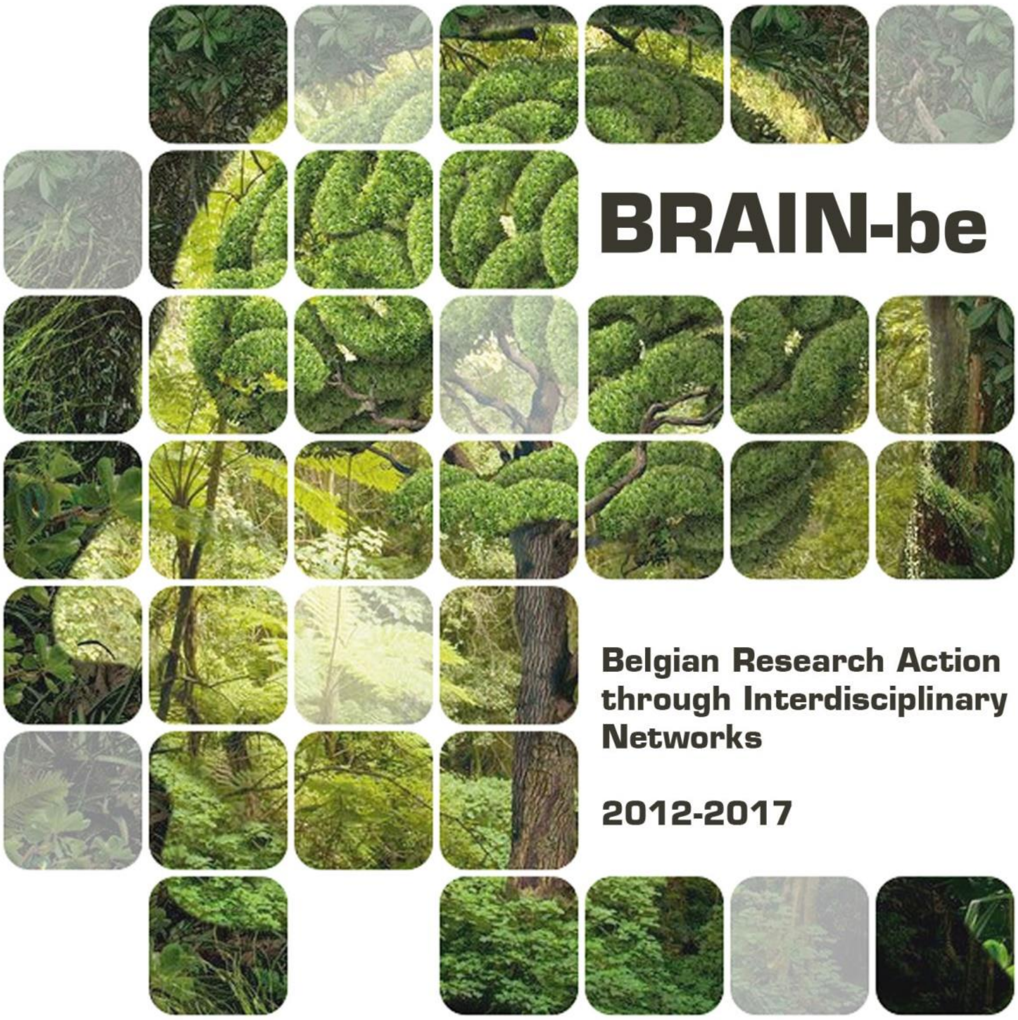

INTRAS

Inequalities in Traffic Safety

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Axis 5: Major societal challenges

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NETWORK PROJECT

INTRAS

Inequalities in Traffic Safety

Contract - BR/121/A5/INTRAS

FINAL REPORT

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ABSTRACT

Context

Given the fact that socioeconomic status and culture both are related to traffic safety – a fact that is abundantly illustrated in the international literature – the questions arise why people of different countries and cultures are in a varying extent involved in traffic accidents and why lower socioeconomic groups and ethnic minorities are often significantly overrepresented in traffic accidents within a country.

Objectives

Based on an exploration of the international literature, we wanted to develop a theoretical framework allowing us to investigate the mechanisms underlying inequalities in traffic safety and mobility patterns. Most importantly, we wanted to empirically investigate these inequalities in the local Belgian context analysing a combination of accident data, self-reported driving behaviours and opinions related to those behaviours at two different levels, i.e., at neighbourhood level and at the individual level. Part of these analyses was based on newly collected data. In addition to that, already available data sets to explore inequalities in traffic safety and mobility in Belgium were inventorised as a way to facilitate future research on this matter. From a methodological perspective, different statistical matching techniques were tested to allow data integration in the case valuable information on socioeconomic status would be missing.

Conclusions

International literature clearly demonstrates inequalities in traffic safety in function of socioeconomic and cultural/ethnic background. This finding, together with related inequalities in terms of travel patterns, is replicated to some extent in four different empirical studies conducted in the local context. However, data scarcity, limited operationalisation of socioeconomic status, total lack information on cultural factors (like ethnic background) and of more robust (longitudinal) study designs prevent us from drawing firm conclusions on the more precise importance of socioeconomic status and ethnic origin as predictors of road safety and mobility-related inequalities. Also, formal moderation/mediation analyses are required to verify the theoretical mechanisms that have been proposed and explored in this project as a way to better understand the association between socioeconomic status and ethnic origin on the one hand, and inequalities in traffic safety on the other hand. More research on this topic is definitely required to further advance our knowledge and improve related policy.

Keywords

Road safety, mobility, socioeconomic status, ethnic background, inequalities

1. INTRODUCTION

The project that is described in this report, concerns the different accident involvement of people with different socioeconomic and cultural backgrounds. With this research, we try to fill in some of the lacking knowledge regarding the explanatory mechanisms that clarify the relationship between socioeconomic and cultural characteristics and inequalities in traffic safety. It encompasses a conceptual framework that is based on the international literature, an exploration of possible inequalities in Belgium and methodological issues to analyze them.

From this analysis policy recommendations are made that can aid different policy domains (like road safety and mobility, equal opportunities, city policy, …) to define new measures that will help to reduce possible inequalities in traffic safety in Belgium. The ultimate objective of the project is thus to improve public health and safety in general and of disadvantaged social or cultural groups in particular.

A data warehouse was constructed that integrates information on different levels of aggregation. This data warehouse provides a structure which allows adding new relevant data. This will aid future research on the topic.

2. STATE OF THE ART AND OBJECTIVES

State of the art

Across nations worldwide, we can see differences in the number of road traffic accidents occurring and in traffic safety outcomes. In the past these differences have been partly attributed to cultural and socioeconomic differences (Leviäkangas, 1998). To explain the higher accident involvement in developing countries for instance: these countries face rapid urbanization and motorization with higher speeds and a diverse vehicle mix on the roads (Hyder & Peden, 2003), but physical road infrastructure, vehicle standards and enforcement of road traffic regulations are not always adapted at the same pace (Racioppi et al., 2004). On the other hand, explanations are found in cultural differences between the countries. Cultural traditions within countries have an effect on safety behaviours (Bener & Crundall, 2005) and may accordingly have relevance for the variability in accident frequencies (Nordfjærn et al., 2012).

Cultural and socioeconomic factors do not only produce differences in accident involvement between countries, they also seem to play a role in differences in accident involvement within countries. A large amount of literature points to the different road accident involvement for different cultural groups within countries. This research often concentrates on ethnic minorities in a country (e.g. Henley & Harrison, 2013; Campos-Outcalt et al., 2003; Stirbu et al., 2006). Socioeconomic differences in accident involvement are present in the literature to the same degree as cultural differences(e.g. Zambon & Hasselberg, 2006; Moradi et al., 2017; Factor et al., 2008). Socioeconomic characteristics and ethnicity also seem to influence the types of accident people have (e.g. Factor et al., 2010; Hasselberg et al., 2005; Norris et al., 2000). Based on the above mentioned literature, we can conclude that it has been demonstrated that lower socioeconomic groups and ethnic minorities are often significantly overrepresented in traffic accidents.

Möller et al. (2015) highlight the persistence of inequalities in morbidity and mortality from unintentional injury between indigenous and non-indigenous children across different communities worldwide. One of their conclusions is that comparing the earliest studies from the late 1980s with the most recent studies, it is shown that little progress in reducing these inequalities has been achieved in the last 35 years. Harper et al. (2015) examine trends in education-related inequalities in US motor vehicle accident death rates from 1995 to 2010. Although overall motor vehicle accident death rates declined during this period, socioeconomic differences in motor vehicle accident mortality have persisted or worsened over time. Karb et al. (2016) document area-based socioeconomic disparities in injury mortality across categories of unintentional injury, including motor vehicle collisions, from 1999-2012 and conclude that there is also a trend of increasing areal socioeconomic inequality.

Road accident involvement is a complex problem in which road user and environment characteristics (both social and physical) interact. Where it has been amply demonstrated that lower socioeconomic groups and ethnic minorities are significantly overrepresented in traffic accidents, the factors associated with the elevated risks are only poorly documented. The World Health Organization (Laflamme et al., 2009) concluded its review on socioeconomic differences in injury risk (not only traffic injuries) with the thesis that the distribution of explanatory and protective factors across socioeconomic groups has been studied to a limited extent and that the literature consequently remains silent regarding the nature of the mechanisms lying behind socioeconomic differences in injury mortality and morbidity. For cultural differences, it’s a similar story. Consequently the research at hand provides a poor evidence base for the reduction of socioeconomic and cultural differences in injury risks.

Over the last several decades, studies in traffic safety have been successful in identifying associations between socioeconomic or cultural groups and several risk factors. Mostly, this research has focused attention on risk factors that are relatively proximal behavioural causes of accidents or of severity of outcomes, such as non-use of seatbelt (e.g. Moradi et al., 2014; Lerner et al., 2001; Leveque et al., 2004; Chu, 2004), non-use of helmet (e.g. Haqverdi et al., 2015; Sullins et al., 2014), drunk driving (e.g. Møller et al., 2015; Braver, 2003; Morrison et al., 2002; Vaez & Laflamme, 2005) and non-use of child car seat (e.g. Rok Simon et al., 2017). Elias et al. (2016) point to some shortcomings in relying on this kind of correlational studies to explain the inequalities in accident involvement. They raise caution for neglecting the individual mechanisms actually underlying risky driving behaviours and for the interpretation of correlations as causal relationships. In other words: researchers have to look for the mechanisms that make clear why people behave like they do instead of staying with the behaviours per se. Doing so, they will probably see that dangerous behaviours are only a small, often latest chain in a mechanism that has to be dealt with entirely in order to prevent future accidents.

Factor et al. (2008) propose to develop a variety of qualitative research studies in order to explore social and cultural mechanisms that could produce inter-group differences. The authors propose in-depth interviews or focus groups with scenarios representing different events while driving as starting point. From the reactions of the interviewees, it may be possible to learn about their attitudes, the reasons for their choosing different behaviours and their decision-making process. In order to understand the actual behaviour of different social groups, it might – according to the authors – also be helpful to design a computerized simulation that would simulate driving in a variety of scenarios, including interactions between two drivers with the simultaneous use of two computers. After the groups' particular sociocultural characteristics are explored, it would be possible to develop, for example, customized intervention and prevention programs for school pupils that would focus on different sociocultural groups. Examples of focus group or interview research are Christie et al. (2007), Moran et al. (2010) and Baron-Epel et al. (2016).

Another way of dealing with the mechanisms behind accident involvement, is with multivariate mediational studies in which predictors and/or correlates of accident involvement are classified on the basis of their proximal and distal role in accident causation. Sümer (2003) proposes a model wherein the proximal context includes both stable (e.g. driving style, attitudes) and transitory (e.g. drinking) factors, which are closely related to accident tendency, and wherein the distal context consists of cultural factors (e.g. safety attitudes, political and enforcement environment), sociodemographic factors (e.g. age and type of driver, road, vehicle, other environmental factors), relatively stable personality factors (e.g. sensation seeking, risk taking, psychopathology, aggression, fatalism) and cognitive factors (e.g. attributions regarding accident causation), which indirectly contribute to accident causation and predict accidents via proximal factors. Desrichard et al. (2007) point in this respect to the Theory of Planned Behavior as a suitable theory, with attitudes, subjective norms, perceived behavioural control and intentions as determinants of behaviour and mediators for the effect of distal factors on behaviour and accident involvement. Shin et al. (1999), MacKenzie et al. (2015), Ulleberg and Rundmo (2003), Nordfjærn and Şimşekoğlu (2013), Nordfjærn et al. (2014) are examples of authors using attitudes in mediational studies, intending to explain differences in risk taking driving behaviours between socioeconomic and/or cultural groups.

The main objective of our present study was to reveal also some of the mechanisms that explain the differences that occur in road accident involvement. Since little or no studies have been conducted on the socioeconomic and cultural differences in road accident involvement in Belgium, this theme comprised a large part of the research. A rare study concerning the Belgian differences was the one of Borrell et al. (2005), according to the authors the first attempt to compare the differential impact of traffic fatalities by education among different European settings. More concrete, the objective was to study the differential distribution of transportation injury mortality by educational level in nine European settings (with Belgium as one of them) among middle aged and elderly men and women during the 1990s. Conclusions of the study were that in men, those with a low educational level had higher death rates in all settings. No differences were found among educational levels in the three female age groups that were studied. Only three settings (Finland, Belgium and Austria) had a high mortality rate ratio (low versus middle/high level of education) in the youngest age group, i.e. 30-49 years.

In the next paragraph, we will further explain the objectives of our study in detail.

Objectives

Three work packages were defined, all of them with their own objectives.

Work package 1 involved firstly the conceptualisation of the theme of socioeconomic and cultural differences in accident involvement and secondly the exploration of the extent of the problem in Belgium. As first step in the research an elaborate conceptual framework was constructed from the main theories described in international literature. This model also provided a grip for the remaining tasks throughout the different work packages, since from this model a number of explanatory linkages came to the fore.

Two approaches were followed to study the extent of the problem of inequalities in traffic safety for Belgium. A first approach defined inequality on the level of the neighbourhood or municipality. The main research question was whether more accidents occur in deprived neighbourhoods compared to less deprived areas. Regression models were constructed that describe the number of accidents (of a certain type) in a neighbourhood as a function of some neighbourhood characteristics (including measures of deprivation, population densities, share of foreign nationalities, etc.). For the second approach stated accident involvement was studied on the individual level. In some of the Flemish travel surveys a question was dedicated to the accident involvement of the respondents. These data were used to study the effect of socioeconomic characteristics (next to demographic characteristics like age and gender) of the individual (and the household he belongs to) on accident involvement through logistic modeling.

Objectives of work package 1:

- Creation of an elaborate conceptual framework that integrates the main theories described in international literature and gives an overview and operationalisation of the different dimensions and scales that exist within the issues of socioeconomic differences, culture and inequality.
- Exploration of possible socioeconomic or cultural inequalities in accident involvement in Belgium, on the neighbourhood level and on the individual level.

The second work package went deeper into the underlying mechanisms for inequalities found in work package 1. Some of the mechanisms that were identified in the first work package were further investigated in a Belgian context in 2 cases.

The first case studied whether (and to what extent) mobility patterns differ among people with different nationalities and different socioeconomic background, and to what extent this is influenced by the neighbourhood characteristics. Individual variables – besides nationality – that were included were for instance household size and composition, income, work status, education, age and gender. Neighbourhood variables were socioeconomic level, availability of public transportation and services. Different mobility indicators were studied (e.g. use of transport means, distance travelled…). These mobility indicators were linked to the available explanatory variables through logistic and other regression models.

A second case within this work package mainly focused on inequalities that can be found in unsafe behaviour and unfavourable attitudes. The main focus of this case was the study of the impact of socioeconomic and cultural factors on the determinants of unsafe road user behaviour. Since there are no data available in Belgium that allow to link differences in attitudes to road users' ethnic background, the task was conducted on the basis of an ad hoc developed survey questionnaire, based on two Theory of Planned Behavior questionnaires for speeding that have already been validated in Flanders (Paris & Van den Broucke, 2008 and De Pelsmacker & Janssens, 2007). Different groups of ethnical origin were considered: Belgian, West-European, South-European, East-European, Turkish, Moroccan and Sub-Saharan African & Egyptian. Other factors that were included in the questionnaire were socioeconomic variables, demographic variables, vehicle kilometers by vehicle type, exposure to and experience of road safety measures within the fields of Education (both scholarly as with regard to awareness-raising campaigns), Enforcement and Engineering (safety features at vehicle and road infrastructure level).

Objectives of work package 2:

- Study of differences in mobility patterns among people with different nationalities and different socioeconomic background, and to which extent this is influenced by neighbourhood characteristics.
- Study of the impact of socioeconomic and cultural factors on attitudes regarding speeding, which are seen as possible determinants of unsafe behaviour and accident involvement.

In work package 3 methodological issues were addressed to combine data in such a manner that a maximum of information can be obtained from them. It involved the creation of a data warehouse for Belgium in which data from various sources, at different levels of aggregation are collected. Until now virtually no integration efforts have been made to fully exploit the richness of the variety of available data resources, which range from aggregate accident data to individual safety behaviour and attitude records. The main task within this work package was therefore the development of a methodology for data-integration that is resource-friendly and explicitly takes into account model uncertainty.

The first task in this work package was the identification of the available data sources. In this regard, we can discriminate between primary data resources – which range from individual attitude data and accident reports to aggregate traffic safety data – and secondary data that focus on the explanatory factors that are often associated with traffic accidents. In the explanatory factors, one can distinguish direct factors such as exposure measures, holidays (Van den Bossche, 2006), weather variables (Hermans et al., 2006; Brijs et al., 2008) and infrastructural aspects (e.g. Daniëls et al., 2008), as well as indirect factors which affect traffic safety through their impact on exposure measures, such as weather events (Cools et al., 2010) and public holidays (Cools et al., 2007).

After identifying all the relevant data sources and the contact persons that are in charge of the dissemination of the data sources, a data warehouse was created to facilitate the development of an integrated analysis framework. Next the actual methodological framework was constructed. By combining data from different sources a richer dataset was obtained, giving the opportunity to include more relevant parameters into analyses. A methodological report was written in which the different steps that were taken to construct the integrated dataset are thoroughly described, so other researchers can adopt the followed methodology.

Objectives of work package 3:

- Development of an integrated traffic safety data analysis framework for Belgium.
- Outline of the followed methodology for other researchers.

3. METHODOLOGY

Work package 1

Work package 1 consisted of an international literature study (Task 1.1) and of two studies about inequalities in traffic safety in Belgium (Tasks 1.2.1 and 1.2.2). The used methodology for each of these tasks will be outlined in the next paragraphs.

Task 1.1: Conceptual framework

The international literature study aimed to provide a conceptual framework for research about inequality in traffic safety, in particular inequality in traffic safety for different socioeconomic and cultural groups.

The framework was first of all built on definitions of concepts concerning culture and socioeconomic characteristics and on the elaboration or measurement of these concepts in research. As a next step, determinants and mechanisms in the broader field of health and health inequalities were described. Finally, these determinants and mechanisms were used as a basis for similar determinants and mechanisms in traffic safety. The report ends with examples of models that are useful to investigate and explain inequality in traffic safety.

The literature search and selection followed an informal, rather inductive method, with some basic references (e.g. Laflamme, Burrows & Hasselberg, 2009; Factor, Mahalel & Yair, 2007; Steinbach et al., 2010) as a starting point. It ended the moment that the framework seemed solid and meaningful. We did not intend to give a complete overview of the literature available in the field of cultural and socioeconomic differences in health or traffic safety.

The result of this task can be summarized in the following questions:

- Conceptualisation: What are we considering?
- Does socioeconomic status relate to traffic safety?
- Does culture relate to traffic safety?
- In case of “Yes”: How do socioeconomic status and culture relate to traffic safety?

Task 1.2.1: Inequalities in traffic safety in Belgium on neighbourhood level

The main objective of this study was to determine the differences in associations between predictive variables and injury crashes (i.e. including injury and fatal crashes) in Flanders. It was set up establishing the association between traffic casualties and sociodemographic characteristics, socioeconomic characteristics, traffic exposure data and road network variables, at the neighbourhood level (Traffic Analysis Zones, TAZs) while categorized by different genders and transport modes (‘car driver’, ‘car passenger’ and ‘active mode users’ i.e. pedestrians and cyclists). The included socioeconomic variables per TAZ were income level, car ownership, number of employees, number of school children, population and driving license possession. These variables were extensively scrutinized in the literature, which justifies the choice for including them in the initial analysis. Each of these variables has either a causal relationship with traffic casualties or can serve as a proxy measure for other variables of interest.

