closely the guidelines that are included in the SafetyNet manual. Thanks to this survey, a large database of vehicle-by-vehicle speed data for 150 locations in Belgium is available for analysis by the IBSR. Based on the experience gained through the successive Belgian speed surveys, the pertinence of several recommendations of the SafetyNet manual was discussed in the Belgian Pilot.

Globally, the results of the pilot provide a backing for several recommendations of the SafetyNet manual:

- It confirms that when checking the validity of a measuring location, it is necessary to travel to this location. Desktop checks allow to detect some locations that are not suitable but do not allow to be sure that a location is suitable.
- It confirms that the strict application of the criteria of inclusion of the locations into the sample, does allow reducing the sample variance and thus the sample size needed to reach a desired confidence level on the SPI estimates.
- It confirms that the way the traffic conditions are dealt with when producing the SPIs may have a significant influence on the SPI values. In the Belgian case, 5 seconds proves to be a good period of time to consider when willing to filter the vehicles on the basis of their time-lag with the preceding vehicle.
- The equations that are recommended in the manual in order to compute national-scale SPIs are indeed applicable for most of the SPIs.

The pilot also allows adding some new recommendations to those of the SafetyNet manual:

- When checking the validity of the measuring locations, it is important to establish a good communication with local authorities and the road network managers. This allows to be notified of any modifications that alter the measuring locations. A road network is an entity that is constantly evolving.
- A new equation was proposed for the calculation of the variance of the "mean speed" and "V85" SPIs (see section 2.3.2 for the equation).
- When communicating the SPI values, it must be avoided saying that the SPIs are representative for the whole road network. It must be ensured that one tries not to conclude things from the SPI values that can not be concluded due to the nature of the SPIs.

Finally, it was identified that the statistical theory could be improved in order to take into account the different nature of the speed SPI (mean value, a percentile value and a

percentage value). A robust estimation of the variance of the "percentage of offenders" SPI especially, is not yet documented in the SafetyNet theory.

The second pilot concerns Spain. The Spanish pilot is only constituted by the first stages of a future free speed survey covering all Spain. For these first stages, the methodology recommended in the SafetyNet manual was followed very closely. The sample was designed carefully, taking into account the repartition of the different road types in each Spanish region. The measuring locations were chosen randomly on the basis of the road network database. Desktop verifications were done and in-situ verifications are planned in order to be sure that the measuring locations of the final sample comply with all the suitability criteria listed in the SafetyNet manual. Up to the current stage of evolution of the study, no major bottlenecks have been encountered in applying the SafetyNet methodology. However, the pilot shows that an important investment is needed when willing to select the measuring locations with the rigorous procedure displayed in the SafetyNet manual.

Yet, it will be interesting to follow the future evolution of the Spanish study outside the SafetyNet pilot framework. Indeed this will give more insight on the quality of SPIs that can be produced on the basis of a selection of locations that follows the SafetyNet methodology.

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1 General introduction

Road safety can be assessed in terms of social cost of crashes and injuries. However, the crash or injury counts are not providing complete information about the level of road safety. The crashes occur as a "worst case" consequence of unsafe operational conditions of the road system. Road safety policy makers have no direct influence on the number of crashes but should work in order to reduce the insecurity of the road system by acting on factors influencing the level of insecurity such as drunk driving, speeding or the use of seatbelts for example. The evolution of these factors should be monitored so that the insecurity of the road system can be evaluated and the influence of counter-measures assessed. The SafetyNet project selected seven problem areas for the development of Safety Performance Indicators (SPI) including the area that is the subject of this document: speed.

In the deliverable D3.6 of the SafetyNet project, the Road Safety Performance Indicators Theory, the theoretical background for the development of speed SPIs was presented and it was chosen to concentrate on three main indicators: Average speed, V85 and the percentage of offenders. It was recommended to compute separate indicators for different road types, vehicle types and periods of the day. In the deliverable D3.8, Road Safety Performance Indicators: Manual, the practical procedure recommended in order to produce speed SPIs was described. In the following pages of this document, we will frequently refers to the above two deliverables and simply call them "SafetyNet theory" and "SafetyNet manual". It is recommended to get the SafetyNet manual within reach as a background resource when reading this deliverable. The manual is available for download on the website of the European Road Safety Observatory: www.erso.org.

In this deliverable, two pilot studies are presented that aim to apply the recommendations of the SafetyNet manual and assess their pertinence. The methodologies used in these two pilots are not identical. The first pilot concerns Belgium where a speed survey is already established since 2003. The SafetyNet manual recommendations are evaluated under the light of this now confirmed experience. The second pilot concerns Spain. There, a new free speed study was launched for this pilot and is still ongoing. We present what has been done so far and the resulting lessons that have been learned.

2 Belgian pilot

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2.1 Introduction

An annual survey focussing on speed behaviours over the Belgian road network has been implemented in Belgium in 2003. It is carried out by the Belgian Road Safety Institute (IBSR) and its aim is to produce safety performance indicators. The methodology of the Belgian survey follows quite closely the guidelines that are included in the SafetyNet manual. Thanks to this survey, a large database of vehicle-by-vehicle speed data for 150 locations in Belgium is available for analysis by the IBSR.

In the framework of the present pilot, several guidelines of the SafetyNet manual were discussed on the basis of the Belgian experience. These guidelines relate to the selection of the measuring locations, the sample size, the selection of free-flowing traffic conditions, the SPI computation and the communication of the results. Some of the reflexions and observations are coming from analyses that are anterior to the SafetyNet pilot period but whose results have not been reported until this document offered the opportunity to do so. But most of the material (sections 2.3.2 and 2.4) is coming from analyses that were made especially in the framework of the SafetyNet pilot.

2.2 Belgian speed survey: summary of the methodology

The Belgian speed survey was started in 2003 at the request of the Federal Road Safety Commission. Its aim was to be able to follow the speed behaviour of road users by means of periodic indicators. The Belgian Road Safety Institute is responsible for the organisation of the survey and the analysis of data. Another company is subcontracted for gathering of speed data on the field.

The complete survey lasts for about one month in the autumn. On each measuring location, the speed of the vehicles is monitored during a whole week, without interruption. The speed, the approximate length and the moment of passage of each vehicle are registered. Road-side traffic counters are used for this purpose. At the end of the week of measurement, vehicle-by-vehicle data are retrieved from the device.

Speed is measured on 150 locations distributed between 3 regions (Regional speed estimates are also required) and between 4 speed limits. The selection of the measuring locations is made on the basis of a random sampling procedure. Globally, the speed of about 3.5 millions vehicles is monitored each year.

2.3 Sampling issues

2.3.1 Selecting appropriate locations

As suggested in the SafetyNet manual, the selection of the measuring locations for the Belgian speed survey is done randomly on the basis of the road network database. Once the locations have been sampled, a check is done in order to verify that the measuring locations are fulfilling a certain number of requirements such as those listed in the SafetyNet manual (straightness of the road, absence of speed calming infrastructure, enough distance from crossroads …). Up to 2006, these checks were mainly done in the office, by checking maps and aerial photographs. Furthermore, the sub-contracted firm had to fill a form and take a picture of each location. However, it was observed that all these elements were not sufficient in order to be sure that the measuring locations were fulfilling all the requirements of a suitable location.

For the 2007 study, it was thus decided to have a better procedure of verification of the validity of the locations. The criteria of selection of the sites were not modified (they are very close to the SafetyNet criteria) but we tried to apply these criteria in a stricter manner than for the previous studies. The procedure was as follows:

1) In the office, a first exploratory check was made using a road network database, aerial photographs and digital maps from the Web. This material only allows verifying that the measuring locations are on straight segments of roads and far enough from intersections but it does not gives much more information. The information on the road infrastructure is quite poor and, furthermore, we do not dispose of information about the speed limits of the roads.

2) On the field, we travelled to the measuring locations in order to check the validity of the sites in-situ. We had to travel to approximately half of the locations while the others were already known from previous years. During a typical field day, a maximum of 8 locations could be visited and around 500 km had to be travelled. For bigger countries than the 30528 km^2 Belgium, the field work could thus require a large amount of time and travel. Many speed measuring locations had to be re-located following this field checks. We always tried to search for a suitable new site in the neighbourhood of the initial site. In practice, due to the high density of the Belgium network, we rarely manage to find locations that fulfilled all the suitability criteria. For example, not a single location in the Brussels region could be found complying with the criteria of a minimum distance to intersections of at least 500 meters.

3) From the experience of previous studies, we realized that many things could happen on the chosen locations between the moment of the selection of the location and the moment of the speed measurements (Infrastructure changes, roadworks, change in speed limit, etc.). In order to be informed of these changes, we sent a letter to each municipality and each local police of the sites where measurement were planned approximately 1½ month before the start of the measurements. In this letter, we asked to be informed of any circumstances that could disturb the measurements on the chosen locations. The result of this request was quite impressive. For the latest speed measurements of 2008, 11 locations were affected by roadworks, either directly (roadworks at the site of measurement) or indirectly (roadworks in the neighbourhood, deviation of

traffic…). One location had undergone an infrastructure change. We had to urgently re-locate these measuring locations.

At the end, the sample of locations was considerably changed and improved for the 2007 study. No less than 76 out of the 150 locations were modified comparing to the 2006 and preceding studies. The influence of these modifications on the quality of the SPI estimates proved to be significant, as developed in the next section.

The Belgian experience thus proves the importance of ongoing checking of the validity of the speed locations. It is important for the people who are responsible for the survey to have an efficient communication with local authorities and to travel to the locations on a regular basis. Still, we can regret, in the Belgian case, the poverty of the databases that causes the office checks to be quite inefficient. Especially a dynamic database of the speed limits of the Belgian roads would be a helpful tool in facilitating the speed survey and be able to loose less time in fastidious field checks.

2.3.2 The sample size

When the Belgian speed survey was launched in 2003, it was chosen to measure speed on 150 locations, distributed over 5 different speed limits, allowing thus to have 30 measuring locations by speed limit. Since then, the measurements on motorways have been dropped and the 150 locations are now distributed over 4 speed limits and 3 regions (Brussels, Flanders and Wallonia). Let us remind that the sample does not take into account the road design, even if the measurements only take place on roads with a single lane in the direction of measurement. Due to different practical reasons in the choice of the locations and technical problems on some locations, the amount of locations ends up not being exactly equally distributed over regions and speed limits. The actual repartition is given at table 1.

Speed limit	30	50	70	90
SafetyNet road category	D and E	D and E	A, B and C	A, B and C
Locations in Brussels	12	15	-	-
Locations in Flanders	9	15	18	9
Locations in Wallonia	7	16	16	17
Total	28	46	34	26

Table 1: Composition of the Belgian speed survey sample in 2007

For the purpose of this pilot, the confidence intervals of the SPI estimates and, then, the ideal sample sizes were estimated according to the advices of the SafetyNet manual (Annex 2 to chapter 4 on speeds). The same computation was made for the year 2003, when the sample was the more heterogeneous and for the year 2007, when an extensive field work was made in order to assure that the locations would strictly correspond to the SafetyNet criteria. The calculation was made concerning the SPI "mean speed".

As stated in the SafetyNet manual, a first assumption that will be made is that the measure of speed at each location is correct and, thus, that the sampling error is only function of the variability that is observed between the locations.

Contrary to the example of the SafetyNet manual, all the locations have very different traffic counts. The SPI "mean speed" was thus obtained with the aim of a weighted mean of the mean speed of each measuring location, the weight being the traffic count at each location. Similarly, in order to calculate the sample variance, we used an unbiased estimator of weighted population variance given in Equation 1.

$$s^2 = \frac{\sum_{i=1}^{n} w_i}{\left(\sum_{i=1}^{n} w_i\right)^2 - \sum_{i=1}^{n} w_i^{\,2}} \sum_{i=1}^{n} w_i (x_i - \bar{x})^2 \qquad \text{Equation 1}$$

with s^2 the sample variance,

w_i the weight (traffic count) for each location i

x_i the mean speed at location I,

$\bar{x}$ the sample weighted mean,

n the sample size (i.e. number of measuring locations)

Table 2 gathers the variance and the confidence intervals for each road type and each region in 2003 and 2007. The confidence intervals are computed for a confidence level of 95%.

