Deliverable 7.11
Overview and Executive Summary of Work Package 7

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Executive Summary

This report summarizes the activities of Work Package 7. On the one hand, the most important conclusions with respect to the use of special statistical techniques for time series data and hierarchical data (accident and geographical) are given. On the other hand, each of the analyses conducted on time series data, geographical data, and fatal accident data is summarized to give an overview of the most important conclusions they offered for road safety.
1 Chapter 1 - Introduction

This deliverable gives an overview of the activities of Work Package 7 (WP7) of the SafetyNet project. This Integrated Project brought together the most experienced organisations within the EU to assemble a co-ordinated set of data resources and form them into the European Road Safety Observatory (ERSO). The Observatory will enable the European Commission to monitor progress towards targets, identify best practises, and ensure that new regulatory and other safety actions will result in the maximum casualty reduction.

Work Package 7 was set up to investigate a number of methodological and statistical problems that might arise when analysing the data, find solutions for these problems and present example analyses.

1.1 Questions in road-safety

Many important questions with respect to road-safety concern the development of the number of casualties over time. As examples:

- Has the number of fatalities decreased?
  - Is the latest reduction in fatalities what was to be expected in the preceding years?
  - If not, what explanations can be given for this change in trend?
- What is the prognosis for the next years?
  - How will the fatalities develop if everything goes on as it does now?
- Has driving a motorbike become more dangerous in the recent years?
  - How did the distance travelled on motorbikes develop?
  - Did the number of accidents and/or fatalities behave accordingly?

When answering these questions, one has to analyse time-series data. This means analysing a whole series of data of the same type (e.g., number of fatalities, population size, or distance travelled) which are repeatedly measured (e.g. monthly or yearly).

A different type of question might concern differences between regions:

- Do regions with more enforcement measures have safer roads?
  - Do measures in one region influence the neighbouring regions as well?
- Are there differences with respect to the safety behaviours and attitudes between regions?
  - Are these differences reflected in the accident or fatality numbers?
  - Do they lead to different acceptance with respect to e-safety technology?

The data to be used in order to answer such questions may show a geographical structure. Regions are nested within countries and counties within regions. Neighbouring regions might be more similar to each other than regions that are situated at the other end of the country.
Finally, questions might concern the accident events themselves:
- What are risk and protection factors in severe accidents?
  - Which parts of the vehicle provide protection in severe accidents?
  - Which actions of drivers can protect the occupants in their vehicles?
  - Are older people more at risk to die when involved in a severe accident?
- Are there different types of severe accidents?
  - Do these types occur under different road conditions?
  - Do they involve different type of drivers (e.g.: in terms of age, impairment…?)

To answer these questions, one has to rely on relatively detailed accident data.
As depicted in Figure 1.1, these data typically have a hierarchical structure, because they describe road-users, vehicles, and accidents with some road-users having been seated in the same vehicle and some vehicles having been involved in the same accident.

![Figure 1.1: The hierarchical structure of accident data](image)

WP7 has been dedicated to investigate these three different types of data-structures – time series data, geographic data and hierarchical accident data – to answer the question whether they require special treatment when they are statistically analysed. The problem with these data is called dependency and will be shortly sketched here (for details see D7.4 and D7.9).

### 1.2 Dependency in statistical models

Most statistical techniques are based on building a simplified model to describe the data. Factors that are assumed to play a role (e.g. whether a road-user wore a seatbelt or not) can be introduced in this model. Statistical tests are then used to evaluate whether this actually allows the model to describe the data better. These tests rely on the general assumption of the independence of the observations involved. Examples for problems with dependencies are grouped data (some cases are more similar to each other than to others) or data on a
time line (data that were observed more closely to each other in time are more similar than those observed at distant moments), or periodic data (data from the same month over different years resemble each other). These dependency structures pose a problem for standard statistical techniques.

Deliverable D7.4 offers a review of various statistical methods that are appropriate to handle that problem, and investigates how serious is the problem posed for conducting statistical tests on time-series data and hierarchical data. Two types of hierarchical data have been considered, namely geographical hierarchies (e.g.: regions within countries and counties within regions; see D7.4 and D7.8) and accident data (see D7.6 and D7.9). The problem has been addressed for all types of data-structures, and two types of statistical techniques – time series analyses and multilevel analyses data were presented as solutions. As can be seen in Table 1.1, the conclusions for time-series data are much stronger than those for hierarchical structures.