All socioeconomic variables were collected for each household in the entire study area and were then geographically aggregated to a macroscopic level. This has been carried out at zonal level, comprising 2200 TAZs in Flanders. The average size of TAZs is 6.09 square kilometres with standard deviation of 4.78 square kilometres and the average number of inhabitants equal to 2416 persons. Moreover, for each TAZ a set of road network variables was collected. The crash data used in this study consist of casualties derived from a geo-coded set of fatal and injury crashes that occurred during the period 2010 to 2012. The data were provided by Statistics Belgium and by the Flemish Ministry of Mobility and Public Works. Table I shows a list of selected variables, together with their definition and descriptive statistics as they have been used in the study.

In addition to the abovementioned variables, an activity-based model within the FEATHERS (Forecasting Evolutionary Activity-Travel of Households and their Environmental RepercussionS) framework (Janssens et al.,2007) was applied to the Flemish population. This was done to derive more in-depth information on Flemish peoples' travel behaviour and demand. A sequence of 26 decision trees was used in the scheduling process, which was derived from observed travel behaviour, by means of the chi-squared automatic interaction detector (CHAID) algorithm. Decisions were based on a number of attributes of the individuals (e.g. age, gender), of the household (e.g. available number of cars) and of the geographical zone (e.g. population density, number of shops). The model simulates whether an activity (e.g. shopping, working, leisure activity, etc.) will be carried out or not for each individual with its specific attributes. Subsequently, amongst others, the location, transport mode, start time and duration of the activity are determined, taking into account the attributes of the individual (Kochan et al., 2008). FEATHERS produces for each individual in the population a schedule consisting of a listing of all consecutive activities and trips during the day. When schedules of all individuals are predicted, it becomes possible to derive traffic demand in the form of origin-destination (OD) matrices. These OD matrices include the number of trips for each traffic mode at different segmentation levels (i.e. age, gender, day of the week, time of day, and trip motive). Within the context of this study, the FEATHERS model output was labelled as "Exposure variable" and is also presented in Table I.

The FEATHERS system is equipped with a dedicated data module. The data module provides access to the data that needs to be accessible throughout all other modules' activities inside the FEATHERS. Four major types of data are provided by the data module, namely: observed travel behaviour data, level-of-service data, land-use data, and microscopic population data (Bellemans et al., 2010). Observed travel behaviour input data is used in order to estimate FEATHERS' sub-models so that person's travel behaviour in the study area can be captured and used in future forecasts. The observed travel behaviour data used in FEATHERS was collected by the Flemish government and is called "Onderzoek VerplaatsingsGedrag" (OVG) (Moons, 2009). The OVG data has been collected from August 2007 till June 2008 and comprises four random samples of the Flemish population.

Table I: List of explanatory variables with their definition and descriptive statistics

	Variable	Definition	Average	Min	Max	SD[a]
Dependent variables	Cas_CD_M	total casualties of male car drivers observed in a TAZ	23.52	0	274	28.73
	Cas_CD_F	total casualties of female car drivers observed in a TAZ	14.16	0	156	17.10
	Cas_CP_M	total casualties of male car passengers observed in a TAZ	2.97	0	37	3.94
	Cas_CP_F	total casualties of female car passengers observed in a TAZ	4.70	0	53	6.13
	Cas_SL_M	total casualties of male active mode users observed in a TAZ	9.29	0	156	14.39
	Cas_SL_F	total casualties of female active mode users observed in a TAZ	5.74	0	142	11.11
Exposure variables	Exp_CD_M	daily produced/attracted trips by male car drivers in a TAZ	1620.73	1	15414	1546.7
	Exp_CD_F	daily produced/attracted trips by female car drivers in a TAZ	1129.36	1	7236	1099.2
	Exp_CP_M	daily produced/attracted trips by male car passengers in a TAZ	202.42	1	1210	194.36
	Exp_CP_F	daily produced/attracted trips by female car passengers in a TAZ	481.94	1	2876	451.76
	Exp_SL_M	daily produced/attracted trips by male active mode users in a TAZ	523.13	1	4016	610.84
	Exp_SL_F	daily produced/attracted trips by female active mode users in a TAZ	580.27	1	4846	706.56
Network variables	Speed	average speed limit in a TAZ (km/hr)	69.4	30	120	10.91
	Capacity	hourly average capacity of links in a TAZ	1790.1	1200	7348.1	554.6
	Area	total area of a TAZ in square kilometers	6.09	0.09	45.22	4.78
	Link Length	total length of the road network in a TAZ (km)	15.86	0.39	87.95	10.79
	Intersection	total number of intersections in a TAZ	5.8	0	40	5.9
	Motorway	presence of motorway in a TAZ describes as below: 'No' represented by 0 'Yes' represented by 1	0	0	1	-[b]
	Urban	Is the TAZ in an urban area? 'No' represented by 0 'Yes' represented by 1	0	0	1	-
	Suburban	Is the TAZ in a suburban area? 'No' represented by 0 'Yes' represented by 1	0	0	1	-
Socioeconomic variables	Driving License	average driving license ownership in a TAZ describes as below: 'No' represented by 0 'Yes' represented by 1	1	0	1	-
	Income Level	average income of residents in a TAZ describes as below: 'Monthly salary less than 2249 Euro' represented by 0 'Monthly salary more than 2250 Euro' represented by 1	1	0	1	-
	School Children	total number of school children in a TAZ	364.09	0	9245	772.4
	Population	total number of inhabitants in a TAZ	2614.52	0	15803	2582.1
	Employees	total number of employees in a TAZ	888.73	0	16286	1574.9
	Car Ownership	average car ownership per household in a TAZ	1.13	0	14	0.47
	Total Cars	Total private cars owned by households of a TAZ	1119.26	0	6772	1057.6

a: Standard deviation b: Data not applicable.

The raw data format of the OVG data is not directly readable by FEATHERS. Hence, a pre-processing step is needed to create so-called diaries, a term commonly used in the domain of activity-based modelling. These diaries are the input format for FEATHERS. In case FEATHERS receives such diaries, it is able to estimate sub-models based on these data in order to capture travel behaviour that can be used in a later stage to predict travel behaviour for the full Flemish population. Level-of-service (LOS) data is a qualitative measure used to describe the quality of traffic service for different kinds of available transport modes. These level-of-services have an impact on choices people make when choosing a transport option or alternative for their commute trips, leisure trips, etc. The availability of LOS data allows to implement LOS related scenarios where one can alter measurements of LOS. These alterations will then have impacts on personal choices. The LOS data used in FEATHERS was derived by Significance, a Dutch research institute located at The Hague with strong expertise in quantitative research on mobility and transport. Land-use data contains information on geographical zones in the study area such as the attractiveness of a zone for conducting certain activities. In FEATHERS, land-use data help to determine where people can perform their activities. Individuals can often choose between various locations to conduct their activities. At the same time, however, the physical system restricts human behaviour. The fact that a particular location only has a single function, implies that only one activity type can be conducted at that location. Land-use data is, therefore, required to represent the opportunities available to travellers. During the activity-travel scheduling process inside FEATHERS, the availability of locations is determined based on sector employment size at the lowest possible geographical level. Microscopic population data is an important input for FEATHERS as it is the starting point for predicting person activity/trip schedules. It is typically used in activity-based modelling as opposed to traditional models where person information is commonly aggregated on the zonal level. In FEATHERS, individuals are characterized by a set of attributes such as their age, gender, driving license possession, etc. These person attributes are then used to start modelling the activities and the trips that people perform throughout the day. In Flanders, we employed the CENSUS data provided by the government, which was collected for all individuals residing in Flanders.

FEATHERS is an implementation of an activity-based demand model that simulates individuals' daily activity-travel schedules, which are consistent in time and space (Bellemans et al., 2010). FEATHERS succeeds in this by gradually building a schedule for a day starting from scratch by sequentially modelling various activity-related decisions such as: decision to go to work, at what time, where, with which transport mode, whether or not to have a lunch break, and so on. When making these decisions, characteristics of the individual together with the information of its household and the environment (including the access to different transport modes) are taken into account. FEATHERS makes all of these decisions while taking into account constraints in terms of time (no overlapping activities), space (you can only perform activities in one place at a time), time-space (travel takes time and is not instantaneous, so typically only a subset of locations are within reach given a finite time window of opportunity) and social constraints (household composition, availability of transport modes to household members). The result is a detailed listing of what individuals do (in terms of activities and trips) throughout the day, and this for each member of the population in the study area. As a result, travel demand can be derived for the entire population and be segmented according to any desired dimension.

After the collection of all needed variables per TAZ, the phase of model development for crash counts or casualties started. The negative binomial (NB) model which allows the variance to differ from the mean was applied as an extension of the Poisson model. The NB model is the most commonly used model in crash data modelling when over-dispersion is observed (Lord & Mannering, 2010). Several models were constructed by regressing the casualty counts of different road users in each TAZ together with other socioeconomic network variables on the natural logarithmic transformation of produced/attracted trips, with the latter operating as the exposure variables. Zonal Crash Prediction Models (ZCPMs) were developed for 'car driver', 'car passenger' and 'active mode user' as transportation modes and for males vs. females separately, in order to find the relationships between casualties of different road users and the explanatory variables.

A summary of the research questions in this task is:

- Does socioeconomic status relate to traffic safety at neighbourhood level in Flanders?
- In case of "Yes": To what extent does socioeconomic status relate to traffic safety at neighbourhood level in Flanders? and
- How does socioeconomic status relate to traffic safety at neighbourhood level in Flanders?

Task 1.2.2: Inequalities in traffic safety in Belgium on the individual level

In this part of the research, stated accident involvement was studied on the individual level with the aim of finding associations between socioeconomic characteristics (next to demographic characteristics like age and gender) of the individual (and the household he belongs to) and accident involvement. Furthermore, a mechanism that could explain these associations was involved in the study, in the form of self-reported behaviours and individual attitudes.

For Belgium, two datasets were available which we could use in this study: the Vias Attitude survey 2015 and the Vias Unsafety Barometer 2015 (part of ESRA-survey). The Attitude survey 2015 was conducted on 1537 Belgian car drivers, for which the mean distance driven over the past six months was 7340 km, with a median of 5000 km, a minimum of 1500 km and a maximum of 90000 km. In Table II, we describe the sample of the Attitude survey.

Table II: Sample description Attitude survey 2015 (Vias)

Gender	Frequency	Percent
Male	757	49.25
Female	780	50.75

Age	Frequency	Percent
18-29	280	18.22
30-38	235	15.29
39-49	319	20.75
50-62	332	21.60
63-76	264	17.18
77+	107	6.96

Region	Frequency	Percent
Flanders	717	46.65
Wallonia	515	33.51
Brussels	305	19.84

The Unsafety Barometer 2015 was conducted on 630 Belgian car drivers, which had a mean distance driven over the past six months of 7705 km, with a median of 5450 km, a minimum of 1500 km and a maximum of 85000 km. The sample description can be found in Table III.

Table III: Sample description Unsafety Barometer 2015 (Vias)

Gender	Frequency	Percent
Male	372	59.05
Female	258	40.95

Age	Frequency	Percent
18-24y	26	4.13
25-34y	100	15.87
35-44y	85	13.49
45-54y	197	31.27
55+	222	35.24

Region	Frequency	Percent
Flanders	377	59.84
Wallonia	210	33.33
Brussels	43	6.83

Through logistic modelling, we first of all examined which individual characteristics (gender, age, province, region, diploma, driving frequency, driven distance in the last 6 months) influence the accident involvement as a car driver. To gain insight in mechanisms behind this influence, we examined in a next step how the aforementioned characteristics influence self-reported behaviour and attitudes concerning alcohol, speed, seat belt use, use of child safety systems and distraction while driving. The only available socioeconomic characteristic was diploma. We need to highlight the fact that the operationalisation of diploma in categories differed for the two datasets. They are presented in Table IV and V respectively.

Table IV: Operationalisation of diploma in Attitude survey 2015 (Vias)

Diploma	Frequency	Percent
Primary	103	6.79
Lower secondary	155	10.22
Higher secondary	441	29.09
Lower professional	60	3.96
Higher professional	153	10.09
Higher non-university	403	26.58
University	201	13.26

Notice that only 4% of the respondents have a lower professional diploma and only 6.8% a primary school diploma as highest certification.

Table V: Operationalisation of diploma in Unsafety Barometer 2015 (Vias)

Diploma	Frequency	Percent
Primary education	21	3.33
Secondary education	369	58.57
Bachelor's degree or similar	160	25.40
Master's degree or higher	80	12.70

Notice that only 3% of the respondents have a primary education diploma as highest certification.

Both operationalisations of diploma are comparable in the following manner: primary equals primary education. Lower and higher secondary and lower professional are all secondary education. Higher non-university is the same as a bachelor's degree and university is a master's degree. Only higher professional, mentioned in the first operationalisation, does not have an equal certification in the second operationalisation. In fact, it is situated between secondary education and bachelor's degree.

In Tables VI-IX, all independent and dependent variables for the logistic regressions are outlined.

Table VI: Independent variables

	Attitude survey 2015	**Unsafety Barometer 2015**
Gender	**Q4**: male/female	**V001**: male/female
Age category	**Q5LT_groep**: 18-29/30-38/39-49/50-62/63-76/77+	**Age_5category**: 18-24/25-34/35-44/45-54/55+
Province	**Q6_Province**: Brussel/ Waals-Brabant/ Vlaams Brabant/ Antwerpen/ Limburg/ Luik/ Namen/ Henegouwen/ Luxemburg/ West-Vlaanderen/ Oost-Vlaanderen	**Province**: Brussel/ Waals-Brabant/ Vlaams Brabant/ Antwerpen/ Limburg/ Luik/ Namen/ Henegouwen/ Luxemburg/ West-Vlaanderen/ Oost-Vlaanderen
Region	**Q6_Gewest**: Flanders/Wallonia/Brussels	**Region**: Flanders/Wallonia/Brussels
Diploma	**QG26**: Primary school/secondary lower level/secondary higher level/lower professional/higher professional/higher non university/university	**V027**: Primary education/secondary education/bachelor's degree or similar/Master's degree or higher

How often do you drive a car?	**QG27**: at least 4d days a week/1 to 3 days a week/few days a month/few days per year/never	**V004**: at least 4d days a week/1 to 3 days a week/few days a month/few days per year/never
Day of week	**S_JSE**: Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, Sunday	NA
Kilometers driven over the past 6 months	**Km1000**: kilometers divided by 1000	**Km1000**: kilometers divided by 1000

Table VII: Dependent variable accident involvement

Attitude survey 2015	**Unsafety Barometer 2015**
Q24_nieuw. Were you involved in a traffic accident over the past 3 months?	**V022_7.** Were you involved in a traffic accident as car driver over the past 3 months?
Q24_7. Were you involved in a traffic accident as car driver over the past 3 months?	

Table VIII : Dependent variables behaviour

	Attitude survey 2015	**Unsafety Barometer 2015**
Alcohol/drugs	**QB12** How often over the past 12 months were you checked for alcohol?	**V025** How often were you checked for alcohol in the past 12 months?
	QB13 How many days in the past 30 days did you drive with to high alcohol promillage?	**V016_1** How often in the past 30 days did you drive with possibly over legal limit for drinking and driving?
		V015_14 How often in past 12 months did you drive after consuming alcohol?
		V015_15 How often in the past 12 months did you drive after using illegal drugs?
Speed	**QC15_a** How often over the past year did you drive 140 km/h on motorways?	**V015_13** How often over the past year did you drive faster than the speed limit on motorways?
	QC15_b How often over the past year did you drive 70 km/h in built area (BIBEKO)?	**V015_11** How often over the past year did you drive faster than the speed limit in built area (BIBEKO)?
	QC15_c How often over the past year did you drive 50 km/h where 30 km/h	

	Attitude survey 2015	Unsafety Barometer 2015
	was allowed?	
	QC15_d How often over the past year did you drive up to 10 km/h above the legal limit?	
		V015_12 How often over the past year did you drive faster than the speed limit outside built area (BUBEKO not on motorways)?
Seat belt	**QD18b_1** How often do you wear your seat belt as car driver?	**V015_1** How often over the past year did you wear your seat belt as car driver?
	QD18b_2 How often do you wear your seat belt as car passenger in the front?	**V015_2** How often over the past year did you wear your seat belt as car passenger in the front?
	QD18b_3 How often do you wear your seat belt as car passenger in the back?	**V015_3** How often over the past year did you wear your seat belt as car passenger in the back?
	QD20 When you drive a child in your car, how often do you use the correct safety system?	**V015_4** How often over the past year, did you make children (under 150cm) travelling with you use appropriate restraint (child seat, cushion)?
Distraction	**QE22_a** How often in the past 12 months did you talk on hands-free mobile phone?	**V015_17** How often in the past 12 months did you talk on hands-free mobile phone?
	QE22_b How often did you call hand-held over the past year?	**V015_16** How often in the past 12 months did you talk on hand-held mobile phone?
	QE22_c How often did you read sms, message or e-mail over the past year?	**V015_18** How often in the past 12 months did you read text message or e-mail?
	QE22_d How often did you send sms, message or e-mail over the past year?	**V015_19** How often in the past 12 months did you send text message or e-mail?

Table IX: Dependent variables attitudes

	Attitude survey 2015	Unsafety Barometer 2015
Alcohol/drugs	**QB14_a** Driving under influence of alcohol seriously increases the risk for an accident.	**V017_1** Driving under influence of alcohol seriously increases the risk for an accident.
	QB14_b Most of my friends find driving under influence of alcohol	**V017_2** Most of my friends find driving under influence of alcohol unacceptable

	Attitude survey 2015	Unsafety Barometer 2015
	unacceptable.	
	QB14_c If you drive under influence of alcohol, it is difficult to react correctly in a dangerous situation.	**V017_3** If you drive under influence of alcohol, it is difficult to react correctly in a dangerous situation.
		V017_4 Driving under influence of drugs increases the risk for an accident seriously.
		V017_5 Most of my friends find driving under influence of drugs unacceptable.
		V017_6 I know very well my own limit of drug use to be able to drive safely.
Speed	**QC16_a** Driving fast is socially unacceptable.	
	QC16_b Driving fast is putting your own life and that of others at risk.	**V017_7** Driving fast is putting your own life and that of others at risk.
	QC17_a I have to drive fast, otherwise I get the impression of wasting time.	**V017_8** I have to drive fast, otherwise I get the impression of wasting time.
	QC17_b If one drives faster than the speed limit, it is difficult to react correctly in a dangerous situation.	**V017_9** Driving faster than the speed limit, makes it more difficult to react correctly in a dangerous situation.
	QC17_c Most of my friends think that speed limits should be respected.	**V017_10** Most of my friends think that speed limits should be respected.
	QC17_d Speed limits are usually set at acceptable levels.	**V017_11** Speed limits are usually set at acceptable levels.
	QC17_e If you increase your speed by 10 km/h, you have a seriously higher chance to have an accident.	**V017_12** If you increase your speed by 10 km/h, you have a seriously higher chance to have an accident.
Seat belt	**QD19b_a** It is not necessary to wear a seat belt in the back.	**V017_13** It is not necessary to wear a seat belt in the back.
	QD19b_b I always ask my passengers to wear their seat belt.	**V017_14** I always ask my passengers to wear their seat belt.
	QD21_a The instructions for use of child's seats are unclear.	**V017_15** The instructions for use of child's seats are unclear.
	QD21_b It is dangerous to drive a child that is not attached in the correct way.	**V017_16** It is dangerous to drive a child that is not attached in the correct way.
	QD21_c For short trips it is not	**V017_17** For short trips it is not really

	Attitude survey 2015	Unsafety Barometer 2015
	really necessary to use the correct child safety system.	necessary to use the correct child safety system.
Distraction	**QE23_a** Your attention for traffic decreases if you call hands-free while driving.	**V017_18** My attention for traffic decreases if I call hands-free while driving.
	QE23_b Your attention for traffic decreases if you call hand-held while driving.	**V017_19** My attention for traffic decreases if I call hand-held while driving.
	QE23_c Almost all car drivers every now and then call hand-held while driving.	**V017_20** Almost all car drivers occasionally call hand-held while driving.
	QE23_d People who call hand-held while driving, run a higher risk to be involved in a car accident.	**V017_21** People who call hand-held while driving, run a higher risk to be involved in a car accident.
		V017_22 When I feel sleepy, I should not drive a car.
		V017_23 Even if I feel sleepy while driving, I will continue driving.
		V017_24 When I feel sleepy while driving, there is a higher risk to be involved in an accident.

Models were built to find out which independent variables, and eventually interactions, had a significant influence on the dependent variables. For car accident involvement, we had 1 model for the Attitude survey 2015 and 1 model for the Unsafety Barometer 2015. For self-reported behaviours, we had 13 models for the Attitude survey 2015 and also 13 models for the Unsafety Barometer 2015. For attitudes finally, we had 19 models for the Attitude survey 2015 and 17 models for the Unsafety Barometer 2015. According to the type of the dependent variable, the type of analysis was chosen: Poisson regression for counts, logistic regression for dichotomous endpoints and cumulative logit for ordered multinomial responses. In each of the analyses the same set of candidate explanatory variables was considered at the start of the model building process. First a stepwise procedure was used to select the significant main effects. Next all possible two-way interactions of the significant main effects were tested and kept if significant.