	30 km/h roads		50 km/h roads		70 km/h roads		90 km/h roads	
	Var.	Conf. interval	Var.	Conf. interval	Var.	Conf. interval	Var.	Conf. interval
2003								
Brussels	14.1	± 2.5	73.8	± 7.6	-	-	-	-
Flanders	41.9	± 4.8	24.2	± 3.6	48.8	± 4.6	46.5	± 5.5
Wallonia	132.1	± 7.5	37.7	± 3.3	124.1	± 9.8	71.0	± 5.2
Belgium	228.7	± 5.9	35.3	± 2.4	83.0	± 4.8	61.0	± 3.8
2007								
Brussels	52.5	± 4.1	24.4	± 2.5	-	-	-	-
Flanders	32.1	± 3.7	11.3	± 1.7	27.0	± 2.4	35.6	± 3.9
Wallonia	30.6	± 4.1	24.0	± 2.4	66.6	± 4.0	45.3	± 3.2
Belgium	45.6	± 2.5	17.2	± 1.2	51.0	± 2.4	49.3	± 2.7

Table 2: Variance and confidence intervals at 95% of the SPI “mean speed”.

With the exception of the sample for 30 km/h in Brussels, we can see that all the sample variances are smaller in 2007 than in 2003. The confidence interval on the national estimate in 2003 is only decent for the 50 km/h roads. What makes the big difference between the sample of 2003 and the sample of 2007 is that the conditions of inclusion of a location in the sample were stricter in the latter than in the former, as explained in the above section. This finding thus confirms the statement of the SafetyNet manual saying that before willing to increase the sample size, it is better to concentrate on the strict application of the inclusion criteria of the locations in the sample in order to reduce the uncertainty on the SPI estimates.

In the “corrected” sample of 2007, all 95% confidence intervals are smaller than 5 km/h for the regional samples and smaller than 3 km/h for the national sample. The 50 km/h roads are the roads where the variance of mean speed between locations is the smaller in all the regions and at the national level. The differences in variances between regions, especially on 70 km/h roads, may require that samples of unequal size should be taken in the different regions, in order to get mean speed estimates with similar confidence intervals. However it is not really possible in the Belgian case as a balance must be kept between the sample sizes of the different regions. The Belgian road categories defined by the speed limits include several SafetyNet road categories. If the recommendation of the SafetyNet manual to have different SPI estimates for each SafetyNet road category were applied, it is likely that the variance of each sample should be even lower.

Based on the calculated variances in 2007, an ideal sample size can be calculated, considering a maximum acceptable error of 2 km/h on each estimate. The required sample size for each region and road category is given in Table 3. The sample sizes are calculated for Belgium as if regional estimates were not needed.

	30 km/h roads	50 km/h roads	70 km/h roads	90 km/h roads	Total
Brussels	50	23	-	-	73
Flanders	31	11	26	34	102
Wallonia	29	23	64	44	160
Belgium	44	17	49	47	157

Table 3: Ideal sample size for a confidence level of 95% and a maximum error of 2 km/h

At the Belgian level, the current sample size of 150 locations would be almost sufficient to allow a maximum confidence interval of 2 km/h for each speed regime if the locations were spread differently across the different speed limits (More locations would be needed on 30, 70 and 90 km/h roads at the expense of 50 km/h roads). The recommendation of the SafetyNet manual to use at least 30 locations per road type is thus not to far from the reality if a precision of 2 km/h is desired. Regional sample should be increased comparing to the current situation if a similar precision in the SPI estimate should be attained. In order to reach the maximum error of 2 km/h in each region and for each speed limit, a total sample size of 335 locations would be needed.

2.4 Dealing with traffic conditions

In the SafetyNet manual, at section 4.4.2.2.1., it is argued that when producing indicators aiming at evaluating speeds, only the vehicles in reasonably free flowing traffic conditions should be considered. Various solutions are suggested in order to select free-flowing traffic:

- Avoid to measure speed during peak hours.
- Exclude from the data all the periods with a traffic flow that is too heavy. A threshold of 600 vehicles per hour and per lane is suggested.
- Only select the vehicles that have a significant headway to the vehicle in front of them. Headways from 5 to 10 seconds are suggested.

Across Europe, a large set of practices are encountered. In some countries, all recorded data are used to compute SPIs while in others only the vehicles with very large headways are considered. The purpose of this part of the pilot is to test the different options of selection of free-flowing traffic in order to quantify their impact on the final SPI values and to see to which extend comparisons of SPIs computed with different methods are still valid.

For this purpose, all 2007 speed data gathered at the 150 locations in Belgium were used and the different methods were applied in order to assess the differences.

Different computations were made for each speed limit (30, 50, 70 and 90). Let us remind that all locations are located on roads with one single lane per direction and that only one direction of traffic is monitored. The Belgian locations are selected randomly, regardless of their traffic count. However, the locations are always far from intersections and speed calming devices, which means that, in practice, very few locations suffer of highly congested traffic conditions. The average number of daily registered vehicles by location typically ranges between 1000 and 10000 vehicles.

2.4.1 Excluding peak hours

The first method that was tested in order to select free-flowing traffic consisted in simply discarding from the data all the observations taken between 7h30 to 9h00 and 16h00 to 19h00, corresponding to peak hours in Belgium. The resulting SPIs are given in Table 4 and compared with the SPIs for the whole period of measurement.

	30 km/h roads		**50 km/h roads**		**70 km/h roads**		**90 km/h roads**	
	All data	Without peak hours	All data	Without peak hours	All data	Without peak hours	All data	Without peak hours
Number of observations	393195	254311	997899	670966	100374 0	653502	508196	317652
Mean speed	50.3	51.3	52.6	53.2	70.9	71.7	83.0	83.5
V85	61.6	63.1	61.9	62.5	81.6	82.6	96.8	97.7
Percentage of offenders	94.0	94.5	58.1	59.7	50.9	52.6	29.9	31.1

Table 4: SPI values for Belgium in 2007 when considering all the traffic and when excluding observations from 7h30 to 9h30 and 16h00 to 19h00

It appears that the SPI values are not very different between the situation with and without the peak hours. The maximum difference is 1km/h for the mean speed, 1.5 km/h for the V85 and 1.7 % for the percentage of offenders. However, the number of observations that have been dropped to compute the “without peak hours” indicator is important. For some individual locations, the effect of not considering peak hours may have a bigger influence on the values of the SPIs but this effect is smoothed when aggregating the results of the 150 locations.

2.4.2 Excluding hours when the traffic is heavier than a fixed threshold

Among the 150 locations of the Belgian study, it was observed that the threshold proposed by the SafetyNet manual (600 vehicles per hour and per lane) was barely reached, even during the peak hours. Only 3 locations experienced traffic counts higher than 600 vehicles per hour during 1 or 2 hours a day. On the busiest location – one of the main entrance road to Brussels – the traffic count culminated at 850 vehicles per hour and per lane at the maximum.

Applying such a threshold would thus have an insignificant influence on the national SPIs. Further research would be needed in order to assess the influence of implementing lower thresholds. However, using a filter for traffic count is a coarse solution that is not likely to be more efficient in detecting the free-flowing traffic than the equally coarse but easier solution of simply not measuring the speed during peak hours.

2.4.3 Headway filter

An alternative way to calculate SPIs for vehicles in free flowing conditions is to include in the sample only the vehicles that have a given time-lag with the preceding vehicle. This method should not only remove from the data the vehicles that are driving during a highly congested period but also the vehicles that are inside a platoon during less trafficked periods.

The analysis is inspired by a study by Brady (2004) over Irish data. In this study, Brady observed that the speed of a vehicle was very dependent on the amount of free road in front of it and that speed increases until a gap of about one mile between vehicles.

Filtering the data on the basis of a headway filter is only possible when individual speed data are available and when the passing time of each vehicle is known. This is not the case with many traffic counter systems that produce aggregated data over a period of time (e.g. 5 minutes). However, the Belgian data do allow for this kind of analysis.

By means of the statistical software R, we computed the time-lag between the vehicles of the 150 measuring locations on the basis of their passing time in front of the traffic counter. We then filtered the data on the basis of different time-lag threshold and computed the speed SPIs for each of these filtered databases. The more interesting results are presented below and the complete results of the analysis are available in Annex 1.

Figure 1 shows the effect of different headway filters on the estimation of the mean speed and the V85 on 90 km/h roads. Figure 2 shows the same effect concerning the percentage of offenders. Time-lags of 2, 5, 10, 30 and 60 seconds are used. Similar patters of results are observed for the other speed limits but not reported on the figure as a matter of clarity.

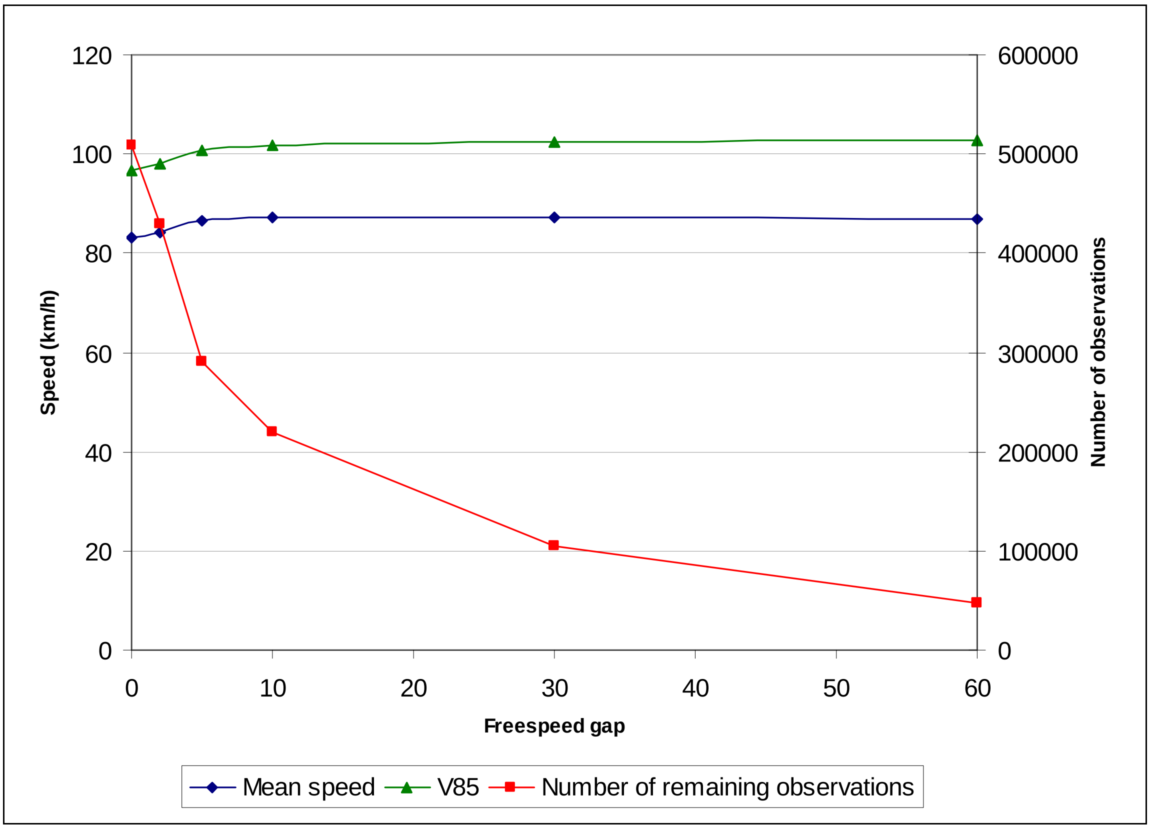

Figure 1: Effect of the headway filter on the mean speed and V85 estimates for 90 km/h roads.