<table>
<thead>
<tr>
<th>Potential problem for statistical tests</th>
<th>Time-series</th>
<th>Hierarchical (accident)</th>
<th>Hierarchical (geographical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methods for solution</td>
<td>Large</td>
<td>Unknown, probably small</td>
<td>Medium</td>
</tr>
<tr>
<td>Applicability</td>
<td>Time series analysis</td>
<td>Multilevel modelling</td>
<td>Multilevel modelling</td>
</tr>
<tr>
<td></td>
<td>Well applicable</td>
<td>Difficult to apply</td>
<td>Possible to apply</td>
</tr>
</tbody>
</table>

Table 1.1: Three types of dependency structures

1.3 Overview

The work in Work Package 7 was dedicated to three different data structures: (1) Time series data, (2) Geographical data, and (3) In-depth accident data. Data structures (2) and (3) both have a hierarchical structure, and were therefore candidates for multilevel modelling. In the remainder of this document, we will describe specific issues for each of the three structures and the results obtained. First, however, an overview of the deliverables presented by WP7 is given. Note that some deliverables were preliminary versions of others and are consequently not listed here.

D 7.4
Multilevel modelling and time series analysis in traffic safety research – Methodology
This deliverable gives the theoretical background for the two families of analyses, multilevel and time series analysis. For each technique the objectives, detailed model formulation, and assumptions are described. The technique is subsequently illustrated with an empirical example relevant to traffic safety research.

D7.5
Multilevel modelling and time series analysis in traffic safety research – Manual
This deliverable contains the manual to support the methodology report in D7.4. For each technique described in the methodology report, this manual presents
the instructions to fit the models on the basis of user friendly software, along with guidelines for interpreting the results. The aim of the manual is to enable the reader to conduct all analyses described in D7.4, and in this way to get hands on experience in the analysis of road safety data. To enable the reader to track every step presented, the data sets discussed in the various sections are available on the ERSO website (http://www.erso.eu/safetynet/content/wp_7_data_analysis_and_synthesis_1.htm).

D7.7
Multivariate time series analysis of SafetyNet data
This deliverable demonstrates the use of time series analysis techniques. In particular, structural time series models are developed and demonstrated for France and the Netherlands, as well as disaggregated models for two types of networks in France, and disaggregated models for several accident types in the Netherlands. It is demonstrated how the developments of the traffic volume, the number of accidents, and the number of fatalities can be considered simultaneously. The time series model isolates the general trend in these observed measures from short term seasonal variation and links them to the trend in exposure, accident risk and accident severity. Some interpretations are given. In addition, the performance of the time series model is compared to the performance of one classical alternative: the linear regression model.

D7.8
The CARE accident data in perspective
This deliverable relates the data from the macroscopic European accident database CARE to other, very different types of data. It is first shown how accident data can be linked to spatial and infrastructural data (which counties are connected by roads) on the basis of Greek example data. In another section, the accident outcomes in CARE are related to hospital injury data for 5 different member states. Finally, the accident data for different age and gender groups were linked to these groups’ road safety attitudes as measured in the SARTRE project.

D7.9
Analysing European in-depth data: Methodological framework and results
This deliverable is dedicated to the analysis of the Fatal Accident Investigation Database built in the framework of the Work Package 5 of SafetyNet. The general aim is to demonstrate the multiple uses of these data, and to propose a set of techniques that are appropriate for the analysis of data that are limited to fatal accidents.

D7.10
Time series applications on road safety developments in Europe
This deliverable shows how traffic safety data can be analysed to understand the development of traffic safety over time.

The report shows a number of principles of time series analysis
• The current state of the art of structural time series analysis is described. We illustrate the importance of changes in distance travelled, and how this affects the number of accidents or the number of fatalities.

• Further understanding of the development of traffic safety asks for disaggregation of the safety data into different subgroups. Such disaggregation reveals different trends for different groups.

• The development of traffic safety is shown to depend strongly on the composition of the population of a country. Changes in the demographics are related to safety, and forecasts are sensitive to this composition.

• As an example of a factor that affects all accidents, we choose weather parameters to incorporate in our models, and use different techniques to analyse the effect of precipitation, frost and temperature on safety.
2 Chapter 2 – Time series data

All over the world road safety policy makers want to understand why the number of road casualties changes, and how this can be influenced by effective strategies. Policy makers try to estimate the effects of safety measures or other factors on the number of casualties. The changes over time in either the number of fatalities, fatal accidents, serious accidents or the number of Killed or Seriously Injured (KSI) is used as a guide, and for future years safety targets are expressed in such terms. Analysts try to understand the yearly, or monthly, changes in the number of casualties. A common way of doing this is to look at the time series of the number of casualties, and try to match these figures with important influencing factors. This is a complex and sophisticated profession, called time series analysis. The description of the mathematical techniques used can be found in D7.4, while D7.5 is meant as a manual to apply these methods. In this chapter we briefly explain some essential insight gained in WP7 and give examples of applications of the methods.