The main research questions that were considered at the end were:

- Does diploma influence stated car accident involvement?
- Does diploma influence self-reported behaviours concerning alcohol impaired driving, speeding, seatbelt use, use of child safety systems and distraction while driving?

- Does diploma influence attitudes concerning alcohol, speeding, seatbelt use, use of child safety systems and distraction while driving?
- Do results for the above 3 questions replicate across the 2 surveys?

Work package 2

Work package 2 consisted of a study about the different traffic exposure of people with different national backgrounds (Task 2.1) and a study about inequalities in attitudes towards speeding (Task 2.2).

Task 2.1: Differences in traffic exposure

In this study, data stemming from the 2010 Belgian National Household Travel Survey were used to assess the effect of a traveller’s nationality on daily travel time expenditure. Negative binomial models were estimated to isolate the effect of nationality after other contributing factors such as sociodemographics, residential characteristics, transport options and temporal characteristics were controlled for. The research particularly focused on whether the total daily travel time expenditure (i.e. the travel time spent on all trips realized during the day of reporting, irrespective of the trip motive) as well as the daily travel time expenditure for the most common trip motives vary by nationality.

To assess the effect of nationality on daily travel time expenditure, data stemming from the 2010 Belgian National Household Travel Survey (BELDAM) were analyzed (Cornelis et al., 2012). For each individual, the daily travel time expenditure was defined as the sum of the duration of all trips performed during the day of reporting. The daily travel time expenditure was defined as zero for the respondents who indicated that they did not make any trip during the day of reporting. With respect to factors accounting for differences in daily travel time expenditure, it should be highlighted that information about nationality, the main factor of interest, was collected in the person questionnaire of the BELDAM survey. Given the fact that the BELDAM survey uses a random sample from the population residing in Belgium, the relative share of respondents with a nationality different from Belgian is relatively low. Therefore, the analysis focused only on the nationalities for which at least 30 individuals were surveyed. In particular, data from travellers with the following six nationalities were considered (the number of unweighted observations is reported in parentheses): Belgian (7399), Dutch (51), French (153), Italian (135), Moroccan (36) and Spanish (37). To account for the imbalance in the number of observations per nationality, a dedicated methodology was adopted (see further) to ensure that the relative weights of each group in the final analysis were equal and that there was optimal efficiency in the comparison of the different nationalities. Besides nationality, a series of other factors that have been indicated as contributing factors to travel time expenditure were incorporated in the data. These additional factors could be broadly categorized into sociodemographics, residential characteristics, transport options and mode use frequencies, and temporal characteristics. With respect to the sociodemographic factors, the age, gender, obtained educational level and professional activity of the respondents were considered for the analysis as well as the net monthly household income, the household size and whether the respondent had a partner or companion, children, or both. With regard to the residential characteristics, the urbanisation degree of the residence, dwelling type and ownership were taken into account. Concerning the transport options, the respondent’s possession of a season ticket for public transport and driver's license were considered as well as bike and car possession at the household level. Furthermore, whether the respondent's mobility was restricted because of impairments was explicitly considered. In addition, the frequency (defined as at least 4 days a week) of walking, biking, car use (either as driver or passenger) and public transit was assessed. Finally, in terms of temporal characteristics, the effect of weekend days and school holidays was taken into account as well as the travel time expenditure spent on the remaining trip motives (referred to as "travel time expenditure: other"). The last was defined as the difference between the total travel time expenditure and the travel time expenditure on trips for a given motive.

An overview of the basic descriptive statistics of the travel time expenditures per nationality and per trip motive is given in Table X. These expenditures only correspond to respondents who made at least one trip during the day of reporting, as was explained earlier. The share of respondents who did not make any trip during the day of reporting, defined as immobility, is also presented in Table X.

Table X: Daily travel expenditure in minutes by nationality

Expenditure	**Parameter**	**Belgian**	**Spanish**	**French**	**Italian**	**Moroccan**	**Dutch**
Total	Mean	80.0	75.0	100.0	67.8	82.2	99.4
	SD	6.1	45.9	48.5	27.1	85.6	56.8
Commuting	Mean	24.8	30.5	34.9	24.0	26.3	29.7
	SD	3.1	40.0	20.3	21.8	40.2	36.8
Shopping	Mean	12.0	13.8	11.8	8.6	15.7	12.7
	SD	3.1	27.4	13.5	9.1	33.7	19.8
Leisure	Mean	7.9	9.1	6.8	4.8	2.1	7.0
	SD	2.5	26.8	12.9	8.5	10.2	11.2
Visits	Mean	8.9	4.9	20.1	5.7	7.2	6.9
	SD	2.1	12.3	43.7	7.8	26.2	16.4

NOTE: Immobility: Belgian = 25.7%; Spanish = 19.6%; French = 23.5%; Italian = 32.5%; Moroccan = 35.7%; Dutch = 22.7%

Table XI provides an overview of the descriptive statistics of the remaining explanatory factors considered in the study. For the continuous variables, the correlation with travel time expenditure is given, whereas for the categorical explanatory variables the mean travel time expenditures are tabulated per category.

Table XI: Descriptive statistics for travel time expenditure and explanatory variables

Parameter	**Total**	**Commuting**	**Shopping**	**Leisure**	**Visits**
Continuous Pearson correlation					
Age	0.027	-0.157	0.174	-0.044	0.063
Household size	-0.066	0.038	-0.110	-0.009	-0.015
Travel time expenditure other	na	-0.291	-0.076	-0.068	-0.129
Categorical Av. expenditure (min.)					
Sociodemographics					
Gender: female	84.5	26.3	14.2	6.2	9.9
Gender: male	83.7	30.4	10.7	6.3	8.0
Higher education: yes	100.1	33.9	15.9	6.9	8.9
Higher education: no	72.3	24.3	9.9	5.9	9.0
Professional activity: yes	95.1	39.9	10.8	4.5	5.9
Professional activity: no	71.8	15.6	14.2	8.3	12.3

Net monthly HH income: €0-1499	79.1	19.6	12.5	7.8	9.4
Net monthly HH income: €1500-3999	88.3	29.4	14.2	6.4	12.0
Net monthly HH income: ≥€4000	88.2	35.3	8.9	5.8	4.8
Net monthly HH income: undeclared	64.7	30.4	11.4	2.5	1.2
Companion: yes	88.9	28.6	15.0	4.9	9.2
Companion: no	77.7	28.0	9.1	8.1	8.6
Child(ren): yes	87.2	28.9	11.1	5.8	6.5
Child(ren): no	82.7	28.1	13.0	6.5	10.0
Residential characteristics					
Urbanisation: urban	81.5	28.0	12.4	6.1	9.5
Urbanisation: suburban, rural	90.0	29.3	12.5	6.7	7.7
HH dwelling ownership: yes	82.3	27.2	12.1	5.0	10.8
HH dwelling ownership: no	86.9	30.3	13.1	8.5	5.8
Detached house: yes	89.7	24.9	14.6	6.6	7.4
Detached house: no	82.6	29.3	11.9	6.2	9.3
Transport options and mode use frequencies					
Season ticket public transport: yes	103.6	39.3	13.8	8.7	11.3
Season ticket public transport: no	76.5	24.2	11.9	5.4	8.0
Car driver's licence: yes	91.7	29.2	14.3	5.6	9.7
Car driver's licence: no	63.1	26.1	7.3	8.2	6.9
Mobility restraints: yes	59.7	23.1	10.0	6.1	9.2
Mobility restraints: no	88.9	29.4	12.9	6.3	8.9
Bike possession: yes	92.1	31.5	12.2	6.9	9.3
Bike possession: no	66.2	21.3	13.0	4.9	8.3
Car possession: yes	84.1	28.3	13.2	5.6	8.8
Car possession: no	83.7	28.7	9.4	9.1	9.4
Frequent walking: yes	86.9	26.7	13.5	7.0	9.7
Frequent walking: no	74.0	34.3	8.5	3.9	6.4
Frequent cycling: yes	90.3	24.5	12.8	14.2	9.9
Frequent cycling: no	82.4	29.4	12.3	4.2	8.7
Frequent public transit use: yes	93.7	37.0	11.9	7.5	6.4
Frequent public transit use: no	76.9	22.0	12.8	5.4	10.8
Frequent car use: yes	86.3	27.0	13.3	5.0	10.0
Frequent car use: no	76.3	33.0	9.4	10.7	5.3
Temporal characteristics					
Weekend day: yes	75.1	9.1	16.5	12.1	11.0
Weekend day: no	87.1	35.0	11.0	4.3	8.2
School holiday: yes	80.5	29.9	7.9	3.3	17.1
School holiday: no	84.7	28.1	13.3	6.8	7.4

NOTE: na = not applicable; HH = household

To investigate the effect of contributing factors on the variability of daily travel time expenditure, and to assess the effect of traveller's nationality in particular, five (zero-inflated) negative binomial models were fitted. As noted in the data description, two sets of weights were used in the analysis. The first (conservative) set makes sure that the weighted number of observations per nationality is equal to the smallest group size (i.e. 36 observations), whereas the second (progressive) weighting scheme makes sure that the weighted number of observations per nationality is equal and that the (weighted) total number of observations equals the (unweighted) total number of observations used in the analysis (the number of data points). The negative binomial models were developed in a backward manner, keeping variables significant at the 5% level in the model. All non-significant variables, with exception of the main variable under study – nationality – were omitted from the final model. All explanatory variables in the models are continuous or dummy variables, and thus the overall significance of these variables can be assessed by interpreting the corresponding *p*-values of the Wald chi-square tests. The only exception is the effect of nationality, for which the six nationalities were represented by five dummy variables, with Belgian nationality as the reference category. Since reference coding was used, the overall level of significance is assessed by using a likelihood ratio test comparing the final model with the model excluding the five dummy variables.

In addition to the weighting procedure, which ensures that each investigated nationality has the same weight in the final analysis, a second approach – bootstrapping – was adopted to verify and validate the results obtained from both weighting approaches. The basic idea behind bootstrapping is that inferences about a population from a sample (in this study the BELDAM sample) can be modelled by resampling the data and by making inferences on these bootstrap samples. The most important advantages of bootstrapping are (*a*) fewer assumptions (e.g. with respect to the data distributions or sample sizes), (*b*) greater accuracy in comparison with many classical methods, and (*c*) promotion of understanding (conceptual analogies to theoretical concepts discussed in classical methods) (Hesterberg et al., 2003).

Task 2.2: Differences in attitudes towards speeding

This study focused on inequalities in unsafe traffic behaviour and unfavourable attitudes. The aim was to study the impact of socioeconomic (e.g. educational level) and cultural (e.g. ethnic background) factors on the determinants of unsafe road user behaviour by means of a cross-sectional survey. Speeding was the chosen topic for this in-depth investigation, thus focusing on the most important risk factor identified in in-depth traffic accident studies (OECD, 2006; Elvik, 2012).

To investigate the underlying mechanisms that account for differences in speeding behaviour, the Theory of Planned Behavior (TPB) (Ajzen 1991, 2006; Figure 1) was adopted as the theoretical framework. The TPB framework has already been widely used to explain speeding behaviour (e.g. Connor et al., 2007; Elliot et al., 2003; Godin & Kok, 1996; Haglund & Aberg, 2000; Paris & Van den Broucke, 2008; Parker et al., 1992; Pelsmacker & Janssens, 2007). According to the TPB, conscious behaviour (behaviour influenced by human will) is largely determined by the intentions of showing this behaviour. This intention is, in turn, determined by the interaction between three sociocognitive variables: attitudes towards the behaviour, subjective norms regarding the behaviour and perceived behavioural control. More specifically, the attitude towards the behaviour is defined as the positive or negative evaluation of the expected outcomes of this behaviour. Subjective norms refer to the perceived social acceptability of this behaviour as it can be deduced from the behaviour and/or direct feedback of others. The perceived behavioural control is the extent to which is believed that the behaviour itself is under control of the individual.

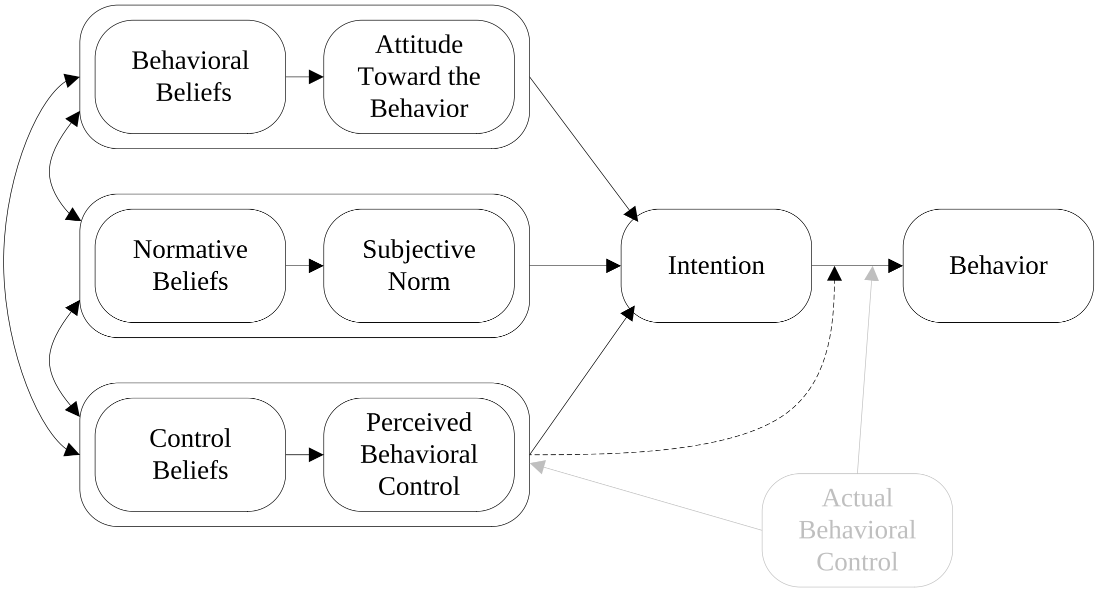

Figure 1: Theory of Planned Behavior (Ajzen, 2006)

To assess the socioeconomic factors that affect unsafe road user behaviour, a particular emphasis was laid on the factors that determine the socioeconomic status. Socioeconomic status (SES) refers to the position of an individual or group within a hierarchical social structure. SES gives an indication of the economic and social position of an individual or family in society. There are several theoretical approaches to the conceptualisation of SES and social class (e.g. Marks, 1999). Depending on the theoretical framework used, the collected data and the research questions, different indicators of SES can be used. Reynders et al. (2005) examined different possibilities to determine SES-scores. Based on their literature review and factor analysis they proposed two possible methodological options: (*i*) to weight the following five variables based on factor scores and consider the total sum of these five variables as SES-score: income, educational level of the mother and the father, occupational level of the mother and the father; (*ii*) to use the same weight for the following three variables and to consider the total sum of these three variables as SES-score: income, occupation and educational level. In the present study, we followed the second approach and focused on the variables: (*i*) educational level, (*ii*) current professional occupation and (*iii*) family income (corrected for number of adults and children living in the household) based on the OECD-modified scale as first proposed by Hagenaars et al. (1994). The three variables were included separately, but also as a combined score using the same weight for every variable.

Besides socioeconomic status, the present study also focused on cultural influences. Culture is defined as the social behaviour and norms found in human societies (e.g. Macionis & Gerber, 2011). Leviäkangas (1998) defined traffic culture as the sum total of all factors influencing the skills, attitudes and behaviour of the road user. One of the elements that influence traffic culture is the ethnic background of the road users (Christie et al., 2008). Since there are no data available in Belgium that allow to link differences in traffic culture to road users' ethnic background, it was decided that the INTRAS survey would focus on ethnic background and its relation to (un)safe traffic behaviour (more precisely: speeding). To define the ethnic background of the respondents, the INTRAS survey did not only take into account the respondent's nationality, but also his or her migration history (a more detailed description of the definition of ethnic background can be found in what follows).

Data were collected using a combination of face-to-face interviews and a self-administered questionnaire (both computer assisted). The combination of these methods allowed to reach a very difficult target population, but at the same time minimize the pitfalls of face-to-face interviews such as socially desirable responding.

The target population consisted of car drivers living in Belgium with different ethnic backgrounds. Therefore, the following requirements for participation were used: respondents had a minimum age of 18 years, possessed a valid car driving license at the moment of participation and drove a car on a regular basis (i.e. at least once a week). Moreover, respondents needed to be able to do the interview either in Dutch, French or English. The respondents were recruited from different ethnic backgrounds. A pragmatic approach was adopted. Seven relevant groups were defined based on the number of persons with a certain region of origin, living in Belgium: Turkish, Maghreb, sub-Saharan African & Egyptian, East European, South European, Belgian and (North and) Western European for comparison purposes (see Figure 2a). Other ethnic groups remained outside the scope of the study. A respondent's ethnic background was decided based on a decision tree (see Figure 2b) which was inspired by a definition of foreign origin by Noppe and Lodewijckx (2012). This definition does not only take into account a respondent's nationality, but also his or her migration history. The targeted number of respondents was 1750 (N=250 for each of the seven groups). The total sample size (after data cleaning) consisted of 1697 respondents.

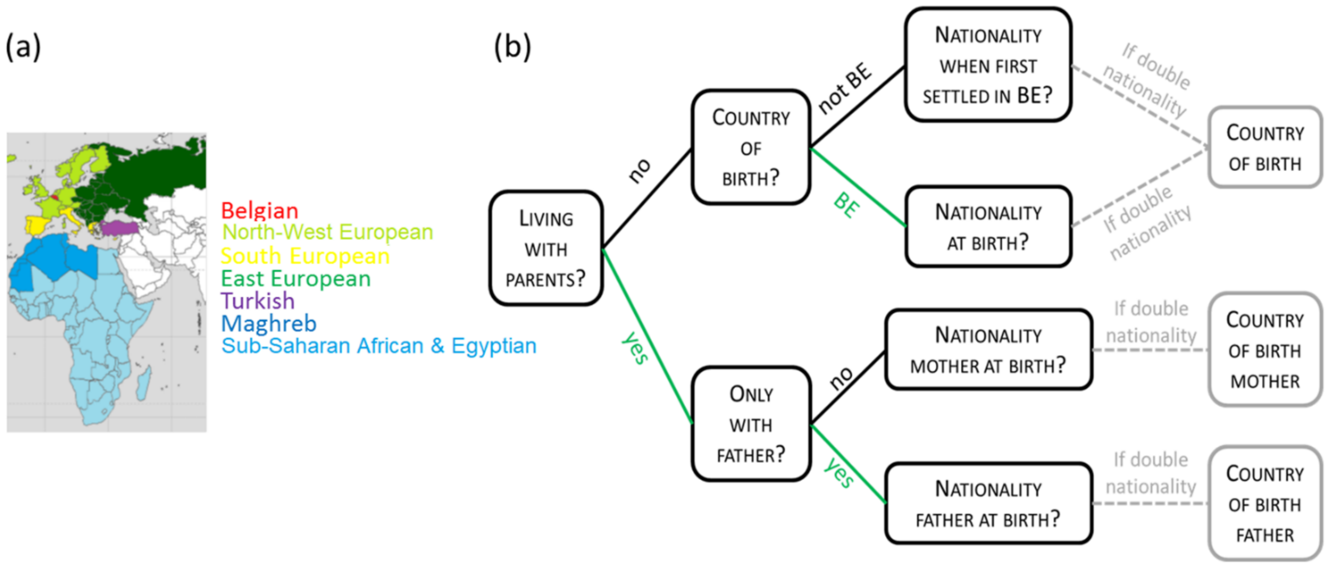

Figure 2: (a) Ethnic origins used in the study; (b) Schematic overview of criteria to classify respondent's ethnic background

In order to assure a sufficiently large and representative sample of all cultural and socioeconomic groups in the current study, a disproportional stratified quota sample has been used. After all, in international research, Carlsson et al. (2006) demonstrated that classical probability samples may lead to a relatively important under-representation of migrant populations mainly due to non-response. Therefore, respondents were recruited using the random walk method. With this sampling approach, the interviewers follow a pre-defined map and ring at every fifth house. Moreover, all interviews were computer assisted personal interviews (CAPI). The screening was done by the interviewer (face-to-face interview), but the second part of the survey was a self-administered questionnaire. Data collection took place from September, 14th 2015 until January, 3rd 2016.

The self-administered questionnaire was developed based on two validated TPB questionnaires with the same targeted unsafe traffic behaviour: speeding (Paris & Van de Broucke, 2008; Pelsmacker & Janssens, 2007). The questionnaire consisted of two parts and was available in three languages: Dutch, French and English. The first part (screening) contained sociodemographic information, a set of questions to define ethnic origin and basic mobility information. The second part focused on attitudes towards speeding (based on the TPB, Ajzen, 2006), but also contained some general questions about road safety, more sociodemographic and mobility information, and a social desirability response scale based on the one used by Lajunen et al. (1997).