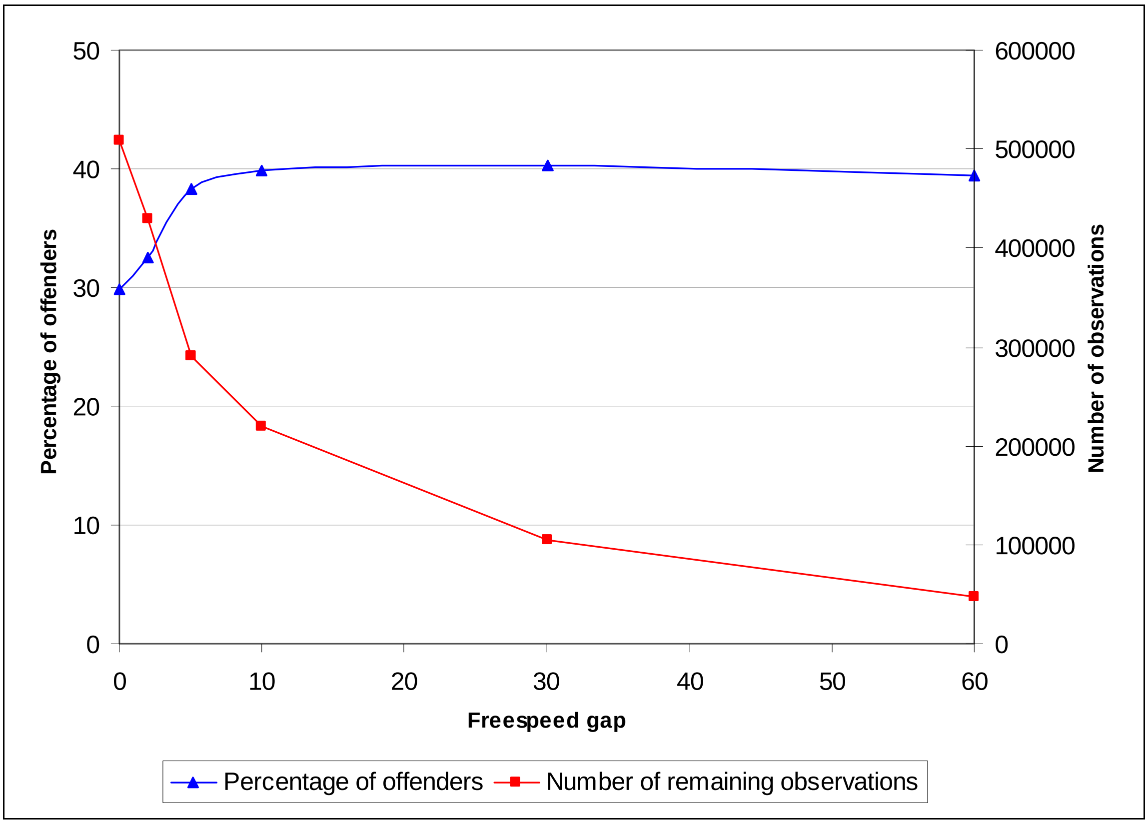

Figure 2: Effect of the headway filter on the percentage of offenders for 90 km/h roads.

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Applying a headway filter has a noticeable effect on the estimate of the different SPIs. However, it seems that for a time-lag filter of 5 seconds, the SPI values start to level off. A further increase in the time-lag between vehicles does not result in big increases in the SPI values. This finding is different compared to the study of Brady where it was observed that the mean speed increased almost linearly until a time-lag of 1 minute between successive vehicles. With a time-lag of 5 seconds the respective values of the indicators are as follows:

	Data without filter	Vehicles with a headway bigger or equal to 5 seconds
Mean Speed	83.0 km/h	86.5 km/h
V85	96.8 km/h	100.6 km/h
Percentage of offenders	29.9 %	38.3 %

Table 5: Effect of a headway filter of 5 seconds on the SPI values.

Differences of almost 4 km/h are thus observed for the mean speed and the V85 between the situations with and without filter. Moreover, the difference in terms of number of offenders is 8.4 %. Something that is also interesting to note is the fact that when the filter is applied with a time lag of 5 seconds, the number of dropped observations is only a little bit higher than when we used a free-flowing speed measure based on the exclusion of peak hours. The filter based on the headways between vehicles is thus far more effective in removing vehicles that are not in free-flowing conditions than the filter based on the exclusion of peak hours.

Brady estimated that free speed surveys carried out by human observers equipped with a hand held speed detection device (e.g. Ireland, Austria) would typically include only vehicles with a headway of 10 seconds. In Belgium, it was chosen to use the 5 seconds time-lag between vehicles to produce the SPIs. We use to report this methodology choice along with the SPI values because of the influence of this choice on the values.

2.4.4 Discussion

The choice of how to deal with traffic conditions in a speed study is not easy. One option is to select only perfectly flowing vehicles on the basis of human observations of using a time-lag filter. This method has the advantage of producing indicators that are only influenced by the speed behaviour of drivers and not by external conditions. When studying a time series of this kind of indicators, one may be sure that the observed changes are due to changes in behaviours and not changes in traffic conditions. On the other hand, one can reproach to these indicators that they represent only a small part of the traffic because the traffic conditions are actually often not perfectly free-flowing.

The opposite option of not taking into account traffic conditions produces speed SPIs that are more representative of the whole traffic but where the evolution of speed behaviours can be hidden by the changes in traffic conditions. Between the two opposite options, several median ways exist. There is thus not a perfect methodology in terms of dealing with traffic conditions, even if, when willing to study speed in a road safety point of view, it is recommended to at least exclude obvious congested traffic conditions from the data.

The Belgian example has shown that the choice that is made can have a significant influence on the SPI estimates, even if the Belgian roads where the measurements are carried out are not very trafficked. One must remember, when wanting to compare SPIs coming from studies that differ in the way the traffic conditions are taken into account, that a large part of the difference in the SPI values may thus be due these differences in methodology. However this issue seems to be often underestimated in the practice.

2.5 SPI computation

The section 4.3.3 of the SafetyNet manual presents the formulas that are needed in order to compute an aggregate national SPI value. In the case of the Belgium study, it is the following equation that is used, which is basically a weighted mean of the SPI values computed for each measuring location.

$$SPI = \frac{\sum_{r=1}^{R}\left[\left[\frac{\sum_{i=1}^{n_r}(SPI_{ir} * W_{ir})}{\sum_{i=1}^{n} W_{ir}}\right] * Long_r * \frac{\sum_{i=1}^{n_r} W_{ir}}{n_r}\right]}{\sum_{r=i}^{R}\left[Long_r * \frac{\sum_{i=1}^{n_r} W_{ir}}{n_r}\right]}$$

Equation 2

As written in the manual, SPI_{ir} is the value of the SPI for the location *i* located in region *r,* which is part of the n_r sampled regional road locations and W_{ir} is the number of vehicles that have been measured at that location. $Long_r$ is the length of road in the region r.

The choice of this formula was made by default because no information regarding million vehicle-kilometres (MVKms) by road type and by region is available in Belgium. The length of the road network is thus used as an alternative weighting variable as suggested in the manual. However, this variable is also not known with precision in Belgium because no database containing dynamic speed limits of the road network exists. The length of network of each road category by region was thus estimated by asking the advices of a panel of experts in the field of road network management in Belgium. It was done in 2003 prior to the first speed campaign and we have no means to evaluate the accuracy of the initial estimation nor any reasonable idea on how things have changed since 2003 (e.g. We know that a lot of 90 km/h roads in Flanders have been converted to 70 km/h roads but we do not know exactly how much). Furthermore, the use of road network length as a weighting variable causes the Brussels regions to have a very small influence in the national SPIs. Indeed, the panel estimated that the proportions of roads in the Brussels region among the total of the 30 km/h and 50 km/h roads of the country are only 0.8% and 1.2% respectively. However we know that the roads of the capital region are the busiest of the country. Nearly 60% of the jobs in the Brussels region are occupied by people coming from outside the region, in majority with their car. The utilisation of road length as a weighting variable thus underestimates the importance of the Brussels region in terms of traffic intensity. This example demonstrates the limitations of the "length of road network" as a weighting value in the computation of national SPIs from regional estimates.

In the future, it is planed to re-discuss how the regional estimates are weighted in Belgium in order to compute the national indicators. A change in the weighting values would have a big influence on some of the national SPIs because the regional SPIs are significantly different between regions on 30 and 90 km/h roads.

Concerning the weighting of the different locations based on the traffic count, we found that this option does make sense because of the big differences in traffic counts between Belgian locations. On the most trafficked location, 120000 vehicles were counted during a week of observation while another location experienced less than 5000 vehicles during the same period. It seems logic to give more importance to the speed values recorded on the former location than to those recorded on the latter.

Concerning the mathematical correctness of Equation 2: computing the "mean speed" SPI and the "percentage of offenders" SPI by means of Equation 2, thus by taking a mean of the SPI values of individual locations weighted by their traffic count, is equivalent to a method that would consist in putting together the individual data from all the locations together and simply compute the mean or the percentage of offenders of this hypothetical huge database (We do not discuss the regional stratification here, as that complicates things further). However, this statement is not true concerning the V85 or any other percentile indicator. It would be easy to demonstrate that the weighted mean of V85 values of individual locations is not equal to the V85 of the hypothetical huge database (that may be considered as the "true" V85). We are aware of this problem in Belgium but we have not the computing capacities to handle databases of more than 1 millions observation that would be the result of the appending of all the individual location databases. The V85 is thus nevertheless computed by means of Equation 2.

Finally, the SafetyNet manual does not propose a way to calculate the uncertainty on the SPI estimates. At the section 2.3.2 of this pilot report, we do propose a simple formula to estimate variance (see Equation 1). This estimation take into account the variability of speed between measuring locations but not the intra-location variance or other uncertainties due to, for example, the margin of error of the measuring devices. It must be noted that the estimation of variance by means of Equation 1 is valid under a hypothesis of normality of the x_i. If x is the mean speed or the V85, the hypothesis of normality, although not verified in the Belgian case, is probably fulfilled. In the case of the "percentage of offenders" it is more doubtful that the normality hypothesis is still verified, especially for 30 km/h roads where some locations experience a percentage of offenders of nearly 95 %. An alternative way to measure the variance of the “percentage of offenders” SPI should thus be found, but that is outside the scope of this pilot study.

2.6 Communication of SPIs

Something that was often observed when communicating the values of the SPIs is that they were used to draw abusive conclusions. It is for example often stated that the SPI values are representative of the entire road network. In fact, they are not. The SPIs result from observations taken under certain traffic circumstances on certain types of road segments (typically where relatively good free-flowing conditions are encountered). A SPI value is thus not representing the global speed for all the country.

It is often tempting to derive an expected change in road traffic number of accidents or fatalities directly from changes in the Speed SPI by applying formulas such as those of the well-known power model (Nilsson, 2004). This is however an over-simplification of things as the speed SPIs only aim to measure the changes in speeds that are due to changes of behaviours. Beside these changes in behaviours, there are other causes of speed variations that are not assessed by the SPIs, such as the modifications of the road network and the modifications of the traffic conditions.

The problem with the Belgian study is that the SPIs allow us to know the changes in behaviours for roads of different speed limits, but we do not know exactly what is the exact share of all these speed limits in the Belgian network and how this share is evolving.

In order to avoid misinterpretations of the SPIs, it is thus an important task of the road safety researchers to communicate in an understandable manner over what the speed SPIs really are and what they allow to do and not to do.

2.7 Conclusion

The Belgian speed survey has now been running for 5 years with a methodology that shows many similarities with the methodology proposed in the SafetyNet manual. The only noticeable difference is that the road categories are defined only by their speed limit in the Belgian study while the SafetyNet manual recommend to also use road design in order to define different road categories. Based on the experience gained through the successive Belgian speed surveys, the pertinence of several recommendations of the SafetyNet manual was discussed in the Belgian Pilot.

Globally, the results of the pilot provide a backing for several recommendations of the SafetyNet manual:

- It confirms that when checking for the validity of a measuring location, it is necessary to travel to this location. Desktop checks allow to detect some locations that are not suitable but do not allow to be sure that a location is suitable.