2.1 Risk ratios under consideration of exposure data

The most important factor explaining road safety is mobility (distance travelled). Mobility can change enormously over the years, or months, and differences in road safety between countries are known to be strongly correlated to mobility. The preferred way to relate road safety data to mobility is by using survey data on person distance travelled or vehicle distance travelled. Unfortunately, many countries do not have these data available, in which case proxies are used, e.g., passenger car fleet, oil sales, demographic data, or a combination of those.

An example is shown in D7.10, Chapter 3. There, an analysis of the development of mortality (fatalities per inhabitant) over time is given for different European countries. This is compared to motorization rate. The analysis shows how motorization rate and mortality relate, and what different patterns evolve when countries are compared.

Summarising, this chapter shows that:

- different countries reach specific motorization rates in different years (temporal landmarks);
- some of these countries exhibit their major breakpoint in fatality risk within a narrow range of motorization rate values (320-370 vehicles per 1000), suggesting that these breaks take place under similar social and economical conditions;
- this range is different for certain subgroups of the examined countries, indicating that some grouping of countries may be required.

These preliminary findings can serve as an adequate starting point to obtain a further understanding of why, and when, these important breakpoints are observed. Research already conducted in this field will be taken into account so
as to facilitate a useful grouping of the examined countries. The ultimate objective of this research is to utilize these findings in order to make reliable predictions for countries or regions for which the major turning point has not yet occurred.

Disaggregation by country also clearly shows that different countries may show their own specific developments, and thus that disaggregation helps to better understand the development of aggregated data.

2.2 Simultaneous modelling of different levels of road-risk

A common way to analyse the relation between road safety data and mobility consists of simultaneously analysing mobility, accident numbers, and fatality rate. In D7.10, Chapter 2, the basics of structural time series analysis is described. We illustrate the importance of changes in distance travelled, and how this affects the number of accidents or the number of fatalities. Preferably, current methods simultaneously analyse the development of distance travelled, and of the number of accidents or fatalities, so as to allow for robust forecasts of both mobility and road safety data.

Deliverable 7.7 provides a more elaborate description of this method, both in the technical sense and in the examples used. A simultaneous analysis of the time series of distance travelled, risk (accidents per distance travelled) and lethality (fatalities per accident) was carried out, both for main roads and motorways. The results show these two types of roads differ from each other in the development of distance travelled, risk and lethality. Importantly, the development of the accident risk and the lethality are dissociated for these two road types. While motorways have a lower accident risk than rural roads, the lethality of those accidents that do happen is higher as compared to rural roads. The accident risk is generally decreasing, but not so much anymore for motorways. The lethality is generally decreasing, but not on rural roads.

2.3 Disaggregate!

When only passenger car mobility is used to explain traffic safety changes over time, the resulting models behave poorly. This is because, in any country, the safety figures not only depend on passenger car mobility, but also on two-wheeler mobility (bicycle, moped, motorcycle). This is especially true when long time series are analysed. In the Netherlands in 1950, for example, no passenger car was involved in 70% of the fatal accidents. The same is true even today, for more than 30% of the fatal accidents.

One might argue that it is more appropriate to use motorized vehicle mobility instead of passenger car mobility. Although this is indeed the case, this remains problematic, in the sense that changes in modal shift (e.g., from motorcycle to passenger car) induce gross changes in the number of fatalities per distance travelled, which is left unexplained by the total motor vehicle travelled. Therefore, further understanding of traffic safety development asks for
disaggregation of mobility and accident data into different models for different traffic modes.

An example is given in D7.7, Chapter 5, where accidents with cars are analysed. There, a difference was made between single vehicle car accidents and car-car accidents. Car-car accidents were further stratified by type, namely frontal, rear and side impact car-car accidents. This indicated that the risk of being involved in a single car KSI accident was approximately equal to the risk of being involved in a car-car KSI accident. Risks for three different car-car-accident types were approximately equal.

Stratification by traffic mode is not the last step required to better understand road-safety developments: Driver age is a very important factor as well. Changes in demographic data indeed also affect the number of road casualties. This is particularly true for changes of the proportion of young inexperienced drivers, or of elderly vulnerable drivers out of the general driver population. A decrease in birth rate has led to a gradual decrease in the number of young drivers twenty years later, as was observed in many developed countries after the introduction of the birth control pill. The baby boom that took place after World War II is another example of a demographic change that can help understand road traffic trends. Such changes in demographics have a strong impact on road safety data.