A small-scale pilot study using the exact same methodology as the final study was initiated. This pilot phase had a twofold purpose: (*i*) testing the feasibility of the screening method and (*ii*) reduction and selection of the items for the final TPB questionnaire (based on psychometric testing). This pilot phase also served the purpose of examining the practicality of using the random walk method to recruit respondents. The pilot phase took place in May 2015; 140 respondents took part (N=20 for each of the seven ethnic origins). The final questionnaire consisted of 59 questions in total (104 variables); the average length of interview was 20 minutes.

Recall that the main objective of the study was the assessment of the impact of socioeconomic and cultural factors on the determinants of speeding. In particular, inter-group differences according to socioeconomic status and ethnic background were assessed for three variables of interest, i.e. (*i*) self-declared speeding, (*ii*) the number of speeding tickets obtained during the last three years, and (*iii*) the number of car accidents involved in during the last three years as a car driver.

First, the focus was laid on the TPB concepts, where the self-declared speeding was analyzed as a function of the other TPB concepts and socioeconomic and cultural factors using linear regression. Self-declared speeding is defined as driving at least 60 km/h at a given moment during a 15 minute drive in an agglomeration where the speed limit is set to 50 km. To ensure that the total effect of the socioeconomic and cultural factors, i.e. the direct effect on speeding, as well as the indirect effect via the other TPB concepts, was measured, a two-stage least square approach was followed. In this approach, first the other TPB concepts are regressed as a function of the socioeconomic and cultural effects. The corresponding residuals then can be considered as pure TPB concepts, corrected for the socioeconomic and cultural effects. Secondly, self-declared speeding was modelled as a function of the socioeconomic and cultural effects, as well as the pure TPB concepts (i.e. the residuals from the first stage). The R^2 was used to assess the fit of this linear regression model.

Secondly, the number of speeding tickets obtained during the last three years was analyzed. To this end, a negative binomial model was fitted to determine the influencing socioeconomic and cultural factors. The residual of the self-declared speeding model was also entered as an explanatory factor to assess the impact of the pure (i.e. controlled for other explanatory factors) speeding behaviour on the number of speeding tickets. Note that in contrast to the linear regression model of speeding, where the parameters are interpreted as additive effects, for the negative binomial model, the parameter effects should be interpreted as multiplicative effects on the mean number of speeding fines.

Finally, the number of car accidents in which the respondents were involved as driver during the last three years was modeled. Similar to the number of speeding tickets, a negative binomial model was fitted, and the pure speeding behaviour was also used as an explanatory factor.

Given the additional complexity of addressing hard-to-reach groups and the decision to use a combination of face-to-face screening and self-administered questionnaire, special attention was paid in all three models to potential interview effects. In terms of data cleaning, all data collected by interviewers that collected less than 10 respondents were deleted (57 observations). Besides, the potential influencing effect of interviewers was explicitly taken into account in the model building process by adding the interviewer ID as a control variable. All models were analysed using SAS 9.4.

The total sample sizes (after data cleaning) and configuration of the final sample are shown in Table XII. The configuration of the different groups of respondents differs significantly (p-values of the chi-square tests testing association between ethnicity and the sociodemographic factors all smaller than a level of significance of 0.05), and these differences in configuration need to be taken into account during analyses.

Table XII: Sample composition

			Age (%)							**Region** (%)			
Ethnic back-ground	Total	**Gender** (% ♂)	18-24y	25-34y	35-44y	45-54y	55-64y	≥ 64	**House-hold size** (% ≥ 5p)	Flanders	Wallonia	Brussels	**Education** (% at least bachelor)
BE	221	52.0	10.9	18.1	15.8	20.4	17.7	17.2	8.6	58.4	31.2	10.4	43.0
N+W EU	249	59.4	12.5	20.1	18.9	23.3	18.1	7.2	11.2	47.0	30.1	22.9	56.2
South EU	245	62.5	9.0	25.7	18.8	21.2	13.1	12.2	14.3	16.3	55.5	28.2	39.6
East EU	242	60.7	14.9	34.3	29.8	13.6	5.0	2.5	21.5	43.4	17.4	39.3	34.3
Turkish	248	72.6	9.7	31.5	29.0	16.5	10.9	2.4	28.6	49.2	24.6	26.2	20.6
Maghreb	243	67.9	13.2	32.9	32.9	14.4	5.4	1.2	28.8	32.1	22.6	45.3	39.9
Sub-Saharan	249	62.3	7.6	30.5	32.5	21.3	6.0	2.0	27.7	31.7	26.9	41.4	44.6

African & Egyptian						
Chi²-value[1]		25.4	198.4	67.0	213.5	73.9
P-values[1]		< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Total	1697					

[1] P-values correspond to the Pearson independence test between ethnicity and the respective sociodemographic factor

The different explanatory factors that were considered for modeling the three variables of interest (i.e. speeding behaviour, the number of speeding tickets and the number of car accidents), in addition to factors that describe the sample composition (Table XII), are presented in Table XIII. In this table, one can see that besides classical sociodemographic factors, information about the travel behaviour is recorded. The latter can be used as a measure of exposure, which is essential in accident risk assessments (see e.g. Van den Bossche et al., 2005). Furthermore, general concerns and driving related perceptions are considered. The degree to which the respondents are concerned about a particular topic was measured on a 4-point scale ranging from 'not at all concerned' to 'very concerned'. The acceptability of different unsafe road user behaviours was measured on a 5-point scale ranging from 'unacceptable' to 'acceptable'. In addition to the acceptability of these unsafe behaviours, it was asked which type of person mainly influenced the driving style of the respondent. Finally, the TPB variables were considered. The values presented in Table XIII correspond to the uncorrected values. Recall from before that these TPB constructs were first regressed to the other explanatory factors and that only the pure effects were taken into account in the final models. All the TPB variables represent the averaged scales of the individual indicators, which were measured on a 7-point scale ranging from 'strongly disagree' to 'strongly agree'. Finally, one could note that SES-score as discussed in the introduction is not considered because of the high number of missing values for the individual factors. Instead, the three individual SES-variables were included and missing values were treated as a separate category for these factors.

Table XIII: Descriptive statistics

Variable	Frequencies / Mean and standard deviation
Sociodemographics	
Net monthly household income	€ 0-2000: 34.9%, € 2000-4000: 36.7%, € > 4000: 7.7%, not declared: 20.7%
Professional occupation	Student: 9.6%, Prof. active: 65.4%, Prof. inactive: 19.7%, Missing: 5.2%
Household size	Mean: 3.2, Std. Dev.: 1.6

Number of person in household 12 or younger	Mean: 0.7, Std. Dev.: 1.0
Travel behaviour	
Daily car use	Yes: 65.7%, No: 34.3%
Annual car mileage	< 10,000 km: 38.9%, > 10,000 km: 53.2%, Unknown: 13.5%
Primary use of car	Commuting: 57.9%, Business: 7.3%, Leisure: 34.8%
General concerns and driving related perceptions	
Degree of concern about pollution[1]	Mean: 3.1, Std. Dev.: 0.9
Degree of concern about congestion[1]	Mean: 3.2, Std. Dev.: 0.9
Degree of concern about criminality[1]	Mean: 3.3, Std. Dev.: 0.9
Degree of concern about traffic accidents[1]	Mean: 3.4, Std. Dev.: 0.8
Degree of concern about unemployment[1]	Mean: 3.2, Std. Dev.: 1.0
Degree of concern about quality of heathcare[1]	Mean: 3.1, Std. Dev.: 1.0
Acceptability of transporting children in the car without securing them[2]	Mean: 1.3, Std. Dev.: 0.8
Acceptability of driving up to 10 km/h above the legal speed limit[2]	Mean: 2.9, Std. Dev.: 0.9
Acceptability of typing text messages or e-mails while driving[2]	Mean: 1.5, Std. Dev.: 0.9
Acceptability of driving when they're so sleepy that they have trouble keeping their eyes open[2]	Mean: 1.4, Std. Dev.: 0.8
Acceptability of driving without insurance[2]	Mean: 1.5, Std. Dev.: 0.9
Acceptability of talking on a hands-free mobile phone while driving[2]	Mean: 2.9, Std. Dev.: 1.5
Acceptability of parking their car where it is not allowed[2]	Mean: 2.0, Std. Dev.: 1.1
Acceptability of driving when they think they may have had too much to drink[2]	Mean: 1.4, Std. Dev.: 0.8
Acceptability of talking on a hand-held mobile phone while driving[2]	Mean: 1.6, Std. Dev.: 1.0
Acceptability of not wearing a seat belt in the back of the car[2]	Mean: 1.9, Std. Dev.: 1.2
Main influencing person driving style	Household member 74.4%, Other family 4.8%, Colleagues, friends, acquaintances: 7.5%, Other: 1.5%, Nobody: 11.7%
TPB Variables	
Intention[3]	Mean: 2.1, Std. Dev.: 1.2
Attitude[3]	Mean: 2.8, Std. Dev.: 1.2
Social norm[3]	Mean: 2.3, Std. Dev.: 1.0
Perceived behavioural control[3]	Mean: 2.6, Std. Dev.: 1.2
Behaviour[3]	Mean: 2.9, Std. Dev.: 1.4
Road safety indicators	

Number of speeding tickets during the last 3 years (N=1550)	Mean: 1.5, Std. Dev.: 4.6
Number of accidents involved the last 3 years as car driver (N=1621)	Mean: 0.2, Std. Dev.: 0.7

[1] Measured on a 4-point scale

[2] Measured on a 5-point scale

[3] Composite average score based on individual items measured on a 7-point scale

Work package 3

Work package 3 involved the creation of a data warehouse for Belgium in which data from various sources, at different levels of aggregation are collected. The main task within this work package was the development of a methodology for data-integration that is resource-friendly and explicitly takes into account model uncertainty.

Given the importance of data integration procedure, the main research question of this work package was to determine which data integration techniques can be adopted in the context of road safety and which criteria should be used to assess the quality of the integrated, i.e. synthetic, dataset. A recent study by Shen et al. (2015) has explicitly pointed integrating different related data sources is a crucial pathway for improving data quality and consistency in road safety benchmarking.

Although data integration has been widely used in the domain of transportation in the context of data stemming from sensors (El Faouzi et al., 2009; Bachmann et al., 2012; He et al., 2015; El Faouzi et al., 2011; Xia et al., 2013), and is referred to in this subdomain as data fusion, it has been rarely used in the context of integrating different data sources stemming from survey efforts. Moreover, the few transportation studies that do integrate different surveys, mainly focus on the tabulation of same aggregate indices, like for instance in the study conducted by Nakamya et al. (2007), where trip rates and average travel times for different cross tabulations were computed. Our work package contributes to the state-of-the-art by providing a comparison of different techniques that allow the tabulation of the joint micro-data, with a particular focus on income data, which is often one of the missing indicators in studies focusing on inequalities in road safety.

Data integration methods can be categorized into two categories. The first category of data integration methods, i.e. Record Linkage techniques, are used when the different datasets have common unique identifiers (e.g. national ID number of the participants), enabling the integration of the different datasets based on the unique identifiers. The second category corresponds to Statistical Matching techniques, which encompass analytical techniques that integrate the data from different sources using a set of common variables instead of unique identifiers (Rässler, 2002). The objective of a Statistical Matching can be two-fold: (*i*) providing an (aggregate) estimate of a variable under study, or (*ii*) creating an integrated micro-dataset. Recall that the latter is the objective of Statistical Matching that is envisaged in this work package.

In order to compare the suitability of different Statistical Matching techniques, data from the 2012 BRSI (Belgium Road Safety Institute) Attitude Survey and data from the 2010 Belgian National Household Travel Survey (BELDAM, acronym for BELgian DAily Mobility) are integrated. The BRSI Attitude Survey is a large-scale survey regarding road safety attitudes measuring different behavioural indicators, such as self-reported seatbelt use, speeding and driving under the influence of substances, that is being conducted every three years since 2002 (Meesmann et al., 2014). The 2012 BRSI Attitude Survey contains the data of 1540 individuals, who are 18 years old or above and residing in Belgium. One of the indicators that is not being queried in this survey, is the socioeconomic factor Income. Income is often reported as a crucial factor affecting travel behaviour and associated trip involvement, and as a consequence integration of this factor with the BRSI Attitude Survey data enables the assessment of how socioeconomic factors might influence differences in safety attitudes (Goodman, 2013; Eftekhar et al., 2016; Blumenberg & Thomas, 2014).

The income data that are being integrated are stemming from the BELDAM survey. The BELDAM survey was conducted from December 2009 to December 2010, collecting information from 8532 households, corresponding to 15821 individuals aged 6 years and older (Cornelis et al., 2012). Given the fact that the BRSI Attitude Survey only collects information on adults (age $\geq$ 18), correspondingly only the data with respect to adults in the BELDAM were retained for the analysis (12853 out of 15821 individuals). Although our study focused on the income dimension, it is evident that the BELDAM survey can also be used for providing information about traffic exposure data such as trip distances. However, the BRSI Attitude Survey does include some questions with respect to exposure, and for this reason the integration of mobility data is not being treated explicitly.

As mentioned earlier, one of the main requirements in Statistical Matching procedures is that the considered datasets share some common variables. Table XIV provides an overview of the variables that are common in the two surveys that are being integrated. Note that in practice, a re-categorization or redefinition of some variables, (for instance the merger of different nominal or ordinal levels) is needed to end up with a larger number of common variables.

Table XIV: Common variables shared between BRSI Attitude 2012 and BELDAM 2010

	Label	**Description**	**Type**
1	GENDER	Gender: male and female	Categorical
2	AGE	Age	Continuous
3	PROV	Province: East-Flanders, West-Flanders, Antwerp, Limburg, Flemish-Brabant, Walloon-Brabant, Hainaut, Liège, Namur, Luxembourg	Categorical
4	REGION	Region: Flanders, Wallonia, Brussels	Categorical
5	EDU	Level of education	Categorical
6	CHILD	Having children: Yes or No	Categorical
7	NRCHILD	Number of children	Continuous

D'Orazio et al. (2006) defined Statistical Matching as techniques that integrate two or more datasets (usually sample surveys data) referring to the same target population enabling the study of the relationship between variables that are not jointly (in one single survey) observed. Thus, it is important that the datasets contain a set of common (shared) variables in addition to a set of variables that are unique for each individual dataset.

Generally, there are two datasets. The dataset with the most relevant and required variables to the concerned study serves as the recipient, whereas the second dataset, denoted as donor includes the response variable/s (attribute(s) which are missing from the recipient dataset), as well as a set of common variables with the recipient. The donor dataset preferably has a larger number of observations than the recipient. The reason for this is that if the sizes of the two datasets (in terms of the number of observations) are very different, choosing the smaller dataset as the donor dataset increases the probability that the distribution of response variable/s in the integrated dataset do not match the distribution of the same variable/s in the original (donor) dataset. Technically, it is possible to consider all the common variables between the two datasets as so-called matching variables. Notwithstanding, only the most relevant common variables are considered as matching variables, whereas the remaining common variables are either considered as a donor class (categorical variables), or simply neglected. A donor class is a subset of common categorical variables that serves as a basis for classifying observations, such that an observation of particular donor class in the donor dataset will be attributed to an observation with the same donor class in the recipient dataset.

In terms of classification of techniques, a first classification can be made based on the objective. Recall from the introduction, that Statistical Matching can serve micro and/or macro objectives. The micro objective aims at creating an integrated dataset, in which all the variables of the recipient and required variable/s from the donor are available, whereas the macro objective aims at deriving an estimate of the variables of interest within the discrete datasets (e.g. the correlation coefficient, regression coefficient, the contingency table, etc.) (D'Orazio et al., 2006).

A second classification can be made based on the approach (parametric versus non-parametric). When the data hold the normality assumption (i.e. the data stem from a multivariate normal distribution), the parametric approach is considered. To this end, an explicit model needs to be specified for the joint distribution of the desired variables (common and uncommon between the two datasets). A challenge herein exists in finding an appropriate formulation of the model, as a misspecification leads to unreliable results. Conversely, if data do not hold the normality assumption, the non-parametric approach can be considered. In the non-parametric approach, an explicit model specification is not required, offering protection against model misspecification. Hence, the non-parametric approach provides more flexibility in handing complex situations (mixed types of variables). Besides, when the objective of Statistical Matching is the micro-objective, the non-parametric approach is fairly unequivocal. Lack of need for model choice specification and simplicity has resulted in an increasing popularity in non-parametric approach of Statistical Matching. Finally, a third approach can be considered, mixing parametric and non-parametric approaches. In this approach, initially a parametric model is specified and the model's parameters are estimated. Then an integrated dataset is created according to the non-parametric approach. Considering all the provided explanations, the current work package was devoted to discuss and compare micro-objective Statistical Matching techniques with a non-parametric approach.

Non-parametric techniques were introduced by Okner (1972), where the normality assumption for the matching variables was explicitly disregarded. Non-parametric techniques can be employed regardless of the matching variables' distributions, implying that no estimation regarding the distributions of these variables is required. Hence, when the purpose of Statistical Matching is to produce an integrated dataset, non-parametric techniques have tended to be the most common techniques for integrating data from different sources. Notwithstanding, non-parametric techniques are not completely assumption-free since they implicitly take some assumptions with respect to the distribution or conditional mean function into account (D'Orazio et al., 2006). Non-parametric micro-objective Statistical Matching techniques are distance based techniques that have been also known as hot-deck distance techniques (Cox, 1980; Sande, 1983; Schenker, 1988; Rao & Shao, 1992; Kim & Fuller, 2004; Srebotnjak et al., 2012). Three general existing types of hot-deck techniques for Statistical Matching are known as: Random hot-deck, Nearest Neighbor Distance hot-deck and Rank hot-deck (Ford, 1983).

- In the Random hot-deck technique, the donor is selected randomly. The random selection is performed on records within homogeneous classes. These classes are based on their characteristic/s compliance (e.g. region, province, sex, education level, etc.) that has been referred to as donor class. Therefore, the Random hot-deck technique does particularly suit when the matching variables are categorical (D'Orazio et al., 2006; D'Orazio et al., 2012). Nonetheless, it should be noted that the technique could be used for a (single) continuous matching variable. This is possible by randomly selecting the most relevant records in the donor with the recipient and setting research's criteria according to the matching variable.
- The Rank hot deck technique was introduced by Singh et al. (1993). The Rank hot deck technique is based on matching the records in the recipient's dataset with the records in the donor's dataset based on the closest distance in terms of ranks. If the matching variables are ordinal or categorical, the relationship of the ranks can be used to attribute the values of the response variable from the donor to the recipient dataset. The values of the matching variables in both the donor and the recipient datasets would be ranked separately based on their own values. If the observations in the donor are "n" times the number of observations in the recipient and "n" is an integer, the values of the response variable can be integrated by matching the records of a same rank. In all other situations, the distances are computed using the empirical cumulative distribution function of the continuous matching variable that has the highest correlation with the response variable (D'Orazio et al., 2006; Singh et al., 1990). Furthermore, the Rank hot-deck technique is of interest when the values of the matching variable are directly incomparable due to measurement errors, provided that the order of the values is unaffected by the measurement errors (D'Orazio et al., 2006).
- The technique using the Nearest Neighbor Distance has been widely used in non-parametric micro Statistical Matching practices (Okner, 1972; D'Orazio et al., 2012; Shao & Wang, 2008; Sande, 1982; Rao, 1996; Van Hulse & Khoshgoftaar, 2014). In Nearest Neighbor Distance, each of recipient's records will be matched with the nearest donor records in accordance with a distance calculated respecting matching

variables. If matching variables are from the same type (continuous or categorical), the Nearest Neighbor Distance can be computed using the Euclidean, Mahalanobis, or Manhattan distance, where the Mahalanobis distance yields better results in a variety of situations (Rosenbaum, 2002; Iacus & Porro, 2007). If the matching variables are both continuous and categorical, then the Gowers distance is used, which is a distance measure between 0 and 1 for each variable based on the Gower's dissimilarity coefficient (Gissing, 2014; Gower, 1971).

The aforementioned distance techniques can be adopted following either a constrained or unconstrained computation: in the constrained computation, the Statistical Matching procedure uses each record of the matching variables in the donor dataset only once, whereas in the unconstrained computation, there is no restriction in terms of the number of times the records of the matching variable in the donor dataset are used. Consequently, for the constrained approach, the number of observations in the donor dataset must be greater or at least equal to the number of observations in the recipient dataset. The main advantage of the constrained computation is the preservation of the marginal distribution of the response variables in the integrated dataset, particularly when the number of observations in both donor and recipient datasets are relatively close. Despite this advantage, the constrained computation has two main drawbacks. The first drawback is that the average distances between matching records in the donor and recipient datasets are larger in the constrained approach compared to unconstrained approach. The second drawback is that constrained approach is computationally more complex (D'Orazio et al., 2006).