- It confirms that the strict application of the criteria of inclusion of the locations into the sample does allow reducing the sample variance and thus the sample size needed to reach a desired confidence level on the SPI estimates.
- It confirms that the way the traffic conditions are dealt with when producing the SPI may have a significant influence on these SPI values. 5 seconds is indeed a good value to consider when willing to filter the vehicles on the basis of their time-lag with the preceding vehicle.
- The equations that are recommended in the manual in order to compute national-scale SPIs are indeed applicable for most of the SPIs

The pilot also allows adding some new recommendations to those of the SafetyNet manual:

- When checking the validity of the measuring locations, it is important to establish a good communication with local authorities and the road network managers. This allows to be notified of any modifications that alter the measuring locations. A road network is an entity that is constantly evolving.
- An Equation for the calculation of the variance of the “mean speed“ and “V85” SPIs was proposed.
- When communicating the SPI values, it must be avoided saying that the SPIs are representative for the whole road network. It must be ensured that one tries not to conclude things from the SPI values that can not be concluded due to the nature of the SPIs.

Finally, it was identified that the statistical theory could be improved in order to take into account the different nature of the speed SPI (mean value, a percentile value and a percentage value). A robust estimation of the variance of the “percentage of offenders” SPI is especially not yet documented in the SafetyNet theory.

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Nilsson, G. (2004) *Traffic safety dimensions and the power model to describe the effect of speed on safety*. Bulletin 221, Lund Institute of Technology, Lund.

Annex

Annex 1: Results of the study on the influence of the headway filter on the SPI estimates.

30 km/h roads	Time lag					
	0 sec	2 sec	5 seco	10 sec	30 sec	60 sec
Number of remaining observations	393195	371864	282680	223932	113347	55536
Mean speed	50.3	50.5	51.4	51.5	51.8	52.2
V85	61.6	62	63.1	63.2	63.8	64.2
Percentage of offenders	94	93.9	94.4	94.3	94	93.1
50 km/h roads	**Time lag**					
	0 sec	2 sec	5 sec	10 sec	30 sec	60 sec
Number of remaining observations	997899	920026	580299	408797	174560	76413
Mean speed	52.6	52.8	54.4	55.1	56.3	57.3
V85	61.9	62.3	64.2	65.3	67.1	68.7
Percentage of offenders	58.1	58.9	64.2	66	68.7	69.8
70 km/h roads	**Time lag**					
	0 sec	2 sec	5 sec	10 sec	30 sec	60 sec
Number of remaining observations	1003740	859689	541868	378387	147639	58502
Mean speed	70.9	71.4	73.4	74	74.9	75.9
V85	81.6	82.3	84.7	85.8	87.4	89.4
Percentage of offenders	50.9	52.4	58	59.4	60.9	62.8
90 km/h roads	**Time lag**					
	0 sec	2 sec	5 sec	10 sec	30 sec	60 sec
Number of remaining observations	508196	429884	290441	219465	105399	48054
Mean speed	83	84.1	86.5	87.1	87.2	86.8
V85	96.8	98	100.6	101.6	102.3	102.6
Percentage of offenders	29.9	32.5	38.3	39.9	40.3	39.5

3 Spanish pilot

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3.1 Introduction

The present chapter describes the current development of the study on free flow speed in Spain. At the time of publication of this deliverable, the design stage of the survey has been completed and the *in situ* field work is on the stage of budget approval. The following sections are thus focusing on the description of the design stage of the survey. In the end, the complete survey should allow Spain to compute speed SPIs that are complying with the recommendations that are presented in the SafetyNet theory and the SafetyNet manual.

The survey is carried out by the Instituto Universitario de Investigación del Automovil (INSIA) of Madrid at the request of the traffic authority (DGT- Dirección general de Tráfico - Observatorio Nacional de Seguridad Vial - Madrid)

This chapter is structured as follows: in section 3.2 we define the population, in section 3.3 we describe the sampling design, section 3.4 explain the selection of measuring locations and section 3.5 introduces some issues to deal with in the future related to the statistical analysis.

3.2 Defining the population under study

It was decided that the study would cover the whole of Spain. The population is the set of Spanish drivers, but some drivers appear on the road much less than others; for instance, if the time period considered is very short, such as e.g. the week after a given enforcement law is applied, it could be that a significant proportion of the elements of the population would not appear on the road. Thus, the definition of the population may present some subtleties.

3.2.1 Road types

Speed will be measured on the following types of roads:

- Motorways (MW)
- Roads with limited access (RWLA)
- Conventional roads (C)
- Regional roads - type 1 (R1)

- Regional roads - type 2 (R2)

The motorways are generally under concession and toll roads while the RWLA are free and under state or regional government ownership and management.

Conventional roads or national roads are state-owned, managed by the Ministry of Public Works and thus integrated in the so-called State Road network (RCE).

In the Basque country and Navarre the former national roads as well as the high capacity roads are under authority of regional institutions, one per province. The only exception is A-68, which remains under state ownership in the Basque country and Navarre.

The regional network is part of the secondary Spanish road system. They are the most important roads in each region and usually bear heavy traffic. These roads are sometimes turned into roads with limited access by adding two lanes to an existing road. The ownership is of the Autonomous regions (A).

3.2.2 Vehicle types

There will be a different study for each of the following types:

- Passengers cars
- Trucks/buses
- Motorcycles

3.3 Sampling design

A stratified sample is used (see, for example, Thompson (2002) or Särndal et al (1992)) with two stratification variables: region and type of road. Regional stratification is done bearing in mind that there could be regional differences in the speed behaviour, due to e.g. culture, topological characteristics and climatology.

Spain has been divided in eight strata or regions (Figure 3)

- Region 1: Andalusia
- Region 2: Central Plain and Extremadura excluding Madrid
- Region 3: Madrid
- Region 4: East coast: regions of Valencia and Murcia
- Region 5: Catalonia
- Region 6: Northwest: Galicia and Asturias
- Region 7: Cantabria, Basque Country, Navarre and La Rioja
- Region 8: Aragón

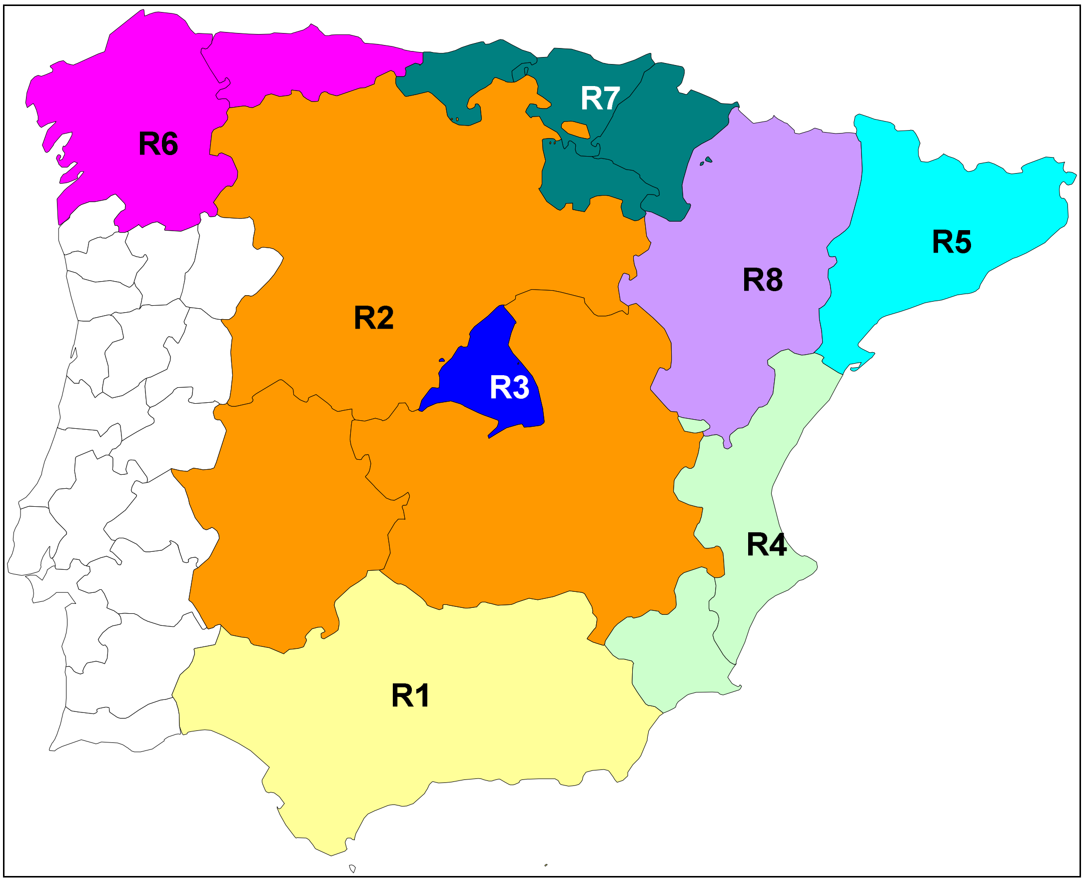

Figure 3: Regional stratification

The sample size in each stratum is proportional to:

1. Population of regions.
2. Within each region, number of km of each type of road.

Theoretically, an optimal stratification should be not only a function of strata population but also of strata variance in the studied phenomenon (here speed). The intra-stratum variance should indeed be as small as possible in order to minimize the uncertainty on the results of the survey. However, these variances are not known a priori before this pilot study. Once the results of this pilot study are known, an improved definition of the strata and their size will thus be possible.

Between regions, the number of km of each road type varies and the composition of the regional sample is thus quite different, as summarized in table 6 and in the graphics in Annex 2.

	MW	RWLA	C	R1	R2
Andalusia	13	56	17	7	7
Central Plain and Extremadura	5	50	30	15	0
Madrid	27	59	0	9	5
Valencia and Murcia	14	59	18	9	0
Catalonia	41	17	17	25	0
Galicia and Asturias	23	31	31	15	0
Cantabria, Basque Country, Navarre and La Rioja	37	36	18	9	0
Aragón	17	33	33	17	0

Table 6: Proportion of the different road types in the sample for each region

The composition of the sample for the whole Spain is showed by Figure 4. For example, it can be seen that 45 percent of the speed measurements will be carried out on roads with limited access.

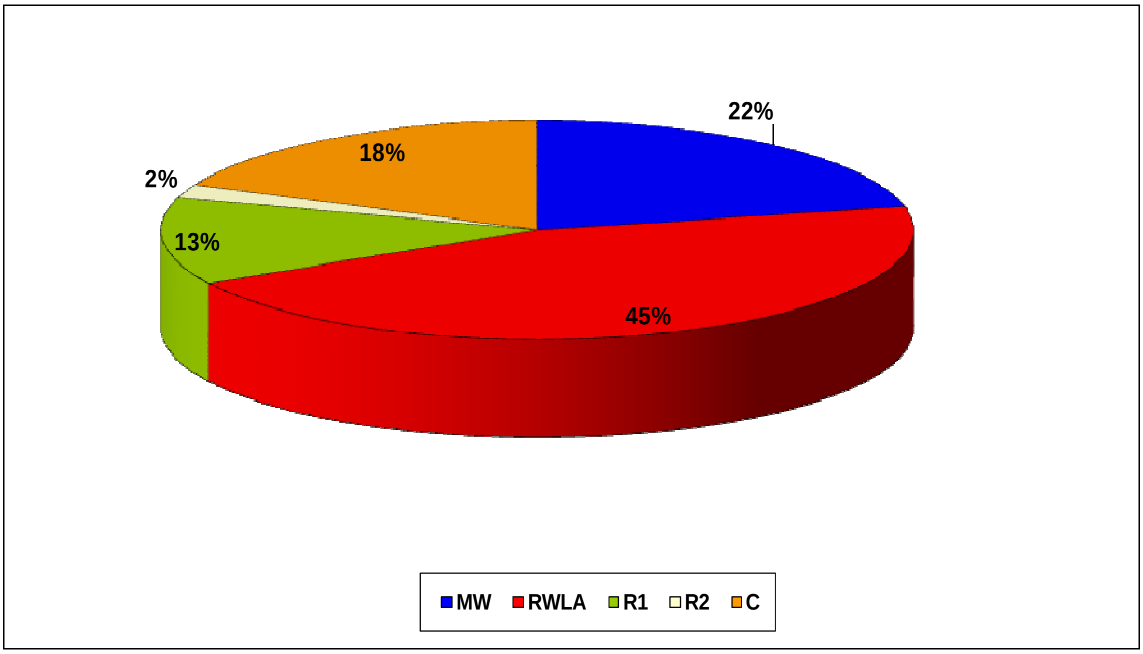

Figure 4: Composition of the sample by road types for all Spain

3.4 Selection of measuring locations

The total size of the national sample is 100 measuring locations. These locations were selected following the steps below:

1. Data base building.
2. Sampling of the road segments
3. A first and non-*in situ* (desktop) inspection of the selected segments
4. *In situ* inspection of the selected segments

3.4.1 Data base building

A database of the Spanish network has been built in order to serve as the basis for the sampling of measuring locations. This database includes the following information:

- Road identification (letters and/or numbers)
- Length of the segments

The database contains the information corresponding to 5659 road segments with a grand total extension of 42781 km, 21% of which are high capacity roads (motorways and roads with limited access) and 79% are conventional roads and regional roads of first and second order.