Unfortunately, not many countries have mobility data stratified by traffic mode, or driver age, at their disposal. This is a serious drawback for modelling effective time series analysis and road safety developments. To show the impact of such data on road safety, an analysis was carried out using Dutch data, in D7.10, Chapter 4. This analysis shows how road safety time series and mobility time series can be stratified by age and gender, and simultaneously analysed. Demographic data were used to obtain mobility data per capita. The results show that in the Netherlands, the number of fatalities per traffic mode and age group can be very different. At the same time, it was investigated how well these differences could be predicted using changes in population data only. The results showed that mobility per capita, stratified by age and traffic mode, changes relatively little over time. As an example, while the number of senior citizens has increased (and will be increasing further), the distance each member of this group travelled with various transport modes changed very little. As a consequence, even when mobility data by age group are not established regularly, a relatively good estimation of changes in road safety over time can be achieved by using demographic data instead of mobility data.

2.4 Explaining the risk

Eventually, models are expected to incorporate other influencing factors or safety performance indicators, such as the quality of roads, seatbelt use, etc.

Ultimately, policy makers are interested in an estimation of the effect of safety measures, e.g., to decide what has to be undertaken to meet their safety targets. This calls for time series analysis with explanatory variables, to relate changes in the number of casualties to changes in external factors. To carry out
such analysis, it is necessary to construct an accurate model that mathematically relates accidents to the measures of interest. For example: to estimate the effect of motorcycle helmet use on the total number of fatalities, a time series of accidents, stratified by motorcycle mobility and, *e.g.*, passenger car mobility (as this is an important traffic mode involved in fatal accidents with motorcycles) is necessary.

At this stage, operational models of that type are a bridge too far, mostly, because most influencing factors are very specific. As an example of a factor that affects all accidents, weather parameters were incorporated in time series analyses. To illustrate the application of explanatory variables in time series analyses, examples are given in D7.10, Chapter 5. Several techniques to analyze the effects of precipitation, frost, and temperature on road-safety are illustrated there.

In a comparison of two countries (France and the Netherlands) and a region (region of Athens), monthly data on temperature, precipitation, and frost were compared to monthly accident data. The general tendency for weather effects on the number of injury accidents was the following:

- Months with more rain see more injury accidents
- Higher temperatures are associated with more injury accidents.
- In months with frost, the number of injury accidents is lower than in other months.

However, these effects are not necessarily homogenous for different regions and road-types, and seasons:

- Rain effects vary in strength (*e.g.* a strong increase of injury accidents on Dutch motorways, but no significant increase on rural roads)
- Rain effects can even turn around (*e.g.* in Athens, an urban area, there are fewer accidents in rainy months rather than in average)
- Temperature effects are not necessarily stable throughout the year (*e.g.* in Athens there are fewer accidents with lower temperature - but only in the winter half-year, from October to March)

Again, because weather conditions may affect the distance travelled, it is desirable to analyse distance travelled and risk simultaneously. For the region of Athens, for example, June was shown to yield more accidents than each month of the autumn period. The use of a model that also utilised exposure data however, showed that this is probably due to the high traffic volume during early summer rather than due to the temperature.

At a region’s level, it was not systematically possible to take an aggregate measure of risk exposure into account, and to clearly attribute the effects to a change in risk on the one hand or a change in exposure on the other hand. In the case of the two French networks (main roads and motorways), however, the distance travelled is measured so accurately that it was possible to separate the direct and indirect (*i.e.* via exposure) effects of weather on the number of injury accidents. The most significant result is related to rain. In France, an increase in rainfall leads to a decrease in distance travelled. So the net increase in the
number of accidents due to rainfall indicates an even stronger simultaneous increase in risk (as the distance travelled decreases at the same time).
3 Chapter 3 – Geographical data

Road safety data are always spread out across several geographical units. These can be as small as the road-site at which the data were collected (see Section 3.1), or up to the size of whole countries (see Section 3.3). These units can also be nested into each other: Road-sites are situated within counties (or regions) which are themselves located within countries.

The following examples consist of different types of studies, but they have one thing in common: The cases that belong to the same unit (road-site, county, country) are more similar to each other than those belonging to different units. This calls for a multilevel modelling approach, which has been implemented for the most important levels.

3.1 Performance indicators: Drink driving

In D7.4 (Section 2.3.3) a Belgian roadside survey on drink driving was presented. In this study, drivers were stopped at test-sites that were selected randomly with respect to location and time. At each test-site, it was established whether the drivers had been drinking-driving, namely: whether their BAC (breath alcohol concentration) was below or above the 0.05 mg per litre (the legal limit in Belgium).