In Statistical Matching, the donor and recipient datasets share one or multiple common variables. When more than one variable is common, not all the common variables should be employed as matching variables, but one has to select the ones that are the most relevant with respect to the response variable. The stronger the relation between the matching variables and the response variables is, the lower the uncertainty of the Statistical Matching will be. Moreover, the adoption of a higher number of matching variables negatively affects the computation of matching distances. This increases the variability in the joint marginal distributions of the matching variables and the response variables.

To determine the strength of the relation between the matching variables and the response variables, Harrell (2015) suggested to use the adjusted R^2 associated with the regression model rank and/or the unadjusted R^2 associated with the squared Spearman's rank correlation coefficient, when the common and response variables are continuous or categorical ordered. If all matching and response variables are categorical, then Chi-square based association measures (Cramer's V*)* or proportional reduction of the variance measures can be used for assessing the strength of the correlation (Agresti & Kateri, 2011).

The computation of the matching distance is more accurate and less computationally complex, when donor classes are taken into account. Recall that a donor class is a subset of common categorical variables that serves as a basis for classifying observations, such that an observation of particular donor class in the donor dataset will be chosen for an observation with the same donor class in the recipient dataset (Gissing, 2014).

To compare the appropriateness of the different Statistical Matching techniques, the Statistical Matching needs to be assessed according to some objective criteria. First, it needs to be verified whether the matching variables have the same marginal distribution in the donor and recipient datasets (Hartman et al., 2015). Besides, it has been indicated that the datasets considered for Statistical Matching procedure must refer to the same target population. Therefore, the marginal distribution can be used as a criterion to compare the integrated dataset with the donor dataset. An empirical approach is favoured, in which the marginal distribution of the response variable/s in the donor and the synthetic datasets are compared through similarity/dissimilarity measures. In this regard, the following measures were considered:

1. *Dissimilarity index.* The dissimilarity index is defined as the total variation distance (tvd) between the marginal distributions, and ranges from 0 (completely similar) to 1 (completely dissimilar). This index represents the fraction of records that are causing differences between the compared distributions. The smaller the dissimilarity index is, the more coherent the marginal distributions of the response variable in the donor and the integrated datasets are. Agresti (2002) suggests that as long as the dissimilarity rate is less than or equal to 6% (tvd $\leq$ 0.06), the compared marginal distributions could be considered consistent.

2. *Overlap.* The overlap is the compliment of the dissimilarity index (sum of overlap and tvd is 1). Its value ranges from 0 (completely dissimilar) to 1 (completely similar). The higher the overlap is, the more coherent the compared marginal distributions are. To clarify, overlap and tvd are complimentary to each other and their sum is equal to 1. Analogously to Agresti's distributions' consistency suggestion (tvd ≤ 0.06), it can be concluded that an overlap ≥ 0.94 indicates that the compared distributions can be considered as consistent.

3. *Hellinger's Distance.* The Hellinger's distance is a dissimilarity index representing the distance between the two marginal distributions, which is non-negative, symmetric, and lies between 0 and $\sqrt{2}$ (González-Castro et al., 2013). Hellinger's distance (Hd) is mathematically related to tvd by the following equation (D'Orazio, 2013): $\mathrm{Hd}^2 \leq \mathrm{tvd} \leq \mathrm{Hd}\sqrt{2}$. Considering this equation and given that tvd $\leq$ 0.06, one can derive that $\mathrm{Hd} \leq 0.042$. In literature, when Hellinger's distance ≤ 0.05 the two distributions are considered consistent (Boone et al., 2005).

4. *Bhattacharyya Coefficient.* The Bhattacharyya coefficient (Bhatt) is a measure of similarity between two distributions, and ranges from 0 to 1 (Bhattacharyya, 1943). This coefficient could be used to estimate the relative closeness of two distributions. The higher the value of the Bhatt coefficient is, the more similar the distributions are. The Bhatt coefficient can be mathematically related to the Hellinger's Distance through the following equation (D'Orazio, 2013): $\mathrm{Hd} = \sqrt{1 - \mathrm{bhatt}}$. Taking into account the limits of an acceptable Hellinger's distance (≤ 0.05), the Bhatt coefficient would be acceptable if $\mathrm{Bhatt} \geq 0.9975$.

4. SCIENTIFIC RESULTS AND RECOMMENDATIONS

Work package 1

Task 1.1: Conceptual framework

Recall that the results of this task were summarized in the following questions, which will be discussed further:

- Conceptualisation: What are we considering?
- Does socioeconomic status relate to traffic safety?
- Does culture relate to traffic safety?
- How do socioeconomic status and culture relate to traffic safety?

Conceptualisation phase

In the conceptualisation phase, we sought at the one hand definitions of concepts concerning socioeconomic characteristics and culture and on the other hand methods of elaboration or measurement of these characteristics in research.

Socioeconomic status is a composite measure of economic status (income), social status (education) and work status (occupation) at a given point in time, which can be measured on an individual, household or neighbourhood level. Social class is seen as one's sociocultural background. Social stratification is the totality of societal processes by which socioeconomic status and social class result in hierarchies of political power, prestige and access to resources or valued goods and hence similar life possibilities for members of a social group.

Given the fact that socioeconomic status is a composite measure, the assessment of this status in research is not unequivocal. Often one characteristic (e.g. education) is chosen as indicator to assign participants to socioeconomic groups, because all characteristics are deemed interchangeable. If the central interest is to show the existence of a socioeconomic gradient in a particular health outcome then the choice of indicator may indeed not be crucial (Galobardes et al., 2006). The conviction of interchangeability receives opposition however, when it comes to explore the mechanisms that underlie differences in health or injury. Toivanen (2007) warns that different socioeconomic characteristics measure different underlying phenomena and tap into different causal mechanisms in relation to health and should therefore not be used interchangeably as indicators of a hypothetical latent social dimension. Rather, the choice of an indicator of socioeconomic status should depend on how one assumes socioeconomic status is linked to health differences (Bartley et al., 2000; Lynch & Kaplan, 2000 – cited in Toivanen, 2007; Galobardes et al., 2006; Shavers, 2007). In the absence of a clear assumption of such link, using more than one measure may help to clarify the causal pathways by which social disadvantage leads to poorer health and injuries (Hasselberg & Laflamme, 2003; Marmot & Bobak, 2000; Galobardes et al., 2007). The use of multiple measures of socioeconomic status is of particular importance when socioeconomic status is a potential confounding factor. Multiple socioeconomic status indicators, preferably measured across the life course, will be needed to avoid residual confounding by unmeasured socioeconomic circumstances (Galobardes et al., 2006). Social class and socioeconomic status can be conceptualised and measured on different levels: the individual, household and neighbourhood or community level (Krieger et al., 1997). Krieger and Fee (1994 – cited in Williams & Collins, 1995) emphasize that in health research, social class should be measured at all three levels, because they provide divergent information.

Culture concerns groups or communities that are distinct from each other. These differences have the nature of language and communication, actions, customs, inner belief structure, values,… Culture is seen as a dynamic process of interaction of people with each other and with their (changing) environment. Ethnic minorities are population groups with linguistic, cultural or religious profiles different from that of the majority culture. They perceive themselves and are perceived to be distinct. We talk about discrimination when the majority group benefits from dominating minority groups, and defines itself and others through this domination and the possession of selective and arbitrary (often physical) characteristics. Discrimination can affect every aspect of the status, opportunities and trajectory throughout the life-course of the people belonging to a minority, e.g. fewer educational and occupational opportunities, lower income, poor housing, absent social networks, experienced hostility and so on. The so-called road traffic or driving culture is a culture on a micro level, related to driving as a specific activity, which proliferates among drivers in a given environment (country, region, city,…). It consists of formal rules concerning driving, applied and enforced by authorities, familiarized through education and translated in infrastructure and engineering systems, and of informal rules, norms and values, resulting from exposure to and interaction with others and which are often transmitted via imitative behaviour.

In research, elaborating the concept of culture is necessary in order to find underlying mechanisms that explain the connection between culture and other variables. In our study, we gathered a few frameworks containing a number of cultural dimensions that can be studied in this respect: Culture's Consequences (Hofstede, 1980, 1999 – cited in Lund & Aarø, 2004), Basic Human Values (Schwartz, 2006), Modernization and post-modernization (Inglehart, 1977, 1990 – both cited in Schwartz, 2006), Culture as symbol exchange (Geertz, 1973 – cited in Rundmo, Granskaya & Klempe, 2012), Cultural Theory (Douglas and Wildavsky, 1982 – cited in Oltedal & Rundmo, 2007).

Relationship between socioeconomic status and traffic safety

In international studies, we found numerous examples of socioeconomic status associated with differences in accident involvement.

Chen et al. (2010) found a higher risk of crash-related hospitalization for young drivers from low socioeconomic status areas in New South Wales, Australia. Whitlock et al. (2003) investigated the association of socioeconomic status with motor vehicle driver injury in New Zealand. The association between injury and occupational status was strong, with participants in the lowest occupational status group being four times as likely to have experienced a driver injury during follow-up as participants in the highest group. There was also an association with educational level, with those participants who had been to secondary school for less than two years being twice as likely to have experienced a driver injury during follow-up as those who had been to university or polytechnic. Townsend & Davidson (1982 – cited in Christie, 1995) found that children (0-15 years) from the lowest socioeconomic group (based on the occupation of the parents) in the United Kingdom were more than 4 times more likely to be killed as pedestrians than their counterparts in the highest socioeconomic group. Factor et al. (2008) investigated the accident involvement of participants over 16 years old who had a driving license in Israel. They found that the more education and the higher a driver's socioeconomic status (based on occupation, assets and family income) was, the lower the probability of involvement in a severe or fatal accident. Hasselberg et al. (2005) found that Swedish drivers with low educational attainment were at greater risk of severe injuries and showed excess risks of crashes of all kinds. Hjern & Bremberg (2002), also in Sweden, found that parental socioeconomic status (occupation of head of household) is a strong determinant of road traffic injuries in children and youth. Moradi et al., (2017) found in Iran that people with a poor socioeconomic status and/or only secondary education were found to have a greater history of road traffic injuries or deaths.

Relationship between culture and traffic safety

A large amount of literature points to the different road accident involvement for different ethnic minorities in a country.

Christie (1995) found a clear over-representation of children from a 'non-white' ethnic origin in the group of accident involved children that she studied in the United Kingdom. Junger and Steehouwer (1990) found large differences in the number of traffic accidents between ethnic groups of pedestrians or cyclists from 2-12 years old in the Hague (the Netherlands). Moroccan and Turkish children were more often hit by a car than Dutch children; Surinamese children were less often or at the same rate victim of a collision as Dutch children. Factor et al. (2008) found the accident involvement probability in Israel to be higher for non-Jews than Jews, and for Jewish drivers of African and Asian origin than of American and European origin. Moran et al. (2010) found that Arab drivers in Israel are involved in road accidents three times more than Jewish drivers. Campos-Outcalt et al. (2003) compared rates of motor vehicle crash fatalities among different ethnic groups in urban and rural Arizona (USA). They found that the only ethnic group to have consistently higher rates of motor vehicle crash fatality was American Indians. In comparison with non-Hispanic whites, Hispanics had significantly lower rates except for urban males. African American males had slightly higher rates in urban areas but lower rates in rural areas; African American females had rates similar to non-Hispanic whites. Quddus et al. (2002) found in Singapore significant differences in injury severity levels for motorcyclists of different nationalities. Dobson et al. (1999) found in Australia that women born in a non-English speaking country (born overseas) had a significantly higher risk of accidents, compared with women born in Australia.

Mechanisms of relationship between socioeconomic status, culture and traffic safety

Based on determinants of health and their classification, on how differences in health take the form of socioeconomic and social gradients and on mechanisms that make these gradients develop, we pursued the same exercise concerning determinants and mechanisms in traffic safety. Doing so, we hoped to find answers to some original questions with which our literature search started: why are people of different countries and cultures in a varying extent involved in traffic accidents and why are lower socioeconomic groups and ethnic minorities often significantly overrepresented in traffic accidents within a country?

Different theoretical models can be found in the literature that explain how socioeconomic status and culture relate to traffic safety. In general, socioeconomic status and culture are considered to be distal factors that influence accident risk via more proximal:

- extra-individual factors such as living environment, access to travel modes, time expenditure, etc. (e.g. accident causation model by Özkan, 2006) (Figure 3)
- intra-individual factors such as beliefs, attitudes, social norms, perceived behavioural control, intentions, behaviour (e.g. Theory of Planned Behavior by Ajzen, 1991) (Figure 4).

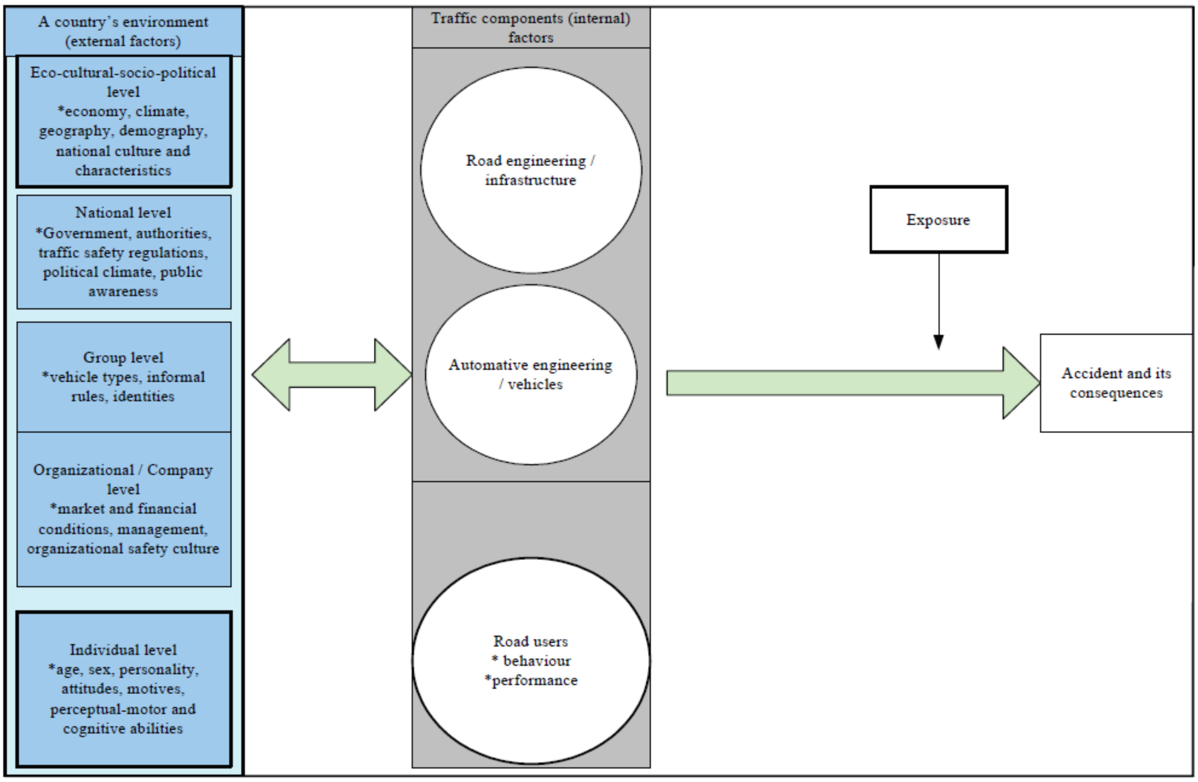

Figure 3: Accident causation model (Özkan, 2006)

Results of studies that Özkan conducted within this framework showed that economy and societal and cultural factors appeared to be important factors in the differences between countries in traffic safety.

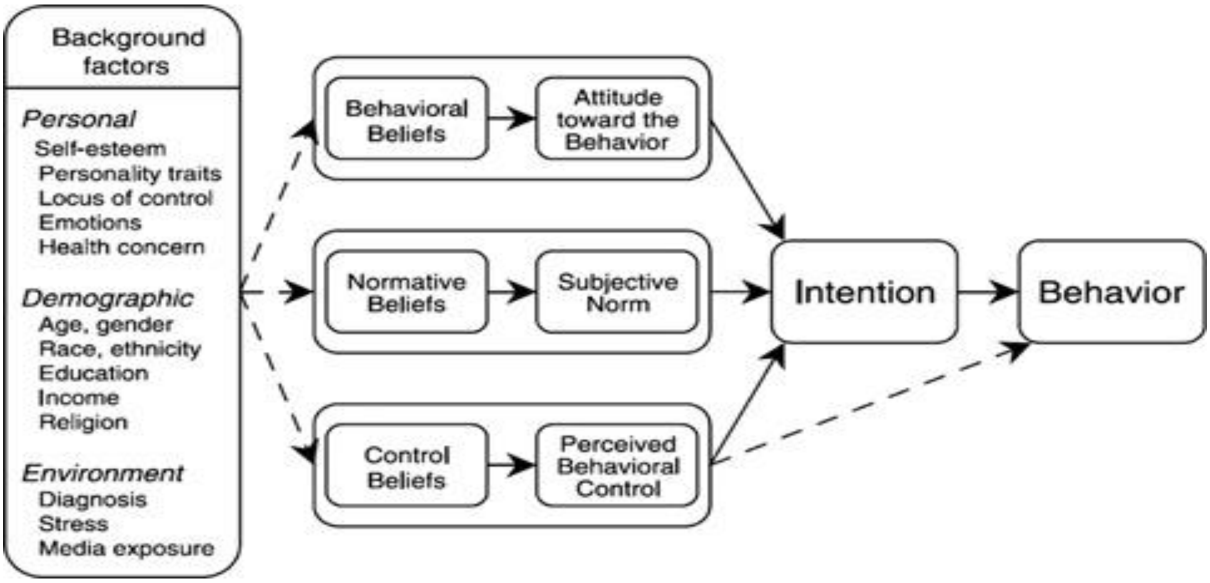

Figure 4: Theory of Planned Behavior (Ajzen, 1991)

In the report of our literature search, we described several of these models, all of them useful with the aim of investigating and explaining inequality in traffic safety.

Task 1.2.1: Inequalities in traffic safety in Belgium on neighbourhood level

The central questions of this task were:

- Does socioeconomic status relate to traffic safety at neighbourhood level in Flanders?
- In case of the answer "Yes": To what extent does socioeconomic status relate to traffic safety at neighbourhood level in Flanders? And
- How does socioeconomic status relate to traffic safety at neighbourhood level in Flanders?

As previously mentioned in the methodology section, distinct models were constructed by regressing the casualty counts of different road users in each TAZ together with other socioeconomic network variables on the natural logarithmic transformation of produced/attracted trips, with the latter operating as the exposure variables. The results show that among the considered predictive variables, exposure measures together with 'Income level', 'Car ownership', 'Capacity', 'Motorway', 'Urban' and 'Suburban' were statistically significant in predicting certain types of casualties.

For all models, exposure variables were the most significant predictors and positively associated with the number of casualties in each TAZ. As the number of trips increased, casualties also tended to increase. Similar associations between the number of produced/attracted trips and traffic safety have been reported by other researchers (Abdel-Aty et al., 2011a, 2011b; Naderan and Shahi, 2010; Pirdavani et al., 2012). In order to incorporate the impact of moving motorized traffic, some network variables were considered to serve as proxy measures. For all car occupant casualties (i.e. car drivers and car passengers) the variable ‘Motorway’ turned out to be a significant predictor. The positive association between this variable and casualties means that for TAZs with motorways, a higher number of car driver and passenger casualties are expected. For active mode users' casualty models, ‘Capacity’ was found to be a significant predictor. The positive sign indicates that TAZs with greater road network capacity are expected to have more traffic in addition to the number of produced/attracted trips. Consequently, potential conflicts between motorized vehicles and active mode users are expected to be higher, leading to more vulnerable road user casualties.

The degree of urbanisation was categorized into three different levels and thus represented by two dummy variables, i.e., ‘Urban’ and ‘Suburban’. When ‘Urban’ and ‘Suburban’ metrics in a TAZ were both 0, then this TAZ was located in a rural area. For all models, the coefficient estimate of the variable ‘Urban’ was larger than the one for ‘Suburban’. This means that the models predict more casualties for more urbanised TAZs. This is in line with the findings of Huang et al. (2010) who also found that counties with a higher level of urbanisation were associated with higher crash occurrence probability.

Given that our main objective was to assess the link between socioeconomic variables and traffic safety, these associations are discussed in more detail. As can be seen in Table XV, all constructed models showed a negative association between casualties and ‘Income Level’. These results are in line with many other studies where it has been shown that lower income level or poverty has a positive relationship with crashes occurring in a TAZ (Aguero-Valverde & Jovanis, 2006; Pirdavani, 2012). The negative sign for the ‘Income Level’ variable indicates that TAZs with higher income level are expected to have fewer casualties compared to less prosperous TAZs. Despite this negative association for all models, ‘Income level’ was not a significant predictor at 90% confidence level for each type of casualty. Average household income level at the TAZ level was found to be a significant predictor for all types of male casualties. Although we found a negative association between income level and female casualties, this association was less considerable in predicting female car driver and active mode road user casualties. This indicates that active mode or car driver casualties among females are not significantly predicted by their household income level. Car ownership, as another socioeconomic variable, was also found to be a significant predictor of male active mode road users only. This suggests that increased car ownership level leads to less male active mode road user casualties. In general, these results show that female casualties are overall less well explained by household socioeconomic conditions in comparison to male casualties.