In parallel to this database, others sources were used for the retrieval of information on the road sections and their traffic intensity. These sources are the traffic map for 2005 and the road map for 2007 edited by MFOM (Ministry of Public Works).

3.4.2 Sampling of the road segments

The locations used for the speed measurements were selected randomly from the road database by means of a Matlab program. All the road segments of the database with a minimum length of 5 meters were included in the sampling frame. In the later steps of the procedure, a precise location on each of the segments was selected.

Even if only 100 locations were needed for the national sample, more segments (147) were actually sampled in prevention of deletion of some of the segments from the sample in the posterior *in situ* field-work stage.

The complete list of the sampled road segments is available in Annex 2.

3.4.3 Desktop work to determine compliance with SafetyNet conditions

A first and non- in situ (desktop) inspection of the selected segments was carried out using road inventories, digital maps and a geographic information system (GIS) with the purpose of checking the main features of the road segments and to determine as well as possible the chance of finding -within the sample- points which verify the conditions required by SafetyNet.

The recommendations coming from the SafetyNet manual are as follows:

1) To be located in a straight and uniform road section.
2) To be in a section with slope under 5% in the 500 preceding meters.
3) To be at least 500 meters away from intersections.
4) To be at least 500 meters away from speed reduction devices.
5) To be at least 500 meters away from road works.
6) To be at least 1000 meters away from speed limit changing points.
7) To be away from working or parking areas.
8) Good pavement and surface conditions.
9) To be at least 500 meters away from gradient changes.

In order to verify each of these conditions we have used several resources such as the topographic map of the Spanish army (Digital Chart), GIS of the Ministry of Agriculture (SIGPAC). In Table 7, we point out the possibilities of these resources with respect to the verification of some of the conditions of the Safety Net manual.

	CAMPSA GUIDE	**DIGITAL MAP**	**SIGPAC**
To be in a straight line road segment	X	X	X
To be at least 500 meters away from intersections			X
To be at least 500 meters away from humps		X	X
To be at least 500 meters away from road works	X	X	X
To be at least 500 meters away from zebra road markings	X	X	X
To be at least 500 meters away from speed limit change points	X	X	X
To be in a segment with slope below 5%	X	X	

Table 7: Matrix for resources applied for verification of sample segment conditions.

The national topographic map of the Spanish army provides section profiles and slopes after identification with their UTM (Universal Transverse Mercator) coordinates. The GIS of the Ministry of Agriculture (SIGPAC) provides aerial photographs of the segments, with which the road configuration, number of lines and existence of intersections, zebra crossings or entrance ramps and the segment itself can be located precisely by means of its UTM coordinates. The CAMPSA guide provides a first approximation of the section location prior to subsequent processing with the above mentioned techniques.

By means of these tools some of the criteria for point validity can thus be verified, but not all. The result of this first screening stage is a list of potentially valid segments which should be later subject to *in situ* verification by means of field data collection by the researchers of the DGT (Spanish road authority). Non-valid segments are deleted from the data base and replaced by new ones selected at random. This process is repeated until -as mentioned above- a sample size larger than 100 is obtained

The desktop work has been summarized in table format for each of the road segments with a final specification of valid/non valid as shown in the example below.

SEGMENT DATA	**17**	**INITIAL MILESTONE**	464,1	**SEGMENT DATA**	18	**INITIAL MILESTONE**	
ROAD	**N-4**	**STRAIGHT SEGMENT**	YES	**ROAD**	A-92G	**STRAIGHT SEGMENT**	YES
SEGMENT NUMBER	**22/02/2000**	**INTERSECTION AT 500m**	YES	**SEGMENT NUMBER**	1-0-0	**INTERSECTION AT 500m**	NO
NEW DENOM	**A-4**	**GRADIENT CHANGE AT 500m**	YES	**NEW DENOM**	A-92G	**GRADIENT CHANGE AT 500m**	YES
OWNERSHIP	**RCE**	**ROAD WORKS AT 500m**	YES	**OWNERSHIP**	A	**ROAD WORKS AT 500m**	YES
AUTONOMOUS REGION	**Andalucia**	**ZEBRA CROSSING AT 500m**	YES	**AUTONOMOUS REGION**	Andalucia	**ZEBRA CROSSING AT 500m**	YES
PROVINCE	**Sevilla**	**SPEED LIMIT CHANGE POINT500m**	YES	**PROVINCE**	Granada	**SPEED LIMIT CHANGE POINT500m**	YES
TYPE	**RLA**	**SLOPE <5% 500m**	YES	**TYPE**	RLA	**SLOPE <5% 500m**	YES
INITIAL MILESTONE	**456,5**	**TRAFFIC SIGNALS AT 1000m**	YES	**INITIAL MILESTONE**	0,57	**TRAFFIC SIGNALS AT 1000m**	YES
LENGTH	**11,12**	**RADAR AT 5000m**	YES	**LENGTH**	9,51	**RADAR AT 5000m**	YES
		SEGMENT VALIDITY	VALID			**SEGMENT VALIDITY**	INVALID
		UTM X1	308852			**UTM X1**	
		UTM Y1	4155141			**UTM Y1**	
		UTM X2	306992			**UTM X2**	
		UTM Y2	4155294			**UTM Y2**	
		LENGTH OF VALID SEGMENT (m)	1869			**LENGTH OF VALID SEGMENT (m)**	

Table 8: Example of the validity assessment of two road segments in Andalusia

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3.4.4 Field work to determine compliance with SAFETYNET conditions

The final validity of the segments can only be assessed *in situ*. It will be done in a second and last screening stage, which should be carried out following a Technician's guide. Each of the segments that have been considered valid according to the desktop work should be examined *in situ* in the so-called field work. To ease the field work a questionnaire has been designed which will be filled out by the technicians in charge of verifying compliance. These technicians are road researchers from DGT. Additionally the INSIA staff will inspect some segments selected at random, to verify the desktop work and the adequacy of the tools applied.

3.5 Analysis of the data

The analysis of the distribution of free speed will essentially require point estimates and uncertainty bands. Typically, normality is assumed for speed distributions and with suitable sample sizes the parameters can be estimated a priori under this assumption. However, goodness of fit tests for normality should also be included and, if rejected, non parametric methods such as the bootstrap could be applied.

3.6 Conclusion

The Spanish pilot is only constituted by the first stages of a future free speed survey covering all Spain. For these first stages, the methodology recommended in the SafetyNet manual was followed very closely. The sample was designed carefully, taking into account the repartition of the different road types in each Spanish region. The measuring locations were chosen randomly on the basis of the road network database. Desktop verifications have been done and *in situ* verifications are planned in order to be sure that the measuring locations of the final sample comply with all the suitability criteria listed in the SafetyNet manual. Up to the current stage of evolution of the study, no major bottlenecks have been encountered in applying the SafetyNet methodology. However, the pilot shows that an important investment is needed when willing to select the measuring locations with the rigorous procedure displayed in the SafetyNet manual.

Yet, it will be interesting to follow the future evolution of the Spanish study outside the SafetyNet pilot framework. Indeed this will give more insight on the quality of SPIs that can be produced on the basis of a selection of locations that follows the SafetyNet methodology.

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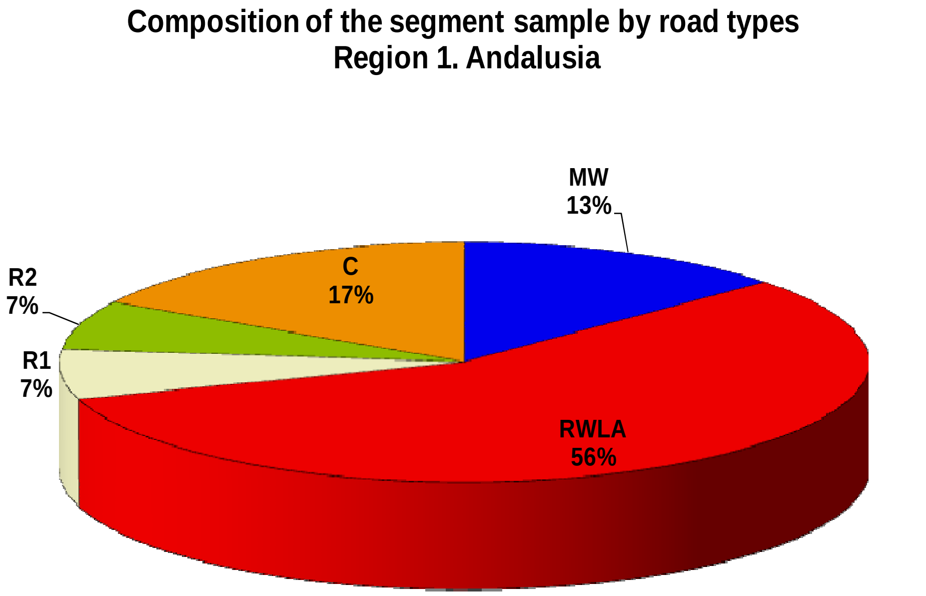
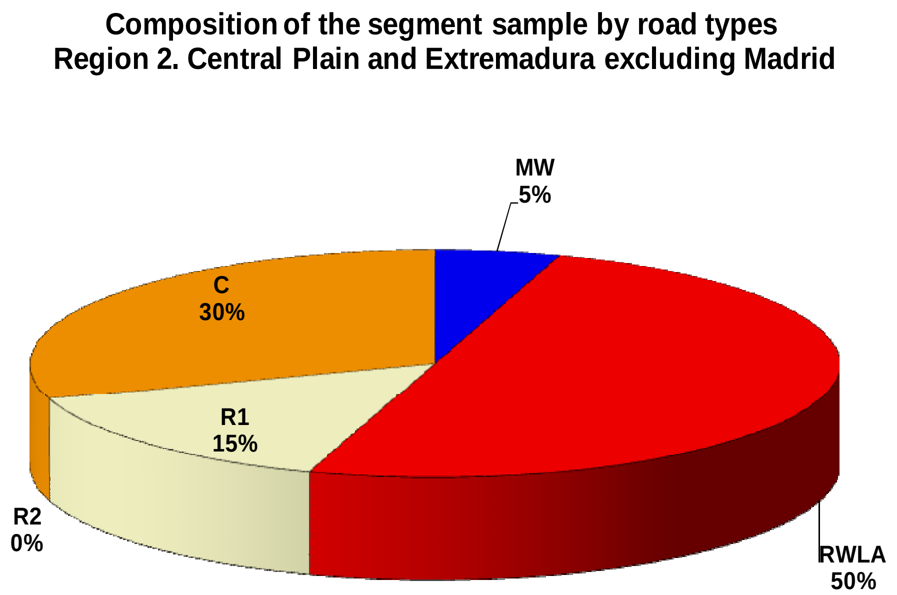
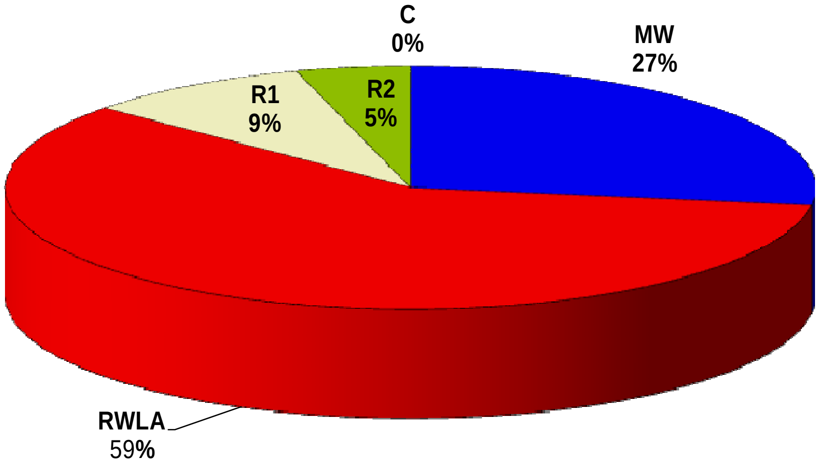
Annexes