At the test-site level (location and time), the time of testing was the most important predictor: Drink-driving on weekend nights exceeds by far that at all other time points. At the individual level, gender and age were the most notable predictors with men between 40 and 54 having the highest risk of drink driving. It was also shown that these variables (weekend night, male, 40-54) had the same effect on both probabilities: The probability to have drunk slightly more than the legal limit (.05mg/l < BAC < .08mg/l), and the probability to have drunk much more than the legal limit (BAC > .08mg/l).

3.2 Enforcement Effects in Greece

In D7.4 (sections 2.3.4 and 2.5) the effects of speed infringements and alcohol controls on the accident and fatality number for each Greek county were analysed. It turned out that both enforcement measures were highly correlated (i.e. counties that executed many alcohol controls also issued many speeding infringements), and that they are together associated with lower fatality numbers. Moreover, it was shown that the enforcement measures were the most effective in those regions that had the highest accident rate in the first place. It was also demonstrated that enforcement had a stronger overall effect on the number of fatalities than on the number of accidents as such, suggesting that the accidents became less severe.

It can be said that enforcement has an important overall effect on fatal accidents (. This effect is uniform in all regions, maybe because drivers perceived an increased nationwide presence of the Police and improved their overall
behaviour accordingly. The decrease of non-fatal accidents, however, varies across regions, depending on the local enforcement practices.

### 3.3 Spatial modelling

Still using Greek data as example, D7.8, Chapter 2, illustrates how the spatial structure of a country can be integrated in an analysis of accident data. In other words, it is demonstrated how the systematic “neighbourhood structure” in the accident/fatality data can be disentangled from those differences that occur purely at random. For this purpose, the accident and fatality numbers per county were extracted from the CARE database. This analysis showed that differences between counties with respect to the number of accidents or fatalities per inhabitant are, for some part, determined by their location: Neighbouring counties tend to be more similar than counties located far away from each other. These data can be used to create a road-safety map for the whole country (e.g., in Figure 3.1).

![Figure 3.1: Fatalities and accidents (per population) according to spatial model](image)

Spatial modelling can also be used to compare different descriptions of the spatial structure of a country. To set up a spatial model, one has to define which counties are neighbours and which are not. In road-safety this is not always straightforward and consists in itself of an interesting question: Is it the arithmetic distance that makes some pairs of counties more similar than others? Or is it the fact that they are connected by a road? Does it matter what kind of a road it is? In the Greek example, different spatial models are compared to test whether regions that are connected by ferry could be seen as neighbouring regions just like those connected by roads. The conclusion from this exercise was that ferry connections do not facilitate neighbourhood effects in the way that road connections do.

The Greek example illustrates the principle of spatial modelling, which can also be applied to other countries or scaled up to larger regions (e.g. countries within Europe). It can be used to identify borders in road-safety. Such borders can be political or natural borders (or anything that is expected to make a difference in terms of accident or fatalities occurrences on either of its sides). Spatial models can be used to test which regions affect each others’ accident and fatality occurrences and which do not. Questions like this can be important when
determining how far a road-safety measure has to reach to be effective or which areas can be candidate for isolated measures.

3.4 Safety attitudes and accidents

In D7.8 (Chapter 4), the accident data from the CARE data base were linked to the SARTRE database, which contains attitude data concerning road safety from 13 European countries. Drivers’ behaviour and the underlying attitudes are of the most important factors in road safety. It is therefore interesting to see whether there is a relation between an accident database like CARE and a database containing data about road-safety attitudes in Europe, like the one resulting from the SARTRE project. However, CARE and the SARTRE data are inherently different: SARTRE concerns the attitudes of people who did not necessarily have had an accident, while CARE is a collection of accidents involving people of whom we do not know the attitudes. To overcome this difference, both databases were aggregated to the level of country, gender, and age. As an example, the number of accidents, the number of fatalities and the answers of questions on the SARTRE questionnaire were determined for male Austrians of 18 year old.

The aggregated attitude and behaviour data from Sartre were analysed in a Principal Component Analysis and three main components were identified: Aggressiveness and Speeding, (2) Other Unsafe Behaviour (no seat belt, drink driving), and (3) Perceived Control Likelihood of Control. This means that groups where many people admit to show aggressive behaviour are also those where many people admit to speed, whereas other unsafe behaviours, like drink driving and not using a seatbelt, are not necessarily shown in these groups.