Table XV: Parameter estimates for casualty prediction models

	Model results for male car driver casualties				Model results for female car driver casualties			
Variable	Estimate	Std. Error	z value	Pr(>|z|)	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	1.4276	0.1785	7.996	0.000	0.9219	0.1778	5.184	0.000
Ln(Exp_CD_M)	0.2449	0.0242	10.134	0.000	-	-	-	-
Ln(Exp_CD_F)	-	-	-	-	0.2504	0.0251	9.963	0.000
Income level	-0.219	0.0824	-2.658	0.008	-0.1184	0.0874	-1.354	0.176
Urban	0.7383	0.1167	6.325	0.000	0.5796	0.1236	4.689	0.000
Suburban	0.2552	0.0576	4.433	0.000	0.2126	0.0613	3.470	0.000
Motorway	0.233	0.0529	4.405	0.000	0.2181	0.056	3.894	0.000

	Model results for male car passenger casualties				Model results for female car passenger casualties			
Variable	Estimate	Std. Error	z value	Pr(>|z|)	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	0.3918	0.1621	2.418	0.016	0.3541	0.1822	1.943	0.052
Ln(Exp_CP_M)	0.1777	0.029	6.122	0.000	-	-	-	-
Ln(Exp_CP_F)	-	-	-	-	0.2152	0.0289	7.449	0.000
Income level	-0.3593	0.0967	-3.715	0.000	-0.2192	0.0955	-2.294	0.022
Urban	0.5261	0.135	3.898	0.000	0.6638	0.1329	4.996	0.000
Suburban	0.1842	0.0689	2.674	0.007	0.1584	0.0673	2.355	0.019
Motorway	0.1947	0.0631	3.084	0.002	0.1411	0.0617	2.288	0.022

	Model results for male active mode user casualties				Model results for female active mode user casualties			
Variable	Estimate	Std. Error	z value	Pr(>|z|)	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	0.4436	0.2018	2.198	0.028	-0.5847	0.2424	-2.412	0.016
Ln(Exp_SL_M)	0.2589	0.025	10.345	0.000	-	-	-	-
Ln(Exp_SL_F)	-	-	-	-	0.3018	0.0297	10.175	0.000
Income level	-0.1584	0.0953	-1.661	0.097	-0.0803	0.1157	-0.694	0.488
Car ownership	-0.1209	0.0587	-2.06	0.039	-0.879	0.0697	-1.26	0.208
Capacity	0.000228	0.000047	4.883	0.000	0.00027	0.000056	4.718	0.000
Urban	0.7241	0.1375	5.261	0.000	1.02	0.1651	6.179	0.000
Suburban	0.2295	0.0678	3.386	0.000	0.3661	0.0821	4.459	0.000

To answer our initial questions, we can conclude that:

- Income level has an effect on male traffic casualties in general and female car passenger casualties: lower income level implies higher number of casualties.
- In terms of significance and size, the effect of income level on traffic casualties is subordinate to the effect of exposure and degree of urbanisation.
- The effect of income level on traffic casualties is not straightforward but sensitive to gender and travel mode use to some extent.
- The underlying mechanism explaining in which way income level influences (mostly male) traffic casualties, remains unclear.

Task 1.2.2: Inequalities in traffic safety in Belgium on the individual level

The main research questions on the individual level, which were studied using both the Attitude survey 2015 and the Unsafety Barometer 2015, were:

- Does diploma influence stated car accident involvement?
- Does diploma influence self-reported behaviours concerning alcohol impaired driving, speeding, seatbelt use, use of child safety systems and distraction while driving?
- Does diploma influence attitudes concerning alcohol, speeding, seatbelt use, use of child safety systems and distraction while driving?
- Do results for the above 3 questions replicate across the 2 surveys?

For a more detailed overview of statistical output tables with identification of statistically significant main predictors, we refer to the annex section.

Findings of the Attitude survey 2015

Diploma is a significant predictor for self-reported car accident involvement besides age, region and exposure: lower diploma implies higher accident involvement.

Diploma is a significant (interacting) predictor for 8 out of 13 self-reported behaviours related to driving.

Lower diploma overall implies less frequent commission of self-reported risk-increasing behaviours related to alcohol impaired driving, speeding and distraction: lower diploma altogether implies (1) less driving while above the legal BAC-limit, (2) less driving 50km/h where 30km/h is allowed, (3) less driving 10km/h above the legal speed limit, (4) less calling hands-free while driving, and (5) less sending text messages while driving.

Lower diploma overall implies less frequent commission of self-reported impact-mitigating behaviours related to using the seatbelt and correct child safety systems: lower diploma altogether implies (1) less using the seatbelt as a car driver, (2) less using the seatbelt as a front seat passenger and (3) less using the correct child safety system with children in the car.

Diploma seems a less important predictor for opinions related to the 13 investigated behaviours related to car driving. Diploma was a significant (interacting) predictor for 8 out of the 19 opinion statements studied. The effect of diploma on those opinions seems to be internally quite consistent.

In general, lower diploma implies more agreement with opinions that risk-increasing car driving behaviours are dangerous. For instance, lower diploma implies more agreement with the opinion that (1) it is more difficult to react correctly when driving under the influence of alcohol, (2) driving fast is socially unacceptable, (3) driving fast is putting your own life and that of others in danger, (4) speed limits are usually set at acceptable levels, (5) almost all car drivers now and then call hand-held while driving. Contrary to that, lower diploma implies less agreement with the opinion that hand-held driving decreases your attention while driving. Also, in general, lower diploma implies less agreement with opinions that express approval for impact-mitigating behaviours. For instance, lower diploma implies less agreement with the opinion that (1) one should always ask car passengers to wear their seatbelt, and less disagreement with the opinion that it is not really necessary to use the correct child safety system for short trips.

For alcohol impaired driving, speeding, seatbelt use and child safety system use, the effect of diploma on the self-reported opinions related to those behaviours is consistent with the effect of diploma on the self-reported frequency of those behaviours. Formal mediation/moderation testing however is required in order to examine whether the effect of diploma on the self-reported frequency of those behaviours is (partially) operating via the self-reported opinions related to those behaviours.

Findings of the Unsafety Barometer 2015

Diploma is NOT a significant predictor for self-reported car accident involvement. The only significant predictor is exposure (km driven).

Diploma is a significant predictor for only 1 out of 12 self-reported behaviours related to driving. Diploma is NOT related to the self-reported frequency of risk-increasing behaviours related to alcohol impaired driving, speeding and distraction.

Lower diploma implies less frequent commission of self-reported impact-mitigating behaviours related to using the correct child safety systems: lower diploma altogether implies less using the correct child safety system with children in the car. Diploma is NOT related to the use of seatbelts as a car driver, as a front seat passenger or as a back seat passenger.

Diploma seems a less important predictor for opinions related to the 12 investigated behaviours related to car driving. Diploma was a significant (interacting) predictor for only 5 out of the 18 opinion statements studied.

In 2 out of 5 cases where diploma had an effect on car driving-related opinions (i.e. (1) the opinion that driving faster than the speed limit makes it more difficult to react correctly in a dangerous situation, and (2) the opinion that the instruction for the use of a child seat are unclear), the effect was internally inconsistent. Lower diploma implies more agreement with the opinion that (1) most friends think that speed limits should be respected, and (2) almost all car drivers occasionally call hand-held while driving. Lower diploma implies less disagreement with the opinion that it is not really necessary to use the correct child safety system for short trips.

For child safety system use, the effect of diploma on the self-reported opinion related to that behaviour is consistent with the effect of diploma on the self-reported frequency of that behaviour. Formal mediation/moderation testing however is required in order to examine whether the effect of diploma on the self-reported frequency of that behaviour is (partially) operating via the self-reported opinion related to that behaviour.

Summary findings: diploma and self-reported driving behaviours

Across both surveys, the sociodemographic background factors age and gender, together with exposure, are more important as predictors of the 13 car driving behaviours investigated, than the geographical location-related variables region and province, and the socioeconomic background variable diploma. Geographical location and diploma are more important as predictors of the 13 car driving behaviours investigated in the Attitude survey 2015 than in the Unsafety Barometer 2015. More specifically, in terms of effect persistency, diploma is a significant (interacting) predictor for 8 out of 13 car driving behaviours in the Attitude survey 2015, while diploma only predicts 1 out of 12 car driving behaviours in the Unsafety Barometer 2015. In terms of effect consistency, albeit limited to the Attitude survey 2015, the relationship between diploma and self-reported frequency of risk-increasing car driving behaviours is positive (i.e. lower diploma implies less driving above the legal BAC-limit, less driving 50km/h where 30km/h is allowed, less driving 10km/h above the legal speed limit, less hands-free calling while driving and overall less sending of text messages while driving compared to higher diploma) while the same is true for the relationship between diploma and self-reported frequency of impact-mitigating behaviours (i.e. lower diploma implies lower use of the seatbelt as a car driver and as a front seat passenger, and lower use of the correct child safety system with children in the car compared to higher diploma). Notwithstanding, the overall picture that emerges, is that diploma as an indicator of socioeconomic background is a factor of secondary importance at best when it comes to the prediction of behaviour-related indicators of road safety. Age, gender and exposure appear to be more important predictors.

Summary findings: diploma and self-reported driving opinions

Across both surveys, the sociodemographic background variables age and gender, together with exposure, are more important as predictors of the 19 car driving-related opinion statements investigated than the geographical location-related variables region and province, and the socioeconomic background variable diploma. Diploma was a significant (interacting) predictor for 8 out of the 19 opinion statements in the Attitude survey 2015 and for 5 out of the 18 opinion statements in the Unsafety Barometer 2015. Whenever the case, the effect of diploma on opinion statements seems to be internally quite consistent. In general, lower diploma implies more agreement with statements that risk-increasing car driving behaviours are dangerous. For instance, lower diploma implies more agreement with the opinion that (1) it is more difficult to react correctly when driving under the influence of alcohol (Attitude survey 2015) or when driving too fast (Unsafety Barometer 2015), (2) driving fast is socially unacceptable (Attitude survey 2015 and Unsafety Barometer 2015), (3) driving fast is putting your own life and that of others in danger (Attitude survey 2015), (4) speed limits are usually set at acceptable levels (Attitude survey 2015). Contrary to that lower diploma implies less agreement with the opinion that hand-held driving decreases your attention while driving (Attitude survey 2015). Also, in general, lower diploma implies less agreement with opinions that impact-mitigating behaviours are important for safety. For instance, lower diploma implies less agreement with the opinion that (1) one should always ask car passengers to wear their seatbelt (Attitude survey 2015), and less disagreement with the opinion that it is not really necessary to use the correct child safety system for short trips (Attitude survey 2015 and Unsafety Barometer 2015). Notwithstanding, the overall picture that emerges, is that diploma as an indicator of socioeconomic background is a factor of secondary importance at best when it comes to the prediction of opinion-related indicators of road safety. Age, gender and exposure appear to be more important predictors.

Summary findings: mediation or moderation effects

Albeit limited to the Attitude survey 2015, for alcohol impaired driving, speeding, seatbelt use and child safety system use, the effect of diploma on the self-reported opinions related to those behaviours is consistent with the effect of diploma on the self-reported frequency of those behaviours. Formal mediation/moderation testing however is required in order to examine whether the effect of diploma on the self-reported frequency of those behaviours is (partially) operating via the self-reported opinions related to those behaviours.

Synthesis

It is difficult to come to firm conclusions regarding the question if (and to what extent) diploma is a causative factor for road safety-inequalities in terms of self-reported car accident involvement, frequency of car driving behaviours and related opinions.

Educational level as an indicator of socioeconomic background is a factor of secondary importance at best. Age, gender and exposure appear to be more important.

Work package 2

Task 2.1: Differences in traffic exposure

Recall that in this task BELDAM-data were analysed. To investigate the effect of contributing factors on the variability of daily travel time expenditure, and to assess the effect of traveller's nationality in particular, five (zero-inflated) negative binomial models were fitted.

Overall results

To get a comprehensive overview of the different results, the directions of the effects are displayed in Table XVI. From this table, we can see that for some variables the effect is ambiguous (visualized by the question marks). This is partially due to the fact that in a zero-inflated model a variable might have an increasing effect on the mean parameter and simultaneously have an increasing effect on the probability of having a zero and thus decreasing the overall value of the estimate.

Table XVI: Significance and direction of effects

Parameter	**Total**	**Commuting**	**Shopping**	**Leisure**	**Visits**
Sociodemographics					
Nationality: ES	– (2)	+ (3)	– (3)	– (3)	– (3)
Nationality: FR	+ (3)	+ (3)	+ (3)	– (3)	+ (3)
Nationality: IT	– (3)	+ (3)	– (3)	0	– (3)
Nationality: MO	+ (2)	0	+ (3)	– (3)	0
Nationality: NL	+ (2)	0	+ (2)	– (3)	+ (2)
Age	+ (3)	?	+ (7)	?	+ (3)
Gender: female	0	– (5)	+ (6)	?	+ (3)
Higher education	+ (3)	+ (3)	+ (3)	+ (6)	?
Professional activity	+ (3)	+ (4)	– (3)	– (3)	– (3)
Net monthly HH income: €1500-3999	– (1)	+ (3)	– (3)	+ (2)	0
Net monthly HH income: ≥€4000	– (3)	– (2)	– (3)	+ (2)	– (2)
Net monthly HH income: undeclared	– (3)	0	– (3)	– (1)	– (3)
Household size	– (3)	+ (3)	?	– (2)	?
Companion	+ (2)	?	0	+ (3)	– (2)
Child(ren)	0	– (3)	?	– (2)	– (3)
Residential characteristics					
Urbanisation: urban	– (3)	?	– (3)	0	?
HH dwelling ownership	– (3)	– (3)	– (3)	– (3)	+ (3)
Detached house	+ (3)	+ (2)	+ (3)	+ (3)	0
Transport options and mode use frequencies					
Season ticket public transport	+ (3)	+ (6)	?	+ (6)	+ (3)
Car driver's licence	+ (3)	+ (2)	+ (5)	– (3)	+ (6)
Mobility restraints	– (3)	0	– (3)	0	0
Bike possession	+ (4)	+ (3)	+ (3)	?	+ (6)
Car possession	0	?	?	+ (3)	– (3)
Frequent walking	+ (3)	– (3)	+ (6)	0	0

Frequent cycling	0	0	+ (2)	+ (7)	0
Frequent public transit use	+ (3)	+ (6)	+ (3)	0	0
Frequent car use	+ (2)	0	0	?	+ (3)
Temporal characteristics					
Weekend day	– (2)	– (4)	+ (3)	+ (6)	+ (6)
School holiday	0	– (4)	+ (2)	0	+ (6)
Travel time expenditure other	N/A	– (7)	– (4)	– (3)	– (8)

0: no effect, -: negative effect, +: positive effect, ?: ambiguous effect, N/A: not applicable

Values between brackets indicate the number of parameters (in the four models) confirming the effect

A second, although less important, reason for the ambiguity is the fact that the four different models (i.e. conservative and progressive weighting, and conservative and progressive bootstrapping) do not always yield the same direction of effects. In this context, it should be noted that non-significance of parameters did not contribute to the ambiguity. Take as an example the effect of higher education on total travel time expenditure, which has an increasing effect in three out of the four models, but was not significant in the conservative bootstrapping model. In the latter case, the effect of this parameter is considered to have a positive (increasing) effect on travel time expenditure.

Recall that the model for the total daily travel time expenditure is modeled using a classical negative binomial model, whereas the motive specific models were modelled using a zero-inflated negative binomial model. The need to account for the excess in zeros is confirmed by the likelihood ratio tests that compare the likelihood of the zero-inflated models with the alternative without the zero-inflated part. For each of the motive-specific models, the likelihood ratio test is highly significant (p-value smaller than 0.001, acknowledging the need for a zero-inflated model, which was also observed from the inspection of the kernel density estimates of the data distributions).

With respect to the direction of the effects, one could observe from Table XVI that for the majority of the variables, the direction of the effect highly depends on the motive. This provides evidence of the notion of the travel time frontier (see e.g. Volosin et al., 2013), indicating that travellers are not willing to surpass a certain threshold in terms of time travelling a day. Further evidence of this effect is provided by the negative effect of travel time spent on other trip motives than the one under study.

Total daily travel time expenditure

Parameter estimates of the negative binomial model of the total daily travel time expenditure are displayed in Table XVII. From this table, one can observe that in general the estimates of the four adopted techniques lie in the same direction, but that the reported standard errors and p-values using conservative bootstrapping are considerable different. The latter is an indication that when the bootstrap samples are too small in size, the power to detect significant differences is too weak.

Regarding nationality, it should be noted that in comparison to Belgians, French have a significantly higher daily travel time expenditure, whereas Italians spend significantly fewer time travelling on a daily basis. The higher travel time expenditure by French can be explained by their longer travel times on commuting, shopping and visit trips. The lower expenditure by Italians can be accounted for by their lower shopping and visit distance, and by a relative higher proportion of professionally inactive persons. Concerning other sociodemographic effects, one could derive that travellers with a degree of higher education spend 13.4% (= exp(0.126) – 1) more time on travelling in comparison to their counterparts.

With respect to residential characteristics, one could depict that people residing in urban areas have a lower daily travel time expenditure. This can be accounted for by the typical larger and denser number of activity opportunities in urban areas. Moreover, people that are owner of their household dwelling spend less time on travelling. This suggests that in comparison to tenants, owners have a better residential location to satisfy their needs for activity participation. In addition, whether the dwelling type is a detached house has an increasing effect on daily travel time expenditure.

Concerning transport options and mode use, all estimates lie exactly in the direction as one would expect: a higher number of transport options have an increasing effect on daily travel time expenditure. Moreover, the more frequently one uses different transport modes, the higher the daily travel time expenditure. People with physical mobility constraints spend less time travelling, which could be a sign of lower level of out-home activity participation.

Finally, with regard to the temporal characteristics, one could note that less time is spent on travelling during weekend days. Notwithstanding, some preoccupation needs to be taken in generalizing these effect, as this effect was only acknowledged by the two weighted models.

Table XVII: Maximum likelihood parameter estimates negative binomial regression model total daily travel time expenditure

	Weighting			**Cons. bootstrapping**			**Prog. bootstrapping**		
Parameter	**Est.**	**S.E.**	**Sign.**	**Est.**	**S.E.**	**Sign.**	**Est.**	**S.E.**	Sign.
Intercept		0.046	<0.001	3.683	0.389	<0.001	3.717	0.064	<0.001
Sociodemographics									
Nationality: ES	-0.057	0.027	0.036	0.016	0.212	0.941	-0.044	0.036	0.219
Nationality: FR	0.185	0.020	<0.001	0.202	0.240	0.401	0.187	0.041	<0.001
Nationality: IT	-0.133	0.021	<0.001	-0.044	0.206	0.830	-0.107	0.038	0.005
Nationality: MO	0.073	0.029	0.012	0.082	0.240	0.732	0.020	0.039	0.600
Nationality: NL	0.055	0.023	0.018	0.036	0.190	0.848	-0.009	0.036	0.807
Age	0.001	0.001	0.027	0.001	0.004	0.792	0.001	0.001	0.044
Higher education	0.126	0.016	<0.001	0.150	0.140	0.282	0.130	0.023	<0.001
Professional activity	0.079	0.017	<0.001	0.131	0.139	0.347	0.126	0.022	<0.001

Net monthly HH income: €1500-3999	-0.030	0.020	0.130	-0.044	0.156	0.779	-0.058	0.027	0.030
Net monthly HH income: ≥€4000	-0.099	0.026	<0.001	-0.096	0.218	0.660	-0.115	0.034	0.001
Net monthly HH income: undeclared	-0.247	0.031	<0.001	-0.306	0.245	0.211	-0.320	0.039	<0.001
Household size	-0.038	0.007	<0.001	-0.041	0.059	0.487	-0.041	0.010	<0.001
Companion	0.044	0.018	0.014	0.027	0.144	0.853	0.020	0.024	0.402
Residential characteristics									
Urbanisation: urban	-0.039	0.018	0.032	-0.139	0.152	0.360	-0.121	0.025	<0.001
HH dwelling ownership	-0.055	0.018	0.002	-0.137	0.142	0.336	-0.121	0.022	<0.001
Detached house	0.087	0.019	<0.001	0.167	0.171	0.329	0.134	0.029	<0.001
Transport options and mode use									
Season ticket public transport	0.231	0.019	<0.001	0.315	0.165	0.056	0.317	0.027	<0.001
Car driver's licence	0.253	0.024	<0.001	0.238	0.210	0.257	0.264	0.032	<0.001
Mobility restraints	-0.111	0.022	<0.001	-0.212	0.211	0.314	-0.188	0.035	<0.001
Bike possession	0.277	0.017	<0.001	0.298	0.148	0.044	0.311	0.022	<0.001
Frequent walking	0.117	0.017	<0.001	0.165	0.141	0.241	0.166	0.025	<0.001
Frequent public transit use	0.210	0.018	<0.001	0.216	0.153	0.158	0.219	0.026	<0.001
Frequent car use	0.182	0.019	<0.001	0.089	0.151	0.558	0.112	0.024	<0.001
Temporal characteristics									
Weekend day	-0.068	0.016	<0.001	-0.028	0.142	0.841	-0.020	0.023	0.380
Model specific parameters									
Dispersion[1]	0.005	0.000	<0.001						
Dispersion[2]	0.186	0.003	<0.001						
Dispersion[3]				0.440	0.049	<0.001	0.502	0.009	<0.001

[1] Conservative weighting, [2] Progressive weighting, [3] Bootstrapping

Motive specific travel time expenditures

Commuting trips

With regard to the motive specific travel time expenditures, parameter estimates of the model predicting travel time expenditure on commuting (work/school) trips are displayed in Table XVIII. Recall that the motive specific models have two sets of parameters. The first set relates to the parameters estimating the effect on the mean parameter (negative binomial part), whereas the second set relates to the zero-inflation part.