Annex 1: Composition of the sample for the 8 studied regions

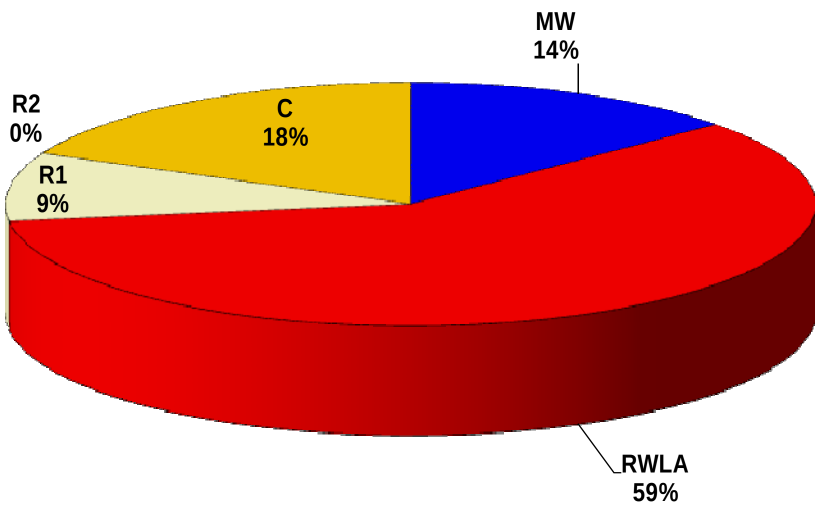


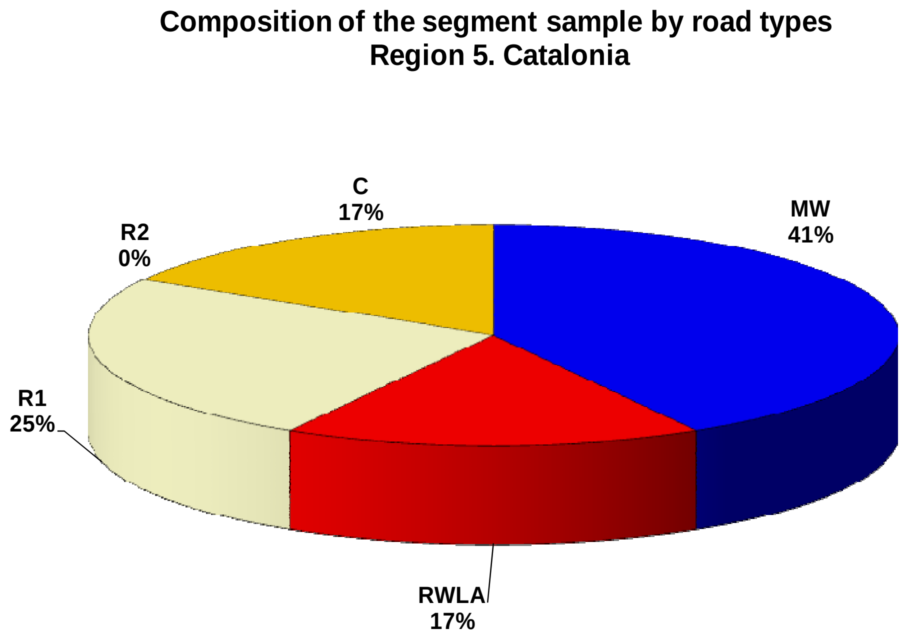


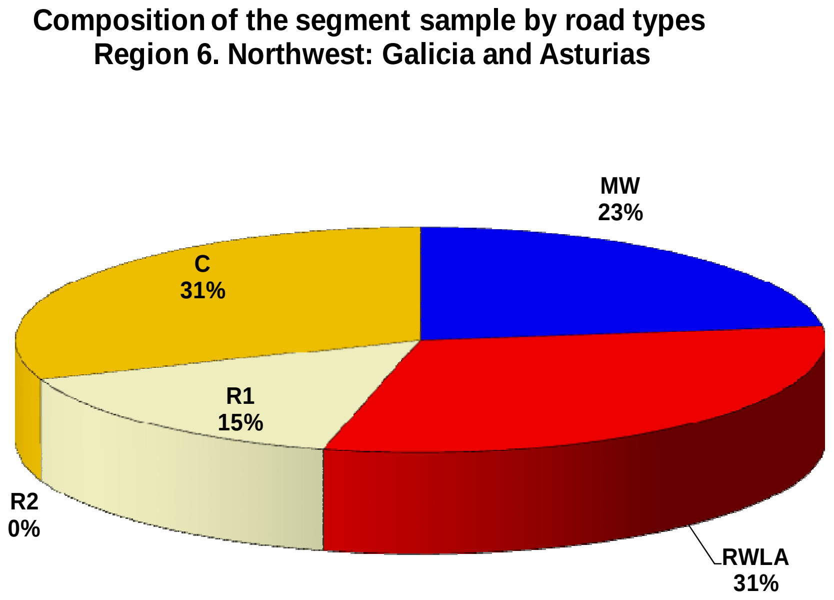
Composition of the segment sample by road types
Region 3. Madrid



Composition of the segment sample by road types
Region 4. East coast: regions of Valencia and Murcia







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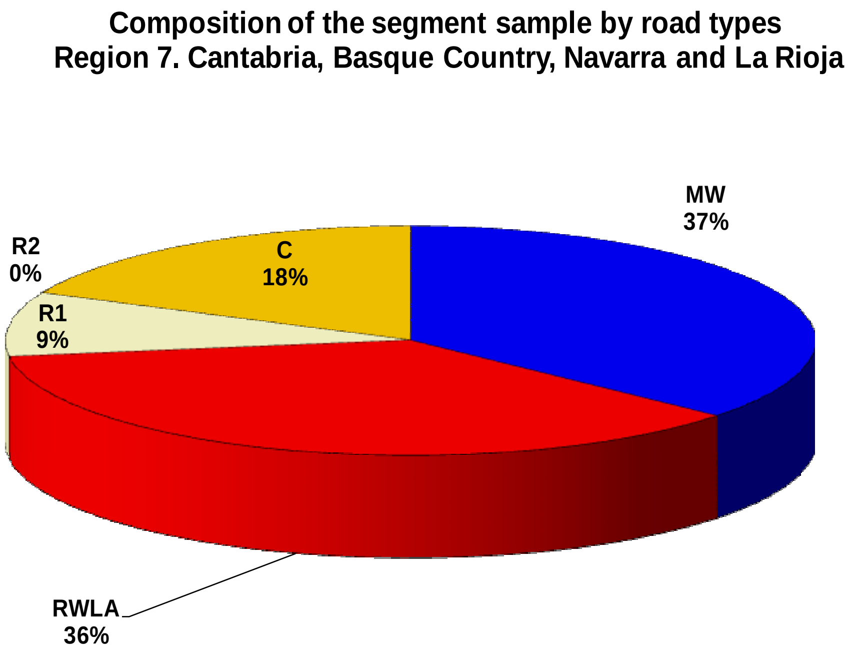
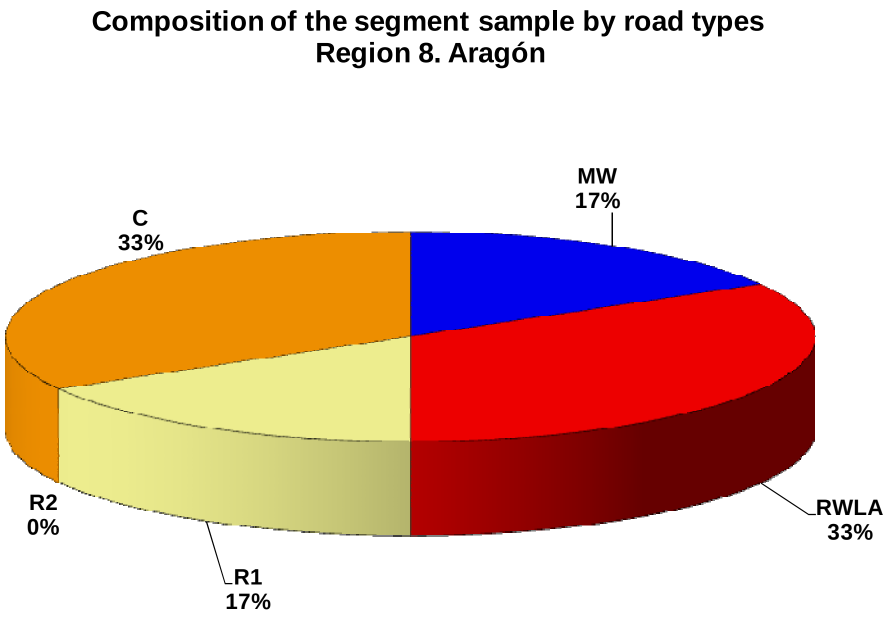

Composition of the segment sample by road types
Region 7. Cantabria, Basque Country, Navarra and La Rioja
MW
37%
R2
0%
C
18%
R1
9%
RWLA
36%


Composition of the segment sample by road types
Region 8. Aragón
MW
17%
C
33%
R2
0%
R1
17%
RWLA
33%

Annex 2: Sample segments selected by the random procedure

Sample segments for region 1: Andalusia.