As a result of the Principal Component analysis, each age gender and country group (e.g., the 18 year old male Austrians) got three scores, one for each of the three components. These scores were subsequently related to the number of accidents and fatalities for each of these groups. This yielded the conclusion that a positive attitude towards speeding and aggressiveness was more frequent in groups that also have a higher number of accidents and fatalities. This is true for men as well as for women. It is important to note that this statistical relation does not prove that the attitudes shown by young drivers actually caused the accidents. However, it shows that a positive attitude towards speeding and aggressiveness is most typical of the problematic groups, and might therefore be the most promising attitude to be addressed in campaigns.

3.5 Acceptance of new technologies: general tendency and country differences

In D7.4 (Section 2.6) the SARTRE data were also used to relate different driver characteristics to their attitudes towards different types of new technologies. The aim was to find out which type of driver supports which type of technology.
On the one hand, three driver characteristics were found to be relevant for the acceptance of new technologies. (1) emotional driving (does the driver get emotional when driving), (2) professional driving (does the driver drive for work) and (3) economic status of the driver. On the other hand three types of new technologies were found that determine their acceptance: (1) assistance and guidance (e.g., support for navigation, congestion warning), (2) warning & intervention (e.g., speed limiting devices, fatigue warning, alcohol meter), and (3) enforcement (electronic identification, black box to identify accident causes).

Subsequently, it was tested how well these patterns actually held for the separate countries. It was shown, that the categorization of technologies and drivers held relatively well for 19 of the 23 country\(^1\). There were, however, variations in the relation between them. In Tables 3.1a and 3.1b, the relation found between different technology types and driver types in general is indicated (first three columns) together with the deviations of single countries from that general relation.

<table>
<thead>
<tr>
<th>General model of relations between driver types and technology types</th>
<th>Deviations from general model per country (A to H)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Driver types</strong></td>
<td><strong>Technology types</strong></td>
</tr>
<tr>
<td>low economic status</td>
<td>Enforcement</td>
</tr>
<tr>
<td>low economic status</td>
<td>warning &amp; intervention</td>
</tr>
<tr>
<td>low economic status</td>
<td>Assistance</td>
</tr>
<tr>
<td>Driving as profession</td>
<td>Enforcement</td>
</tr>
<tr>
<td>Driving as profession</td>
<td>warning &amp; intervention</td>
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<td>Driving as profession</td>
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<td>Enforcement</td>
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<td>warning &amp; intervention</td>
</tr>
<tr>
<td>emotional driving</td>
<td>Assistance</td>
</tr>
</tbody>
</table>

Table 3.1a: Columns 1-3: General model of acceptance of different types of technology by different types of drivers (++ strong support, + support, - opposition). Columns 4-12: Deviations from general model by countries (+ stronger support than in general model, - less support than in general model).

\(^{1}\) For Belgium, Ireland, Portugal and Croatia, the general categorization of drivers and technologies did not reflect the responses given in those countries in a satisfying way.
### Table 3.1b: General model of acceptance of different types of technology by different types of drivers (++) strong support, (+) support, (-) opposition. Columns 4-12: Deviations from general model by countries (+ stronger support than in general model, - less support than in general model).

<table>
<thead>
<tr>
<th>Driver types</th>
<th>Technology types</th>
<th>General Relation</th>
<th>Italy</th>
<th>Netherlands</th>
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<td>low economic status</td>
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<td></td>
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Three main results in driver characteristics can be seen regarding support of new technologies:
- Low economic status drivers are most supportive,
- Professional drivers are also supportive, though less so than the above group, and
- Emotional drivers do not support new technologies (except assistance and guidance systems).

There is, however, no unique pattern of results that would hold for all countries altogether, suggesting that different strategies should be used for a successful introduction of new technologies in different countries.
4 Chapter 4 – Accident data

4.1 Analysing fatal accident data

In D7.9, a series of analyses of the Fatal Accident Investigation database (or FAI database) were presented. Analysing observations that are limited to fatal accidents means that the available information is restricted to the high-end of the accident-severity continuum. The problem with the interpretation of the information in such a database lies in the absence of a meaningful reference point to which it can be compared. Fatal accident data do not provide any information about whether the features or characteristics are specific to fatal accidents. As an example, front damage is the most frequent type of damage in the FAI database (60%). This high proportion does not, however, allow the conclusion that front damage is particularly likely to result in an accident being fatal. To ascertain such a conclusion, one would need a reference point – such as the percentage of front-damaged cars in non-fatal accidents, to test whether frontal are indeed less frequent there. To state it otherwise, by themselves, observations from fatal accidents – whatever the level of detail they offer – do not deliver information on which characteristics are specific for fatal accidents. To obtain such information, data from fatal accidents have to be combined with exposure data, or with similar information from non-fatal accidents.