Focusing on the sociodemographics, one could observe from the estimates of nationality that Spanish, French and Italian travellers spend significantly more time on commuting trips in comparison to Belgians. This can be explained by the fact that they are prepared to commute longer distances to find a job that matches their education. With regard to age, one can depict that on the one hand, age has an increasing effect on the mean travel time expenditure, whereas on the other hand it increases the probability of a zero travel time expenditure. Concerning female gender, one can observe that it decreases the overall travel time expenditure and moreover increases the probability of a zero travel time expenditure. This negative effect provides evidence for two phenomena: (*i*) a lower professional participation rate among females, (*ii*) a better job-housing balance of females, as the female proportion of caretakers of children is still higher than males due to the presence of traditional role patterns.

Table XVIII: Maximum likelihood parameter estimates zero-inflated negative binomial regression model daily travel time expenditure commuting trips

	Weighting			**Cons. bootstrapping**			**Prog. bootstrapping**		
Parameter	**Est.**	**S.E.**	**Sign.**	**Est.**	**S.E.**	**Sign.**	**Est.**	**S.E.**	**Sign.**
Negative binomial part									
Intercept	3.371	0.060	<0.001	3.575	0.581	<0.001	3.631	0.078	<0.001
Nationality: ES	0.127	0.040	0.002	0.258	0.319	0.419	0.196	0.047	<0.001
Nationality: FR	0.112	0.026	<0.001	0.193	0.300	0.520	0.159	0.046	0.001
Nationality: IT	0.105	0.030	0.001	0.181	0.323	0.575	0.140	0.052	0.007
Nationality: MO	-0.019	0.044	0.667	-0.039	0.323	0.903	-0.072	0.048	0.136
Nationality: NL	0.061	0.036	0.095	0.075	0.338	0.824	0.033	0.049	0.506
Age	0.008	0.001	<0.001	0.013	0.009	0.139	0.012	0.001	<0.001
Gender: female	-0.148	0.020	<0.001	-0.111	0.167	0.505	-0.122	0.024	<0.001
Higher education	0.122	0.024	<0.001	0.099	0.215	0.645	0.086	0.029	0.003
Net monthly HH income: €1500-3999	0.095	0.033	0.004	0.202	0.278	0.466	0.178	0.037	<0.001
Net monthly HH income: ≥€4000	-0.075	0.038	0.050	0.016	0.321	0.961	-0.037	0.045	0.415
Net monthly HH income: undeclared	0.050	0.043	0.248	0.085	0.373	0.820	0.066	0.047	0.160
Companion	0.073	0.024	0.002	0.038	0.212	0.856	0.049	0.028	0.082
Urbanisation: urban	-0.203	0.024	<0.001	-0.400	0.231	0.084	-0.363	0.032	<0.001
HH dwelling ownership	-0.145	0.025	<0.001	-0.198	0.203	0.331	-0.181	0.031	<0.001
Detached house	0.093	0.026	<0.001	0.021	0.253	0.935	0.041	0.038	0.283
Season ticket public transport	0.137	0.028	<0.001	0.126	0.272	0.644	0.091	0.033	0.006
Car driver’s licence	0.170	0.033	<0.001	0.026	0.327	0.936	0.044	0.043	0.306
Bike possession	0.111	0.025	<0.001	0.137	0.215	0.524	0.145	0.030	<0.001
Car possession	0.152	0.032	<0.001	-0.103	0.273	0.707	-0.084	0.036	0.019

Frequent walking	-0.139	0.023	<0.001	-0.204	0.194	0.293	-0.191	0.027	<0.001
Frequent public transit use	0.524	0.028	<0.001	0.459	0.265	0.084	0.479	0.036	<0.001
Travel time expenditure other	-0.001	0.000	<0.001	-0.002	0.002	0.412	-0.001	0.000	<0.001
Dispersion[1]	0.004	0.000	<0.001						
Dispersion[2]	0.135	0.004	<0.001						
Dispersion[3]				0.310	0.053	<0.001	0.408	0.009	<0.001
Zero-inflated part									
Intercept	-1.507	0.221	<0.001	-2.358	1.540	0.126	-2.148	0.194	<0.001
Age	0.052	0.003	<0.001	0.065	0.022	0.003	0.059	0.003	<0.001
Gender: female	0.372	0.068	<0.001	0.102	0.547	0.852	0.078	0.073	0.289
Professional activity	-2.767	0.092	<0.001	-3.358	0.777	<0.001	-3.023	0.097	<0.001
Household size	-0.163	0.037	<0.001	-0.138	0.245	0.572	-0.117	0.032	<0.001
Companion	0.417	0.091	<0.001	0.596	0.681	0.381	0.496	0.095	<0.001
Child(ren)	0.413	0.106	<0.001	0.553	0.842	0.511	0.479	0.113	<0.001
Urbanisation: urban	-0.162	0.071	0.023	-0.125	0.647	0.847	-0.086	0.082	0.290
Season ticket public transport	-0.268	0.105	0.011	-0.923	0.744	0.215	-0.814	0.092	<0.001
Car possession	-0.403	0.136	0.003	-0.333	0.743	0.654	-0.337	0.101	0.001
Frequent public transit use	-0.234	0.102	0.021	-0.315	0.736	0.668	-0.306	0.092	0.001
Weekend day	2.907	0.088	<0.001	3.406	0.826	<0.001	3.105	0.106	<0.001
School holiday	1.415	0.090	<0.001	1.746	0.835	0.037	1.605	0.110	<0.001
Travel time expenditure other	0.014	0.001	<0.001	0.026	0.009	0.003	0.023	0.001	<0.001

[1] Conservative weighting, [2] Progressive weighting, [3] Bootstrapping

An obvious, but very significant effect is the decreased likelihood of a zero travel time expenditure on commuting trips when the traveller is professionally active. In the same context, the temporal characteristics (i.e. weekend day and school holiday) significantly affect the probability of a zero travel time expenditure.

In addition, the increasing effect of frequent public transit use draws attention. This effect can be partially explained by the fact that travellers who use the train for their work commute typically travel longer distances and have correspondingly longer travel times.

Shopping trips

Parameter estimates of the model predicting daily travel time expenditure on shopping trips are displayed in Table XIX. The strongest effects with respect to nationality are the considerable higher travel time expenditure of Moroccans and lower expenditure of Italians in comparison to Belgians. The higher daily travel time for shopping for Spanish and Moroccans can be explained by distance between their residence and the shopping locations that correspond to the own food preferences. This could be an index of social exclusion or low integration of these national groups in the Belgian society (Farber et al., 2011).

Regarding other sociodemographics, especially the gender difference is appealing. Females have a higher mean travel time expenditure and a lower probability of a zero travel time expenditure in comparison to males. This provides evidence that the general preoccupation that shopping is mainly a female activity holds true.

Table XIX: Maximum likelihood parameter estimates zero-inflated negative binomial regression model daily travel time expenditure shopping trips

	Weighting			**Cons. bootstrapping**			**Prog. bootstrapping**		
Parameter	**Est.**	**S.E.**	**Sign.**	**Est.**	**S.E.**	**Sign.**	**Est.**	**S.E.**	**Sign.**
Negative binomial part									
Intercept	2.513	0.096	<0.001	1.688	0.956	0.077	2.046	0.138	<0.001
Nationality: ES	-0.124	0.056	0.028	-0.078	0.519	0.881	-0.325	0.097	0.001
Nationality: FR	0.243	0.042	<0.001	0.406	0.533	0.447	0.221	0.093	0.017
Nationality: IT	-0.298	0.047	<0.001	-0.199	0.558	0.722	-0.385	0.093	<0.001
Nationality: MO	0.569	0.060	<0.001	0.882	0.548	0.108	0.615	0.091	<0.001
Nationality: NL	0.132	0.053	0.013	0.325	0.473	0.492	0.054	0.091	0.548
Age	0.008	0.001	<0.001	0.016	0.009	0.071	0.016	0.002	<0.001
Gender: female	0.129	0.029	<0.001	0.181	0.247	0.463	0.187	0.045	<0.001
Net monthly HH income: €1500-3999	-0.207	0.043	<0.001	-0.372	0.436	0.393	-0.355	0.058	<0.001
Net monthly HH income: ≥€4000	-0.451	0.056	<0.001	-0.654	0.551	0.235	-0.668	0.081	<0.001
Net monthly HH income: undeclared	-0.240	0.067	<0.001	-0.250	0.593	0.673	-0.268	0.067	<0.001
Household size	0.091	0.018	<0.001	0.063	0.184	0.731	0.081	0.040	0.045
Child(ren)	-0.416	0.045	<0.001	-0.500	0.534	0.349	-0.534	0.099	<0.001
Urbanisation: urban	-0.120	0.038	0.001	-0.123	0.400	0.759	-0.183	0.063	0.003
HH dwelling ownership	-0.093	0.036	0.010	-0.237	0.284	0.405	-0.221	0.042	<0.001
Detached house	0.141	0.040	<0.001	0.377	0.448	0.399	0.286	0.067	<0.001
Season ticket public transport	0.168	0.042	<0.001	0.184	0.342	0.590	0.153	0.065	0.020
Car driver’s licence	0.122	0.049	0.012	0.281	0.566	0.620	0.217	0.076	0.004
Mobility restraints	-0.224	0.049	<0.001	-0.393	0.571	0.491	-0.449	0.091	<0.001
Car possession	0.512	0.051	<0.001	0.855	0.475	0.072	0.841	0.067	<0.001

Frequent walking	0.153	0.037	<0.001	0.215	0.388	0.579	0.183	0.050	<0.001
Frequent cycling	0.106	0.039	0.006	-0.162	0.346	0.639	-0.096	0.076	0.205
Frequent public transit use	0.343	0.039	<0.001	0.444	0.323	0.169	0.476	0.059	<0.001
Dispersion[1]	0.006	0.000	<0.001						
Dispersion[2]	0.199	0.008	<0.001						
Dispersion[3]				0.257	0.085	0.003	0.446	0.025	<0.001
Zero-Inflation part									
Intercept	0.891	0.180	<0.001	1.640	1.243	0.187	1.516	0.166	<0.001
Age	-0.019	0.002	<0.001	-0.029	0.013	0.034	-0.026	0.002	<0.001
Gender: female	-0.295	0.055	<0.001	-0.240	0.400	0.548	-0.229	0.059	<0.001
Higher education	-0.496	0.060	<0.001	-0.520	0.486	0.284	-0.473	0.065	<0.001
Professional activity	0.527	0.069	<0.001	0.449	0.487	0.357	0.433	0.066	<0.001
Household size	0.146	0.033	<0.001	0.401	0.216	0.063	0.379	0.032	<0.001
Child(ren)	-0.499	0.086	<0.001	-0.934	0.599	0.119	-0.860	0.086	<0.001
Season ticket public transport	0.184	0.073	0.011	-0.379	0.464	0.414	-0.329	0.062	<0.001
Car driver's licence	-0.312	0.092	0.001	-0.007	0.532	0.989	-0.009	0.080	0.912
Bike possession	-0.155	0.067	0.021	-0.733	0.469	0.118	-0.684	0.068	<0.001
Car possession	0.512	0.103	<0.001	0.011	0.549	0.984	0.029	0.071	0.685
Frequent walking	-0.182	0.060	0.003	-0.413	0.544	0.448	-0.398	0.075	<0.001
Weekend day	-0.370	0.063	<0.001	-0.773	0.458	0.092	-0.750	0.064	<0.001
School holiday	-0.265	0.074	<0.001	-0.012	0.513	0.981	-0.041	0.076	0.595
Travel time expenditure other	0.010	0.001	<0.001	0.012	0.005	0.021	0.011	0.001	<0.001

[1] Conservative weighting, [2] Progressive weighting, [3] Bootstrapping

Leisure trips

Regarding the parameter estimates of the leisure trip model (displayed in Table XX), one could depict that especially Dutch and Moroccans are spending less time on leisure trips in comparison to Belgians. A possible explanation for the Moroccans is that they are more committed toward their original cultural traditions, and therefore prefer to spend leisure time with their countrymen, which are often geographically clustered. Furthermore, one could see that the above mentioned effect of owning a dwelling in comparison to be tenant and the effect of higher education play an important role in the context of leisure trips. Concerning temporal characteristics, one can see that leisure trips are especially a weekend day activity, since the probability of zero travel time expenditure is considerably lower during weekends.

Table XX: Maximum likelihood parameter estimates zero-inflated negative binomial regression model daily travel time expenditure leisure trips

Parameter	Weighting			Cons. bootstrapping			Prog. bootstrapping		
	Est.	**S.E.**	**Sign.**	**Est.**	**S.E.**	**Sign.**	**Est.**	**S.E.**	**Sign.**
Negative binomial part									
Intercept	3.768	0.136	<0.001	3.406	2.934	0.246	3.791	0.192	<0.001
Nationality: ES	-0.304	0.101	0.003	-0.176	1.938	0.928	-0.549	0.140	<0.001
Nationality: FR	-0.298	0.067	<0.001	-0.172	1.340	0.898	-0.442	0.104	<0.001
Nationality: IT	0.091	0.075	0.224	0.432	2.323	0.852	0.152	0.124	0.219
Nationality: MO	-0.569	0.152	<0.001	-0.627	7.807	0.936	-0.887	0.148	<0.001
Nationality: NL	-0.761	0.073	<0.001	-0.462	1.027	0.652	-0.896	0.109	<0.001
Age	0.006	0.002	<0.001	0.010	0.031	0.754	0.008	0.002	0.001
Gender: female	0.208	0.045	<0.001	0.284	0.945	0.764	0.243	0.061	<0.001
Higher education	0.141	0.057	0.014	0.321	1.049	0.760	0.248	0.080	0.002
Household size	-0.045	0.021	0.035	-0.010	0.335	0.977	-0.017	0.024	0.466
Companion	0.193	0.063	0.002	0.122	1.003	0.903	0.197	0.073	0.007
HH dwelling ownership	-0.466	0.064	<0.001	-0.716	0.968	0.459	-0.703	0.066	<0.001
Detached house	0.220	0.058	<0.001	0.192	1.184	0.872	0.212	0.098	0.030
Season ticket public transport	0.191	0.055	0.001	0.142	0.901	0.875	0.161	0.073	0.027
Car driver’s licence	-0.232	0.072	0.001	-0.530	1.242	0.669	-0.496	0.092	<0.001
Car possession	0.403	0.086	<0.001	0.707	1.633	0.665	0.676	0.097	<0.001
Frequent cycling	0.464	0.053	<0.001	0.546	0.965	0.572	0.620	0.086	<0.001
Frequent car use	-0.350	0.069	<0.001	-0.552	1.340	0.680	-0.516	0.077	<0.001
Weekend day	0.126	0.052	0.014	0.166	0.893	0.852	0.156	0.080	0.052
Dispersion[1]	0.006	0.000	<0.001						
Dispersion[2]	0.211	0.011	<0.001						
Dispersion[3]				0.093	0.075	0.217	0.318	0.026	<0.001
Zero-Inflation part									
Intercept	1.813	0.179	<0.001	1.554	1.024	0.129	1.478	0.149	<0.001
Age	0.008	0.002	<0.001	0.021	0.017	0.207	0.019	0.002	<0.001
Gender: female	0.168	0.067	0.012	0.800	0.574	0.163	0.745	0.075	<0.001
Higher education	-0.506	0.077	<0.001	-0.839	0.637	0.188	-0.742	0.087	<0.001
Net monthly HH income: €1500-3999	-0.323	0.106	0.002	-0.063	0.647	0.923	-0.067	0.090	0.458

Net monthly HH income: ≥€4000	-0.587	0.123	<0.001	0.012	0.857	0.988	-0.017	0.112	0.880
Net monthly HH income: undeclared	0.086	0.176	0.627	0.624	6.258	0.921	0.556	0.150	<0.001
Professional activity	0.398	0.080	<0.001	0.833	0.661	0.208	0.763	0.086	<0.001
Child(ren)	0.299	0.088	0.001	-0.219	0.714	0.759	-0.142	0.089	0.112
Season ticket public transport	-0.324	0.081	<0.001	-1.037	0.680	0.127	-0.898	0.082	<0.001
Bike possession	-0.181	0.091	0.046	0.344	0.695	0.620	0.314	0.095	0.001
Frequent cycling	-0.244	0.080	0.002	-1.422	0.656	0.030	-1.273	0.082	<0.001
Frequent car use	-0.350	0.108	0.001	-0.396	0.730	0.588	-0.299	0.083	<0.001
Weekend day	-0.583	0.071	<0.001	-1.314	0.573	0.022	-1.167	0.071	<0.001
Travel time expenditure other	0.008	0.001	<0.001	0.006	0.005	0.310	0.004	0.001	<0.001

[1] Conservative weighting, [2] Progressive weighting, [3] Bootstrapping

Visit trips

A final set of parameters corresponds to the parameters of the model predicting travel time expenditure on visit trips. From Table XXI, one could see that Spanish and Italians spend considerable less time on visit trips in comparison to Belgians, whereas French spend significantly more time. This can be partially explained by the fact that Belgian and French people have a higher probability of having family or close friends living in Belgium or in the same city, whereas Spanish and Italian groups have a lower probability. Moreover, for French people, it is still reasonable to visit relatives and friends in France given the geographical proximity, whereas this is less likely for Italians and Spanish. Besides, one should notice the effect of school holidays, which has an increasing effect on overall travel time expenditure and a decreasing effect on the likelihood of a zero expenditure.