REGION	TYPE OF ROAD	ROAD ID	SEGMENT	NEW ROAD ID	OWNERSHIP	AUTONOMOUS REGION	PROVINCE	INITIAL MILESTONE	END MILESTONE	LENGTH	AADT
1	Motorways (MW)	A-4	25-0-2	A-4	RCE	Andalusia	Sevilla	553,2	558,9	5,4	35.069
		A-49	4-2-0	A-49	RCE	Andalusia	Huelva	35,55	47,63	12,5	29.877
		A-7s	84-1-0	AP-7	RCE	Andalusia	Málaga	143,79	156	12,21	16.512
		A-49	3-2-1	A-49	RCE	Andalusia	Sevilla	5,5	16,5	11	57.486
	Roads with limited access (RWLA)	A-92N	14-0-0	A-92N	A	Andalusia	Granada	356,25	377,49	21	9.853
		A-92	5-0-0	A-92	A	Andalusia	Sevilla	62,7	81,88	19,27	19.835
		N-340	4-2-2	A-7	RCE	Andalusia	Málaga	177,41	181,7	6,41	61.544
		A-92	18-0-0	A-92	RCE	Andalusia	Almería	381,08	392,88	11,7	12.835
		N-340	15-1-3	A-7	RCE	Andalusia	Almería	520,29	525,41	5,52	12.112
		A-92	1-0-0	A-92	A	Andalusia	Sevilla	0	11,53	11,69	56.538
		A-92	4-1-0	A-92	A	Andalusia	Sevilla	51,15	62,7	11,66	20.556
		A-376	2-0-0	A-376	A	Andalusia	Sevilla	8,48	29,4	20,93	17.951
		N-331	4-4-0	A-45	RCE	Andalusia	Málaga	146,62	164,89	20,56	51.246
		N-331	4-2-0	A-45	RCE	Andalusia	Málaga	125,6	138,5	11,3	24.040
		N-323	3-0-4	A-44	RCE	Andalusia	Jaén	21	36,45	15,7	25.707

Transport

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Sample segments for region 1: Andalusia (continued)

REGION	TYPE OF ROAD	ROAD ID	SEGMENT	NEW ROAD ID	OWNERSHIP	AUTONOMOUS REGION	PROVINCE	INITIAL MILESTONE	END MILESTONE	LENGTH	AADT
1	Roads with limited access (RWLA)	A-92	4-0-0	A-92	A	Andalusia	Sevilla	41,15	51,15	10	29.273
		N-4	22-2-0	A-4	RCE	Andalusia	Sevilla	456,5	468	11,12	20.487
		A-92G	1-0-0	A-92G	A	Andalusia	Granada	0,57	10,03	9,51	40.274
		A-381	1-0-0	A-381	A	Andalusia	Cádiz	0	5,08	5,11	0
		A-92	11-2-2	A-92	A	Andalusia	Granada	235,94	241,08	5,16	37.132
		A-92N	16-0-0	A-92N	A	Andalusia	Almería	403,81	414,71	10,92	11.036
	Regional roads type 1 (R1)	A-375	1-0-0	A-375	A	Andalusia	Sevilla	0	17,28	17,28	5.028
		A-334	5-0-0	A-334	A	Andalusia	Almería	63,94	69,97	6,01	9.768
	Regional roads type 2 (R2)	A-384	2-0-0	A-384	A	Andalusia	Cádiz	22,37	31,79	9,42	6.324
		A-348	1-0-0	A-348	A	Andalusia	Granada	0	20	20	4.118
	Conventional roads (C)	N-340	9-2-8	N-340	RCE	Andalusia	Málaga	296,3	302,6	6,15	11.541
		N-340	10-3-0	N-340	RCE	Andalusia	Granada	314,32	328,92	14,13	18.504
		N-340ª	14-6-3	N-340a	RCE	Andalusia	Almería	527	535,1	8,33	5.358
		N-432	4-7-0	N-432	RCE	Andalusia	Córdoba	233,1	238,54	5,44	8.647
		N-340ª	14-4-2	N-340a	RCE	Andalusia	Almería	463,7	472,7	9	5.752

Transport

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Sample segments for region 1: Andalusia (continued)

REGION	TYPE OF ROAD	ROAD ID	SEGMENT	NEW ROAD ID	OWNERSHIP	AUTONOMOUS REGION	PROVINCE	INITIAL MILESTONE	END MILESTONE	LENGTH	AADT
1	Roads with limited access (RWLA)	A-92	4-0-0	A-92	A	Andalusia	Sevilla	41,15	51,15	10	29.273
		N-4	22-2-0	A-4	RCE	Andalusia	Sevilla	456,5	468	11,12	20.487
		A-92G	1-0-0	A-92G	A	Andalusia	Granada	0,57	10,03	9,51	40.274
		A-381	1-0-0	A-381	A	Andalusia	Cádiz	0	5,08	5,11	0
		A-92	11-2-2	A-92	A	Andalusia	Granada	235,94	241,08	5,16	37.132
		A-92N	16-0-0	A-92N	A	Andalusia	Almería	403,81	414,71	10,92	11.036
	Regional roads type 1 (R1)	A-375	1-0-0	A-375	A	Andalusia	Sevilla	0	17,28	17,28	5.028
		A-334	5-0-0	A-334	A	Andalusia	Almería	63,94	69,97	6,01	9.768
	Regional roads type 2 (R2)	A-384	2-0-0	A-384	A	Andalusia	Cádiz	22,37	31,79	9,42	6.324
		A-348	1-0-0	A-348	A	Andalusia	Granada	0	20	20	4.118
	Conventional roads (C)	N-340	9-2-8	N-340	RCE	Andalusia	Málaga	296,3	302,6	6,15	11.541
		N-340	10-3-0	N-340	RCE	Andalusia	Granada	314,32	328,92	14,13	18.504
		N-340[a]	14-6-3	N-340a	RCE	Andalusia	Almería	527	535,1	8,33	5.358
		N-432	4-7-0	N-432	RCE	Andalusia	Córdoba	233,1	238,54	5,44	8.647
		N-340[a]	14-4-2	N-340a	RCE	Andalusia	Almería	463,7	472,7	9	5.752

Sample segments for region 2: Central plain and Extremadura excluding Madrid

REGION	TYPE OF ROAD	ROAD ID	SEGMENT	NEW ROAD ID	OWNERSHIP	AUTONOMOUS REGION	PROVINCE	INITIAL MILESTONE	END MILESTONE	LENGTH	AADT
2	Motorways (MW)	AP-71	3-0-0	AP-71	RCE	Castille-León	León	22,8	32,58	9,78	3.673
	Roads with limited access (RWLA)	A-11	6-0-1	A-11	RCE	Castille-León	Zamora	425,36	447,63	22,741	5.290
		N-5	9-1-0	A-5	RCE	Extremadura	Badajoz	310,1	315,54	5,68	7.973
		N-6	14-2-0	A-6	RCE	Castille-León	Valladolid	213,99	225,25	11,84	16.745
		A-610	1-0-0	A-610	A	Castille-León	Palencia	0	7,6	7,6	11.847
		A-62	16-0-0	A-62	RCE	Castille-León	Salamanca	252,2	269	15,248	10.689
		A-66	24-1-0	A-66	RCE	Extremadura	Badajoz	640,3	647,9	7,6	14.722
		A-40	9-0-0	A-40	RCE	Castille-Mancha	Cuenca	139,64	145,66	6	3.503
		N-2	5-0-0	A-2	RCE	Castille-Mancha	Guadalajara	44,35	51,13	6,78	73.549
		N-5	13-2-1	A-5	RCE	Extremadura	Badajoz	352,47	364,825	12,455	16.844
		A-43	20-0-0	A-43	RCE	Castille-Mancha	Ciudad Real	0	9,56	9,56	11.548
	Regional roads type 1 (R1)	EX-117	5-0-0	EX-117	A	Extremadura	Cáceres	57,8	68,03	10,24	634
		EX-111	2-0-0	EX-111	A	Extremadura	Badajoz	9,01	23,77	14,73	479
		CL-626	23-0-0	CL-626	A	Castille-León	Palencia	187,1	205,18	18,08	1.854

Sample segments for region 2: Central plain and Extremadura excluding Madrid (continued)

REGION	TYPE OF ROAD	ROAD ID	SEGMENT	NEW ROAD ID	OWNERSHIP	AUTONOMOUS REGION	PROVINCE	INITIAL MILESTONE	END MILESTONE	LENGTH	AADT
2	Regional roads type 2 (R2)	-	-	-	-	-	-	-	-	-	-
	Conventional roads (C)	N-122	5-3-0	N-122	RCE	Castille-León	Soria	105,42	114,52	9,1	4.306
		N-521	3-6-0	N-521	RCE	Extremadura	Cáceres	101,02	108,29	9,5	1.510
		N-625	3-2-0	N-625	RCE	Castille-León	León	97,67	130	32,69	338
		N-122	21-3-9	N-122	RCE	Castille-León	Zamora	517,9	538,23	20,33	2.094
		N-111	3-2-0	N-111	RCE	Castille-León	Soria	236	244,56	8,56	2.581
		N-630	26-5-0	N-630	RCE	Extremadura	Badajoz	721,99	730,37	8,38	8.504

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Sample segments for region 3: Madrid.

REGION	TYPE OF ROAD	ROAD ID	SEGMENT	NEW ROAD ID	OWNERSHIP	AUTONOMOUS REGION	PROVINCE	INITIAL MILESTONE	END MILESTONE	LENGTH	AADT
3	Motorways (MW)	A-6	1-1-0	AP-6	RCE	Madrid	Madrid	41,82	47,53	7,9	53.184
		R-4	3-0-0	R-4	RCE	Madrid	Madrid	12,1	19	6,9	6.296
		M-40	10-1-1	M-40	RCE	Madrid	Madrid	36,5	42,42	5,92	143.500
		M-45	3-0-0	M-45	A	Madrid	Madrid	8,3	16,98	8,67	73.775
		M-40	5-0-0	M-40	RCE	Madrid	Madrid	16,01	21,22	5,81	180.520
		R-3	5-0-0	R-3	RCE	Madrid	Madrid	22	33,9	12	11.522
	Roads with limited access (RWLA)	N-1	2-3-3	A-1	RCE	Madrid	Madrid	33,93	50,13	15,31	41.296
		N-2	3-5-0	A-2	RCE	Madrid	Madrid	23,88	31,98	8,1	78.950
		N-1	3-2-2	A-1	RCE	Madrid	Madrid	90	95,6	5,6	24.074
		M-501	5-0-0	M-501	A	Madrid	Madrid	22,6	38,7	16,1	18.476
		M-407	1-0-0	M-407	A	Madrid	Madrid	0	5,55	5,55	36.516
		A-3	2-4-0	A-3	RCE	Madrid	Madrid	40,9	49,68	8,78	28.950
		M-501	9-0-0	M-501	A	Madrid	Madrid	57,6	72,22	14,62	7.022
		M-607	8-0-0	M-607	A	Madrid	Madrid	50	58,4	8,4	4.666
		M-506	3-0-0	M-506	A	Madrid	Madrid	12	20,8	5,8	59.120

Sample segments for region 3: Madrid. (continued)

REGION	TYPE OF ROAD	ROAD ID	SEGMENT	NEW ROAD ID	OWNERSHIP	AUTONOMOUS REGION	PROVINCE	INITIAL MILESTONE	END MILESTONE	LENGTH	AADT
3	Roads with limited access (RWLA)	A-6	2-2-2	A-6	RCE	Madrid	Madrid	22	29	7	99.931
		M-506	5-0-0	M-506	A	Madrid	Madrid	28	38	10	11.198
		N-4	3-3-0	A-4	RCE	Madrid	Madrid	21,9	30,73	8,85	101.756
		N-5	3-2-1	A-5	RCE	Madrid	Madrid	24,8	31,5	6,73	70.607
	Regional roads type 1 (R1)	M-100	2-0-0	M-100	A	Madrid	Madrid	11	22,52	11,52	6.295
		M-203	4-0-0	M-203	A	Madrid	Madrid	15,94	21,55	5,61	10.547
	Regional roads type 2 (R2)	M-404	2-0-0	M-404	A	Madrid	Madrid	8	15	7	6.823
	Conventional roads (C)	-	-	-	-	-	-	-	-	-	-

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Sample segments for region 4: Valencia region and Murcia.

REGION	TYPE OF ROAD	ROAD ID	SEGMENT	NEW ROAD ID	OWNERSHIP	AUTONOMOUS REGION	PROVINCE	INITIAL MILESTONE	END MILESTONE	LENGTH	AADT
4	Motorways (MW)	N-3321	1-0-0	N-3321	A	Murcia	Murcia	0	6,5	6,5	10.376
		A-7	44-0-0	AP-7	RCE	Valencia	Castellón	407,01	426,03	18,8	22.534
		A-7	60-0-0	AP-7	RCE	Valencia	Alicante	608,04	621,16	12,13	23.963
	Roads with limited access (RWLA)	CV-81	5-0-0	CV-81	A	Valencia	Alicante	21,1	33,8	12,7	5.457
		C-415	2-0-0	C-415	A	Murcia	Murcia	15	32	17	14.175
		A-7	52-0-0	A-7	RCE	Valencia	Valencia	509,06	527,16	18,18	47.094
		N-340	35-3-0	A-7	RCE	Valencia	Valencia	880,93	890,83	9,68	79.481
		CV-84	2-0-0	CV-84	A	Valencia	Alicante	2,5	7,8	5,3	15.490
		CV-35	8-0-0	CV-35	A	Valencia	Valencia	73,7	86,53	12,83	1.029
		C-3211	7-0-0	C-3211	A	Murcia	Murcia	82,5	95	12,5	10.248
		N-430	18-1-1	A-35	RCE	Valencia	Valencia	620,5	636,3	16,405	27.552
		CV-35	5-0-0	CV-35	A	Valencia	Valencia	26,08	37,9	11,82	10.748
		N-340	20-0-0	A-7	RCE	Murcia	Murcia	654,03	659,93	6	72.268
		CV-35	6-0-0	CV-35	A	Valencia	Valencia	37,9	67,65	29,75	1.960

Sample segments for region 4: Valencia region and Murcia (continued).