Contrary to the accidents themselves - which were all fatal - the severity of their consequences for the individual road-users differs. The question of knowing what differentiates the survivors of these crashes from the fatalities is interesting in its own right. The survivor group can be used as a point of reference for the fatality group and enables the identification of person-, vehicle-, or accident-characteristics that make it more – or less – likely that an individual survived despite his/her involvement in such a severe accident. One should, however, keep in mind that the analysis only informs us about the risk of dying for someone who is already involved in a severe accident. The results say nothing about the risk of becoming involved in such an accident.

When identifying risk and protection factors in severe accidents, it is important to take the types of road-users involved into account. The risk run by a road-user, whenever involved in an accident, strongly depends on (1) his/her own travel mode (i.e., whether he/she is a car occupant, a bicyclist, or a truck driver), and (2) the travel mode of the road user he/she happened to collide with in the course of the accident. A car driver’s chances to die in an accident, for example, are de facto dramatically different depending on whether he/she collided with a bicycle, or with a heavy good vehicle. This is a general law in road accidents.

When analysing exclusively fatal accidents these differences become exacerbated, and care has to be taken that the cases selected offer sufficient baseline (i.e., a priori) comparability. This problem is illustrated in Figure 4.1, where for each conflict type (i.e. a road-user of a particular type with an opponent of a particular type) the percentage of survivors and fatalities is given.
A single glance is sufficient to make two observations:

− The percentages of fatalities differ strongly across the different conflict types.
− Some conflict types have extreme values; either fatalities only (e.g. pedestrian-car) or survivors only (e.g. car-pedestrian).

If the accident took place between a car and a pedestrian, one can be almost certain that the car occupant survived the accident. On the contrary, if the car collided with a heavy good vehicle, that car’s occupant has nearly 100% certainty to become the fatality. Generally speaking, in the case of fatal accidents data, incompatible accidents are accidents in which the risk to die is maximal for the more vulnerable of the road-users, while this risk is basically null for the relatively stronger participant\(^2\).

In Chapter 1 and 4 of Deliverable D7.9 these and other problems are discussed in more detail, and solutions are proposed. The analyses presented in that deliverable, which take account of these problems, are described in the sections below. They aim at answering the following questions:

− What differentiates single from multiple vehicle fatal accidents?

\(^2\) Because in incompatible accidents the outcome is the same for every road-user of a particular type (e.g. pedestrians), it is impossible to determine any further risk and protection factors for these types of accidents on the basis of fatal-accident data.
− What is the probability of being killed, given that one is involved in a fatal accident? What factors affect this probability and thus the consequences of a severe accidents for the persons involved?
− How reliable are the injury severity scores assigned by the Police to road accident casualties? Are there any factors systematically affecting the misreporting of injury severity?

4.2 Survivors and fatalities in fatal accidents

The outcomes of fatal accidents for each individual road-user involved are examined in Chapter 4 of D7.9. Comparing survivors and fatalities provided indications of the risk and protection factors for road-users involved in fatal accidents. The differences in baseline risk (see Section 4.1) were taken in account in three successive steps, which each provided particular improvements in handling these methodological problems posed by the limitation of the data to fatal accidents. First the complete dataset, including the observations made on all road-user types (i.e.: car-drivers as well as pedestrians or heavy good vehicles) was analysed. The remaining analyses focused on car-occupants specifically.

Some variables emerged as “risk factors” in a consistent way for all three analyses, such as the fact that the road-user him/herself could (or could not) be considered as “senior” (i.e.: as being more than 65 years), or that the driver did not reacted properly to the occurrence of the accident by braking. In the specific case of car occupants, seatbelt appeared to be an important protection factor. The risk for the road-user to decease in the accident also appears to increase with the age of the vehicle. Finally, the fact that the accident took place on a road junction also leaves the road-users with increased chances to survive. The risk for car occupants also depends on the area of main damage: Generally speaking, front damages are less dangerous than side damages. This is, however, only true for crashes between two cars or between a car and a light good vehicle, but not for single car crashes or crashes between a car and a heavy good vehicle. This latter result once more underlines the importance of including the transport mode of the opponent in the analysis.

4.3 Reliability of injury reporting

Chapter 2 in D7.9 showed that - although they were not initially meant for this - the FAI data could be very useful in detecting inaccurate reporting of injury severity under the form of misreporting (e.g.: slight injuries recorded as serious, fatalities recorded as serious injuries, and so on). Generally speaking, the analysis performed offered encouraging conclusions with respect to the quality of the reporting of injury severity, at least in the member states that took part in the FAI data-collection. Indeed, several sources of misreporting had been identified on the basis of this analysis among the first wave of the FAI data, suggesting a general pattern according to which, the more complex the road accident conditions were (e.g. more accident participants, higher traffic flow, night time), the higher was the probability of misreporting injury severity. However, running the same analysis on the second wave of data revealed a
very limited number of inaccurate reported cases, indicating that most of the inaccuracies previously identified had been solved.