REGION	TYPE OF ROAD	ROAD ID	SEGMENT	NEW ROAD ID	OWNERSHIP	AUTONOMOUS REGION	PROVINCE	INITIAL MILESTONE	END MILESTONE	LENGTH	AADT
4		N-340	17-1-0	A-7	RCE	Murcia	Murcia	566,11	574,21	8,1	14.144
		A-7	69-1-0	A-7	RCE	Valencia	Alicante	710,09	718,98	9	60.836
	Regional roads type 1 (R1)	CV-95	1-0-0	CV-95	A	Valencia	Alicante	0	6	6	13.961
		C-3314	1-0-0	C-3314	A	Murcia	Murcia	0	13	13	5.006
	Regional roads type 2 (R2)	-	-	-	-	-	-	-	-	-	-
	Conventional roads (C)	N-340	42-1-0	N-340	RCE	Valencia	Castellón	940,8	951,4	10,6	7.963
		N-343	2-1-0	N-343	RCE	Murcia	Murcia	3,61	11,5	7,82	7.307
		N-332	14-2-0	N-332	RCE	Valencia	Valencia	234,94	246,51	11,45	13.682
		N-234	3-4-1	N-234	RCE	Valencia	Castellón	51,27	63,65	12,2	8.554

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Sample segments for region 5: Catalonia.

REGION	TYPE OF ROAD	ROAD ID	SEGMENT	NEW ROAD ID	OWNERSHIP	AUTONOMOUS REGION	PROVINCE	INITIAL MILESTONE	END MILESTONE	LENGTH	AADT
5	Motorways (MW)	N-2	34-0-0	B-10	RCE	Catalonia	Barcelona	611,01	619,09	7,26	129.192
		A-7	24-0-0	AP-7	RCE	Catalonia	Barcelona	182,76	193,2	10,55	74.989
		A-2	12-0-0	AP-2	RCE	Catalonia	Tarragona	193,23	206,63	13,38	13.225
		A-2	7-0-0	AP-2	RCE	Catalonia	Lérida	127,01	140,01	12,77	11.666
		A-2	8-0-0	AP-2	RCE	Catalonia	Lérida	140,01	160,97	20,9	13.224
		A-7	36-0-0	AP-7	RCE	Catalonia	Tarragona	281,05	297,25	16,13	25.670
		A-7	7-0-0	AP-7	RCE	Cataluña	Gerona	56,29	64,2	7,86	47.464
		A-7	13-0-0	AP-7	RCE	Catalonia	Barcelona	111,59	124,5	12,92	65.634
		A-7	21-0-0	AP-7	RCE	Catalonia	Barcelona	161,47	171,7	8,75	84.260
		A-7	34-0-0	AP-7	RCE	Catalonia	Tarragona	257,57	265,25	7,91	28.748
	Roads with limited access (RWLA)	N-2	28-1-1	A-2	RCE	Catalonia	Lérida	484,8	497,713	10,256	32.234
		N-2	27-3-1	A-2	RCE	Catalonia	Lérida	466,7	474	8	37.416
		N-236	1-0-0	LL-12	RCE	Catalonia	Lérida	0,16	5,69	5,52	9.809
		N-2	28-2-0	A-2	RCE	Catalonia	Lérida	497,713	503,02	7	31.685

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Sample segments for region 5: Catalonia (continued).

REGION	TYPE OF ROAD	ROAD ID	SEGMENT	NEW ROAD ID	OWNERSHIP	AUTONOMOUS REGION	PROVINCE	INITIAL MILESTONE	END MILESTONE	LENGTH	AADT
5	Regional roads type 1 (R1)	C-14	7-0-0	C-14	A	Catalonia	Tarragona	35,64	50,79	13,49	3.491
		C-59	6-0-0	C-59	A	Catalonia	Barcelona	28	38,46	10,46	4.507
		C-28	1-0-0	C-28	A	Catalonia	Lérida	23,51	35,8	12,29	6.911
		C-15	2-0-0	C-15	A	Catalonia	Barcelona	2,47	13,59	11,12	21.622
		C-43	1-0-0	C-43	A	Catalonia	Tarragona	0	13,59	13,59	2.294
		N-230	9-1-0	N-230	RCE	Catalonia	Lérida	150,99	162,692	11,742	3.307
	Regional roads type 2 (R2)	-	-	-	-	-	-	-	-	-	-
	Conventional roads (C)	N-420	23-1-3	N-420	RCE	Catalonia	Tarragona	808,68	820,68	12	4.424
		N-240	6-1-0	N-240	RCE	Catalonia	Tarragona	2,18	12,9	9,92	20.909
		N-2	29-2-0	N-2	RCE	Catalonia	Lérida	524,5	530,04	7,24	406
		N-240	6-2-0	N-240	RCE	Catalonia	Tarragona	12,9	25,24	12,34	16.390

Sample segments for region 6: Galicia and Asturias.

REGION	TYPE OF ROAD	ROAD ID	SEGMENT	NEW ROAD ID	OWNERSHIP	AUTONOMOUS REGION	PROVINCE	INITIAL MILESTONE	END MILESTONE	LENGTH	AADT
6	Motorways (MW)	A-66	8-1-0	A-66	RCE	Asturias	Asturias	53,51	59,51	6	16.970
		A-9	9-0-0	MW-9	RCE	Galicia	Pontevedra	94,75	104,05	9,35	18.412
		A-9F	2-0-0	MW-9	RCE	Galicia	La Coruña	3,06	12,45	9,3	19.042
	Roads with limited access (RWLA)	A-52	9-0-0	A-52	RCE	Galicia	Orense	173,46	188,015	14,555	11.141
		A-6	10-1-0	A-6	RCE	Galicia	Lugo	479,5	487,83	9,7	10.080
		A-8	4-0-0	A-8	RCE	Asturias	Asturias	317,02	322,15	5,13	11.657
		A-8	6-0-0	A-8	RCE	Asturias	Asturias	337,086	344,212	7,126	14.843
	Regional roads type 1 (R1)	LU-546	2-0-0	LU-546	A	Galicia	Lugo	10,67	16,43	5,76	10.117
		PO-531	3-0-0	PO-531	A	Galicia	Pontevedra	4,1	11	6,9	20.123
	Regional roads type 2 (R2)	-	-	-	-	-	-	-	-	-	-
	Convencional roads (C)	N-634	9-0-0	N-634	RCE	Asturias	Asturias	325,45	341,57	14,66	5.085
		N-6	32-1-0	N-6	RCE	Galicia	La Coruña	577,35	586,93	9,58	21.749
		N-525	4-2-1	N-525	RCE	Galicia	Orense	168,07	195,12	27,05	3.449
		N-642	1-1-0	N-642	RCE	Galicia	Lugo	0,02	8,6	8,58	2.734

Sample segments for region 7: Basque country, Cantabria and La Rioja.

REGION	TYPE OF ROAD	ROAD ID	SEGMENT	NEW ROAD ID	OWNERSHIP	AUTONOMOUS REGION	PROVINCE	INITIAL MILESTONE	END MILESTONE	LENGTH	AADT
7	Motorways (MW)	A-68	8-0-0	MW-68	RCE	Basque country	Álava	54,14	68,54	14,4	15.356
		A-68	2-0-0	MW-68	RCE	Basque country	Vizcaya	4,74	11,34	6,6	37.643
		A-68	7-0-0	MW-68	RCE	Basque country	Álava	36,44	54,14	17,7	15.424
		A-15	7-2-0	A-15	A	Navarre	Navarra	112,46	126,7	14,5	14.312
	Roads with limited access (RWLA)	N-635	3-2-0	A-8	RCE	Cantabria	Cantabria	7,09	14,11	7,04	48.680
		A-15	8-0-0	A-15	A	Basque country	Guipuzcoa	139,8	156	15,5	13.315
		A-67	7-1-0	A-67	RCE	Cantabria	Cantabria	186,98	199,4	12,43	62.578
		A-8	15-4-0	A-8	RCE	Cantabria	Cantabria	161,4	169,795	8,395	29.382
	Regional roads type 1 (R1)	A-624	3-0-0	A-624	A	Basque country	Álava	41,73	48,44	6,71	3.460
	Regional roads type 2 (R2)	-	-	-	-	-	-	-	-	-	-
	Conventional roads (C)	N-634	1-1-0	N-634	RCE	Cantabria	Cantabria	136,1	143,9	7,18	1.170
		N-111	4-3-0	N-111	RCE	La Rioja	Logroño	315,29	325,49	11,17	6.804

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Sample segments for region 8: Aragón.

REGION	TYPE OF ROAD	ROAD ID	SEGMENT	NEW ROAD ID	OWNERSHIP	AUTONOMOUS REGION	PROVINCE	INITIAL MILESTONE	END MILESTONE	LENGTH	AADT
8	Motorways (MW)	A-2	4-0-0	MW-2	RCE	Aragón	Huesca	70,77	113,61	42,7	15.448
	Roads with limited access (RWLA)	A-23	5-3-5	A-23	RCE	Aragón	Teruel	176,4	181,8	5,4	6.261
		Z-32	1-0-0	Z-32	RCE	Aragón	Zaragoza	0	7	7	3.500
	Regional roads type 1 (R1)	A-133	2-0-0	A-133	A	Aragón	Huesca	6	21	15	450
	Regional roads type 2 (R2)	-	-	-	-	-	-	-	-	-	-
	Convencional roads (C)	N-330ª	29-0-3	N-330a	RCE	Aragón	Huesca	603,8	612,6	10,6	1.480
		N-2ª	17-0-1	N-2a	RCE	Aragón	Zaragoza	260,5	270,41	9,91	1.042

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4 Discussion

The Belgian and the Spanish studies confront the recommendations of the SafetyNet manual with the reality of actual speed surveys. Only few lacks where identified in the manual recommendations, excepted on statistical theory of the estimation of the variance of SPI estimates. In contrast, in the Belgian study, it was observed that the manual recommendations were sometimes too rigorous to be all fully applied (e.g. having all measuring locations at a minimum distance of 500 meters from the closest intersection).

On the other hand, the Spanish researchers have the ambitious objective to fully implement the recommendations of the SafetyNet manual in the selection of measuring locations. So far they have actually managed to do so, thanks to an important investment in the procedure of sampling design and in the checking of the validity of locations. Due to the ongoing status of the Spanish study, only few conclusions can be drawn at the moment but it will be interesting to follow the developments of the study in the near future.

It is interesting to have with the Belgian and the Spanish studies two practical and detailed examples on how the measuring locations of a speed survey were selected. This topic is indeed generally not well documented in the reports about speed surveys even if we know that the choice of the locations will have a big influence on the values of the SPIs.

Not all the speed surveys follow the SafetyNet methodology such as the Belgian and the Spanish ones. Many different options are taken concerning the method of selection of the locations, the way to deal with the traffic conditions or the way to compute the SPIs. The SafetyNet methodology is certainly not the only valid methodology. But, as the Belgian pilot has re-emphasized the SafetyNet manual statements about the importance of the methodology choices on the values of the SPIs, this deliverable should incite researchers in the field of speed survey to think again about the consequences of their choices in terms of methodology on their speed indicators values.