The remaining inaccuracies concerned mostly serious injuries, and very few systematic sources could be identified for these inaccuracies. Notably, inaccuracies were less probable when the victim was taken to the hospital. This could be due to the fact that injuries necessitating transportation to the hospital are intrinsically likely to evolve in the time span taking place between the rating of the injury by the police and its recording by the SafetyNet team.

The FAI data offer the great advantage of providing some “standard”, namely the SafetyNet injury severity score, against which the accuracy of the police records for injury severity can be evaluated. No notable inaccuracy could be identified in the second wave of the FAI data, and no systematic country variation in the few inaccuracies identified. Assuming that the SafetyNet injury records can be considered accurate, this result suggests that no major problems should be expected in terms of country comparison on the basis of different level of injury severity on the basis of the FAI data.

4.4 Characteristics of single vehicle fatal accidents

Single and multivehicle fatal accidents differ on a large number of variables. The drunken young man who rides his car against a tree on a Saturday night is a prototypical case, representing the idea that single vehicle accidents are caused by irresponsible drivers more often than multivehicle ones. However, a different explanatory approach suggests that single vehicle accidents are predominantly observed when the road-conditions are such that an error of one driver is not very likely to involve another driver. The results of a multivariate analysis favoured the second approach.

Conditions of the road have been found to be the most important predictor of whether a fatal accident involves one or several vehicles. Multivehicle fatal accidents tend to take place on junctions and relatively busy roads, while single vehicle accidents tend to take place on empty road-sections between junctions. Roads with physically divided carriageways see relatively few fatal accidents in general and those few that do happen there are more. This suggests that such physical divisions do in fact succeed in preventing drivers who make a mistake to involve other drivers in the accident. The effect of these variables can be summarized under the principle that road-conditions that make it less likely that two vehicles encounter each other prevent the error of one driver to involve another one and thus facilitate single vehicle accidents as compared to multivehicle accidents.

Single vehicle fatal accidents involve mostly cars. Motorbikes are less likely to be involved in single than in multivehicle accidents and heavy good vehicles are involved almost exclusively in multivehicle accidents. The cars in single vehicle accidents have more passengers and the drivers in single vehicle accidents tend to be unfamiliar with the area more often than the drivers in multivehicle accidents.
accidents. Moreover, these drivers failed disproportionately often to even attempt to avoid the accident by braking or steering.

It has also been found that single vehicle fatal accidents take place especially at night and during the weekends and involve young drivers more often than multivehicle accidents. However, these effects seem to be mediated by the fact that at those times the roads are much emptier than during the week at daytime, when middle-aged and older people tend to drive.

Returning to the starting questions it was concluded that road conditions that prevent the error of one driver to spread to others are more important to understand the difference between single and multivehicle accidents than characteristics of the drivers involved.
5 Chapter 5 – Conclusion

The present deliverable gave an overview of the methodological questions and the example analyses that have been addressed by the Work Package 7 of the SafetyNet project throughout the project’s duration.

It was described how data-structures like hierarchical accident data, spatial data, and time-series can pose special problems in terms of statistical analysis. As a solution, the use of time-series analysis and multilevel analysis has been suggested.

Moreover, a number of additional methodological problems that are specific to the various types of data used were also discussed, and solutions were offered to handle them. For time series data, for example, it has been emphasized that the development of the number of fatalities needs to be considered simultaneously with the development of the mobility – and preferably so, separately for different types of accidents. For the analysis of fatal accident data, it was emphasized that each analysis and interpretation of these data needs to take into account that this is a very specific selection: Only the worst cases are present, but not the more positive ones to compare them with.

Along with this summary of the methodological issues that have been dealt with in the whole course of the project, this deliverable also aims at providing an overview of the most important content conclusions that have been achieved using these data.

Finally, and importantly enough, this deliverable aimed at providing the reader with a good insight of what can be accomplished using the data that are – or will be - available as a result of the SafetyNet project. As shown on the basis of the various road-safety research domains that have been addressed in this workpackage, the possibilities are many. Limitations, however, have also been encountered in using these data. Safety Net has initiated a process in terms of data collection, and this process is certainly not concluded. Work Package 7 has probed the quantitative information made available so far, and in so doing has derived conclusions about their limits and possibilities.