Table XXI: Maximum likelihood parameter estimates zero-inflated negative binomial regression model daily travel time expenditure visit trips

	Weighting			**Cons. bootstrapping**			**Prog. bootstrapping**		
Parameter	**Est.**	**S.E.**	**Sign.**	**Est.**	**S.E.**	**Sign.**	**Est.**	**S.E.**	**Sign.**
Negative binomial part									
Intercept	1.682	0.132	<0.001	0.899	2.885	0.755	1.248	0.233	<0.001
Nationality: ES	-0.870	0.103	<0.001	-0.625	1.532	0.683	-1.241	0.121	<0.001
Nationality: FR	0.553	0.062	<0.001	0.527	1.388	0.704	0.276	0.111	0.013
Nationality: IT	-0.651	0.074	<0.001	-0.470	1.474	0.750	-0.881	0.120	<0.001
Nationality: MO	-0.042	0.106	0.688	0.112	1.952	0.954	-0.237	0.135	0.079
Nationality: NL	0.240	0.082	0.003	0.313	1.516	0.837	0.110	0.124	0.375

Age	0.015	0.001	<0.001	0.015	0.030	0.606	0.017	0.002	<0.001
Gender: female	0.201	0.045	<0.001	0.364	0.780	0.640	0.294	0.072	<0.001
Higher education	0.243	0.047	<0.001	0.189	0.810	0.816	0.290	0.062	<0.001
Net monthly HH income: €1500-3999	-0.052	0.063	0.414	0.112	1.145	0.922	0.084	0.093	0.365
Net monthly HH income: ≥€4000	-0.178	0.087	0.041	-0.060	1.771	0.973	-0.112	0.123	0.363
Net monthly HH income: undeclared	-0.524	0.132	<0.001	-4.975	8.348	0.551	-0.915	0.401	0.023
Household size	0.150	0.028	<0.001	0.193	0.529	0.715	0.137	0.037	<0.001
Child(ren)	-0.501	0.069	<0.001	-0.409	1.343	0.761	-0.422	0.113	<0.001
Urbanisation: urban	0.820	0.057	<0.001	1.222	1.052	0.245	1.210	0.086	<0.001
HH dwelling ownership	0.237	0.057	<0.001	0.202	1.382	0.884	0.335	0.084	<0.001
Season ticket public transport	0.319	0.058	<0.001	0.053	1.088	0.961	0.245	0.095	0.010
Car driver's licence	0.212	0.067	0.002	0.257	1.227	0.834	0.259	0.088	0.003
Bike possession	0.244	0.052	<0.001	0.161	0.926	0.862	0.215	0.064	0.001
Weekend day	0.245	0.053	<0.001	0.493	1.123	0.661	0.461	0.084	<0.001
School holiday	0.450	0.061	<0.001	0.394	1.297	0.761	0.389	0.102	<0.001
Travel time expenditure other	-0.001	0.000	0.001	-0.001	0.009	0.931	-0.001	0.001	0.470
Dispersion[1]	0.008	0.000	<0.001						
Dispersion[2]	0.284	0.016	<0.001						
Dispersion[3]				0.159	0.109	0.145	0.512	0.032	<0.001
Zero-Inflation part									
Intercept	1.056	0.147	<0.001	0.759	1.176	0.519	0.790	0.163	<0.001
Higher education	-0.173	0.069	0.013	0.257	0.556	0.645	0.204	0.081	0.012
Professional activity	0.297	0.070	<0.001	0.386	0.537	0.473	0.302	0.071	<0.001
Household size	0.090	0.028	0.001	0.082	0.236	0.727	0.089	0.033	0.006
Companion	0.234	0.070	0.001	0.033	0.576	0.954	0.051	0.072	0.478
Urbanisation: urban	0.220	0.065	0.001	0.849	0.547	0.120	0.728	0.077	<0.001
Car driver's licence	-0.320	0.098	0.001	-0.477	0.771	0.536	-0.409	0.094	<0.001
Bike possession	-0.169	0.077	0.028	-0.269	0.589	0.648	-0.242	0.085	0.004
Car possession	0.287	0.131	0.028	0.896	0.909	0.325	0.821	0.133	<0.001
Frequent car use	-0.430	0.112	<0.001	-1.177	0.950	0.215	-1.016	0.135	<0.001
Weekend day	-0.927	0.070	<0.001	-0.829	0.591	0.161	-0.798	0.080	<0.001
School holiday	-0.678	0.083	<0.001	-0.562	0.724	0.438	-0.471	0.091	<0.001
Travel time expenditure other	0.011	0.001	<0.001	0.014	0.007	0.034	0.013	0.001	<0.001

[1] Conservative weighting, [2] Progressive weighting, [3] Bootstrapping

Overall conclusion is that nationality plays an important role in explaining differences in daily travel time expenditure.

Task 2.2: Differences in attitudes towards speeding

As a reminder the different steps in the analysis: First, the focus was laid on the TPB concepts, where the self-declared speeding was analyzed as a function of the other TPB concepts and socioeconomic and cultural factors using linear regression. Secondly, the number of speeding tickets obtained during the last three years was analyzed. To this end, a negative binomial model was fitted to determine the influencing socioeconomic and cultural factors. The residual of the self-declared speeding model was also entered as an explanatory factor to assess the impact of the pure (i.e. controlled for other explanatory factors) speeding behaviour on the number of speeding tickets. Finally, the number of car accidents in which the respondents were involved as driver during the last three years was modeled. Similar to the number of speeding tickets, a negative binomial model was fitted, and the pure speeding behaviour was also used as an explanatory factor.

Model results

An overview of the contributing factors to the three variables of interest is provided in Table XXII. From this table, one can observe that age and gender have a significant effect in all three models. In terms of the components of socioeconomic status, i.e. education, professional occupation and household income, one could see that education appears to play no role (education was included in the model predicting the number of accidents to ensure stability of the Hessian matrix), whereas occupation and income did influence speeding behaviour (and the number of speeding fines in the case of the variable occupation).

With regard to ethnic background, the analysis showed that it does not influence speeding behaviour, nor the number of speeding fines. However, a significant effect can be found in the number of accidents one was involved in. This implies that differences that can be found in terms of accident involvement are not due to speeding behaviour and might be due to other unsafe driving behaviour styles, which were not the focus of the present study.

In terms of travel behaviour factors, the annual mileage is an influencing factor in all three models. This confirms the aforementioned importance of considering such factors as a measure of exposure.

In terms of TPB constructs, the results support the validity of the TPB as all constructs are highly significant and explain a large part of the variability in the speeding behaviour. In turn, the self-declared speeding behaviour itself does significantly influence the number of speeding fines, but does not affect the number of accidents.

A final variable that is significant in all three models is the interviewer ID. Recall that in the methodological section it was underlined that special attention would be devoted to potential interview effects. By including the interviewer ID as a control variable, the effect of the interviewer has been accounted for. The fact that this control variable is significant in all three models confirms and accentuates the difficulty of assessing sensitive questions even in self-administered questionnaires in which the interviewer is still present in the room.

When the focus is shifted towards the linear regression model predicting self-declared speeding behaviour, one could see from Table XXIII that in terms of sociodemographics, males are more likely to speed then females. Furthermore, the tendency to speed is largest for the youngest age group and decreases with age. Professionally active persons speed more than professional inactive persons, whereas in terms of income, people of the highest income speed significantly more in comparison to the other income groups.

Table XXII: Type III analysis of effects

		Speeding behaviour		Number of fines		Number of accidents	
Parameter	DF	F Value	P-value	Chi-square	P-value	Chi-square	P-value
Gender	1	7.8	0.01	24.9	< 0.01	12.22	< 0.01
Age	5	3.9	< 0.01	15.8	0.01	18.42	< 0.01
Education	2	---	---	---	---	0.98	0.61
Professional occupation	3	2.8	0.04	22.6	< 0.01	---	---
Ethnic Group	6	1.3	0.25	6.6	0.36	14.62	0.02
Net monthly household income	3	3.3	0.02	---	---	---	---
Number of person in household 12 or younger	1	---	---	4.3	0.04	---	---
Daily car use	1	---	---	11.5	< 0.01	7.64	0.01
Annual car mileage	2	18.1	< 0.01	33.1	< 0.01	8.56	0.01
Primary use of car	2	---	---	6.4	0.04	---	---
Degree of concern about pollution[1]	1	53.1	< 0.01	5.8	0.02	---	---
Degree of concern about congestion[1]	1	10.9	< 0.01	---	---	---	---
Degree of concern about traffic accidents[1]	1	7.5	0.01	---	---	---	---
Acceptability of transporting children in the car without securing them[2]	1	---	---	---	---	5.58	0.02
Acceptability of driving up to 10 km/h above the legal speed limit[2]	1	149.3	< 0.01	26.8	< 0.01	5.49	0.02
Acceptability of typing text messages or e-mails while driving[2]	1	---	---	6.6	0.01	---	---
Acceptability of driving when they're so sleepy that they have trouble keeping their eyes open[2]	1	9.9	< 0.01	---	---	---	---
Acceptability of driving without insurance[2]	1	---	---	5.4	0.02	---	---

Acceptability of parking their car where it is not allowed[2]	1	11.8	< 0.01	---	---	6.2	0.01
Acceptability of talking on a hand-held mobile phone while driving[2]	1	12.0	< 0.01	---	---	---	---
Acceptability of not wearing a seat belt in the back of the car[2]	1	6.8	0.01	21.1	< 0.01	---	---
Main influencing person driving style	4	4.6	< 0.01	N/A	N/A	N/A	N/A
Intention[3]	1	123.5	< 0.01	N/A	N/A	N/A	N/A
Attitude[3]	1	155.2	< 0.01	N/A	N/A	N/A	N/A
Social norm[3]	1	6.7	0.01	N/A	N/A	N/A	N/A
Perceived behavioural control[3]	1	137.9	< 0.01	N/A	N/A	N/A	N/A
Behaviour[3]	1	N/A	N/A	25.3	< 0.01	0.72	0.40
Interviewer-ID	54	8.3	< 0.01	171.2	< 0.01	83.05	0.01
Model Fit							
R-Square		0.637					
AIC				4554.7		1636.2	

---: the variable was not included in the model; N/A: not applicable.

Table XXIII: Parameter estimates 2SLS linear regression model predicting self-declared speeding behaviour*

Parameter (Reference category)	Est.	S.E.
Intercept	2.735	0.324
Gender (Female)		
Male	0.130	0.047
Age (65+)		
18-24	0.452	0.131
25-34	0.295	0.108
35-44	0.136	0.108
45-54	0.156	0.107
55-64	0.127	0.110
Professional occupation (Prof. Active)		
Student	0.049	0.098
Professionally inactive	-0.155	0.062
Missing	0.117	0.106
Ethnic Group (Belgium)		
Sub-Saharan Africa & Egypt	-0.035	0.085
East-Europe	-0.088	0.085
Maghreb	-0.142	0.087
North- & West-Europe	-0.044	0.083
South-Europe	0.066	0.085
Turkey	-0.088	0.086
Net monthly household income (> 4000 €)		
0-2000 €	-0.161	0.090
2000-4000 €	-0.249	0.086
Not declared	-0.206	0.096
Annual car mileage (> 10,000 km)		
< 10,000 km	-0.301	0.050
Unknown	-0.024	0.092
Degree of concern about pollution	-0.190	0.026
Degree of concern about congestion	0.092	0.028
Degree of concern about traffic accidents	-0.081	0.029

Acceptability of driving up to 10 km/h above the legal speed limit	0.231	0.019
Acceptability of driving when they're so sleepy that they have trouble keeping their eyes open	0.103	0.033
Acceptability of parking their car where it is not allowed	0.082	0.024
Acceptability of talking on a hand-held mobile phone while driving	0.099	0.028
Acceptability of not wearing a seat belt in the back of the car	0.057	0.022
Main influencing person driving style (Household member)		
Other family	-0.084	0.104
Colleagues. friends. acquaintances. neighbours	0.235	0.083
Other	0.540	0.178
Nobody	-0.025	0.071
Intention	0.272	0.024
Attitude	0.324	0.026
Social norm	0.080	0.031
Perceived behavioural control	0.305	0.026

* The parameter estimates for the Interviewer-ID are not tabulated.

In terms of travel behaviour, persons with a high annual car mileage (> 10,000 km) are more likely to speed. This in accordance with aggregate road safety indicators that show that higher exposure results in higher accident risks (see e.g. Van den Bossche et al., 2005).

In terms of general concerns, the degree of concern about pollution and traffic accidents decrease the likelihood to speed, whereas the concern about congestion increases the likelihood. Besides, the acceptability of various unsafe driving behaviours increases the chance to speed.

In terms of social influence, the results indicate that if the main person that influences the driving style is a family member (household member, other family or the driver him/herself (nobody)), the tendency to speed is considerably smaller in comparison to those that are influenced by persons outside of the family circle (colleagues, friends, acquaintances, neighbours, others).

Finally, in terms of the TPB constructs, they all have the expected signs according to the theory and have an increasing effect on the likelihood to exhibit speeding behaviour. This provides further evidence of the appropriateness of the TPB framework for investigating the deeper underpinnings of unsafe road user behaviour.

Table XXIV: Parameter estimates of the negative binomial model predicting the number of speeding tickets

Parameter (Reference category)	Est.	S.E.
Intercept	-1.051	0.531
Gender (Female)		
Male	0.491	0.098
Age (65+)		
18-24	0.786	0.267
25-34	0.768	0.240
35-44	0.516	0.243
45-54	0.467	0.236
55-64	0.337	0.243
Professional occupation (Prof. Active)		
Student	-0.715	0.207
Professionally inactive	0.356	0.135
Missing	-0.112	0.225
Ethnic Group (Belgium)		
Sub-Saharan Africa & Egypt	0.150	0.177
East-Europe	0.097	0.171
Maghreb	0.242	0.176
North- & West-Europe	0.283	0.166
South-Europe	0.165	0.176
Turkey	0.356	0.168
Number of person in household 12 or younger	0.100	0.048
Daily car use (No)		
Yes	0.360	0.106
Annual car mileage (> 10,000 km)		
< 10,000 km	-0.545	0.107
Unknown	-0.682	0.211
Primary use of car (Commuting)		
Business	0.086	0.164
Leisure	-0.272	0.116
Degree of concern about pollution	-0.111	0.046
Acceptability of driving up to 10 km/h above the legal speed limit	0.188	0.036

Acceptability of typing text messages or e-mails while driving	0.143	0.056
Acceptability of driving without insurance	0.116	0.050
Acceptability of not wearing a seatbelt in the back of the car	0.183	0.040
Behaviour	0.262	0.052
Dispersion	1.315	0.092

When the parameter estimates of the model predicting the number of speeding tickets are assessed, one could see from Table XXIV that the directions of most of the effects are similar to the ones of the model predicting the self-declared speeding behaviour. This is the case for gender, age, car mileage, the degree of concern about pollution and the acceptability of unsafe road user behaviours. In contrast, professionally inactive persons tend to have more speeding fines than professionally active ones.

In terms of factors that were not included in the final model predicting speeding behaviour, one could depict that daily car use has a similar effect as annual car mileage and that if the car is primarily used for leisure trips, one tends to speed less. Finally, one can observe a positive effect of behaviour implying that the more likely one is to exhibit speeding behaviour, the more likely one is to receive speeding tickets. The latter effect confirms to a certain extent the validity of the self-declared speeding behaviour data and the other underlying TPB constructs.

The final set of parameter estimates corresponds to the model predicting the number of car accidents the respondents were involved in as a driver. From Table XXV, one could see that similar to the models predicting speeding behaviour and the number of fines, males are involved in more accidents and that higher exposure (car mileage and daily car use) results in a higher number of accidents. In contrast, age does not exhibit a clear decreasing effect and the number of accidents is the largest in the age range 25-44, accounting for all other variables in the model. Moreover, ethnic background does have an effect on the number of car accidents. Respondents with a Belgian background are considerably less frequently involved in accidents in comparison to their peers of other ethnic groups.

Table XXV: Parameter estimates of the negative binomial model predicting the number of car accidents as driver

Parameter (Reference category)	Est.	S.E.
Intercept	-4.515	1.000
Gender (Female)		
Male	0.605	0.173
Age (65+)		
18-24	0.607	0.504
25-34	1.077	0.456

35-44	0.976	0.459
45-54	0.254	0.473
55-64	0.602	0.485
Education (Max. secondary education)		
Min. Bachelor's degree	-0.160	0.161
Missing	-16.684	4754.987
Ethnic Group (Belgium)		
Sub-Saharan Africa & Egypt	1.075	0.309
East-Europe	0.751	0.313
Maghreb	0.731	0.321
North- & West-Europe	0.353	0.329
South-Europe	0.543	0.336
Turkey	0.694	0.313
Daily car use (No)		
Yes	0.513	0.186
Annual car mileage (> 10,000 km)		
< 10,000 km	-0.465	0.184
Unknown	-0.614	0.356
Acceptability of transporting children in the car without securing them	-0.260	0.110
Acceptability of driving up to 10 km/h above the legal speed limit	0.138	0.059
Acceptability of parking their car where it is not allowed	0.179	0.072
Behaviour	0.070	0.083
Dispersion	1.304	0.278

Conclusions about age, gender, exposure

Age, gender and annual car mileage prove to be significant predictors of self-declared speeding behaviour, number of fines and accident involvement.

Male gender, young age and high annual car mileage are associated with more speeding and higher number of fines and accidents.

Conclusions about socioeconomic status

Professional occupation and income prove to be significant predictors of self-declared speeding behaviour, but do NOT seem to be predictors of primary importance for number of fines and accident involvement.

Professional active persons speed more than professional inactive persons; people of the highest income speed significantly more in comparison to the other income groups.

Professional inactive persons report higher numbers of fines compared to professional active persons.

Regarding the number of accidents, no significant effects were observed.

Conclusions about ethnic background

Ethnic background proves to be a significant predictor of accident involvement, but does NOT seem to be a predictor of self-declared speeding behaviour and number of fines.

Car drivers with foreign cultural background report more involvement in accidents.

Regarding speeding behaviour and number of fines, no significant effects were observed. This finding implies that speeding behaviour most likely is not the unsafe driving behaviour that explains ethnic differences in accident involvement and that other unsafe road user habits might explain this difference.

Conclusions about TPB and interviewer effect

The results demonstrate the validity of the TPB to predict self-reported speeding behaviour (clear significant effect of TPB variables on self-declared speeding behaviour).

The developed recruitment approach (random walk principle and face-to-face screening) proved to be feasible for reaching difficult to approach target groups.

We observed interviewer effects in all three models. This shows the extreme difficulty of assessing sensitive questions even in self-administered questionnaires in which the interviewer is still present in the room, and it underlines the importance of including these effects in the modelling procedure of that type of surveys.

Work package 3

As explained in the methodology section, the first step of Statistical Matching existed in selecting the matching variables among the variables that BELDAM and the BRSI Attitude Survey have in common (Table XIV). Then, the different Statistical Matching procedures were performed in order to obtain integrated datasets that include the response variable/s. Consequently, the appropriateness of the different techniques could be assessed.

As Table XIV summarizes, the seven common variables between BELDAM and BRSI Attitude Surveys are mixed types (continuous or categorical). Thus, as elucidated in the methodology section, the adjusted R^2 associated with the regression model rank and/or the unadjusted R^2 associated with the squared Spearman's rank correlation coefficient could be considered to assess the strength of the correlation between the common and response variables.

According to Table XXVI, number of children (*nrchild*) and education level (*Education*) have the highest values for the R^2 spearman coefficient. This implies that "*nrchild*" and "*Education*" have the strongest correlation with "Income", which is the intended response variable in this study. Therefore, "nrchild" and "Education" were considered as the matching variables for the Statistical Matching procedure. Note that only two matching variables were selected to limit the risk of variance inflation and bias introduction in the Statistical Matching process, as outlined in the methodological section. Since "child" is a categorical variable and has the third largest correlation with "Income", it was considered as a donor class. Besides, since the level of income varies across regions, "Region" was considered as an additional donor class. The three Hot-Deck techniques for nonparametric micro Statistical Matching that were discussed in the methodological section, were implemented in this study. Furthermore, for the Nearest Neighbor and Rank hot-deck techniques both the unconstrained or constrained computation were carried out. Whereas for the Random hot-deck technique no constraint computation can be carried out, a distinction was made between the computation that chooses the donors totally at random and the computation where the donor's record is randomly selected within a specified distance bound. Thus, six integrated datasets have been computed, in which the "Income" variable from the BELDAM survey was integrated to the BRSI Attitude Survey.

Table XXVI: Spearman rho² (response variable: income)

VARIABLES	**Rho²**	**F**	**df1**	**df2**	**p-value**	**Adjusted Rho²**	**Role**
AGE	0.076	526.30	2	12850	<0.001	0.076	None
GENDER	0.003	39.56	1	12851	<0.001	0.003	None
PROV	0.008	55.05	10	12842	<0.001	0.008	None
REGION	0.013	86.20	2	12850	<0.001	0.013	Donor class
EDU	0.109	783.52	7	12845	<0.001	0.109	Matching variable
CHILD	0.089	626.62	1	12851	<0.001	0.089	Donor Class
NRCHILD	0.145	1091.11	2	12850	<0.001	0.145	Matching variable

Table XXVII provides an overview of the similarity/dissimilarity measures of the marginal distribution of "Income" for each of the six integrated datasets compared to the donor dataset (BELDAM). Based on the aforementioned limits for each of these similarity/dissimilarity measures, one can see from Table XXVII that the Rank hot-deck Statistical Matching yielded the best result, followed by the Random hot-deck and Nearest Neighbor Distance hot-deck techniques, which is in line with the existing literature (D'Orazio et al., 2012).

Table XXVII: Comparison of marginal distribution of income in the synthetic datasets with BELDAM 2010

	Similarity/Dissimilarity Measures				Chi-Square test			
Method	tvd	overlap	Bhatt	Hellinger	Pearson	df	q0.05	Delta.h0
NND	0.032	0.968	0.999	0.031	10.524	9	16.919	0.622
NND constrained	0.072	0.928	0.996	0.061	46.069	9	16.919	2.723
Rank	0.017	0.983	1.000	0.019	4.112	9	16.919	0.243
Rank constrained	0.049	0.951	0.998	0.049	28.180	9	16.919	1.666
RND	0.023	0.977	0.999	0.028	8.178	9	16.919	0.483
RND (distance specified)	0.062	0.938	0.996	0.060	47.319	9	16.919	2.797

A noticeable result is the fact that the unconstrained approaches outperform the constrained approaches. A possible explanation is the fact that in our study multiple types (categorical and continuous) of matching variables were taken into account, whereas a better preservation of the marginal distribution by the constrained approaches has been reported in studies that take a single continuous matching variable into account (D'Orazio et al., 2006). Another explanation might lie in the fact that for the Nearest Neighbor Distance hot-deck technique, the distance function varies by the type of matching variables, so in our case the "Gower" distance was used, whereas in the aforementioned study the "Manhattan" distance was used, given a single continuous matching variable was considered.

Considering the results obtained and the tight conformance of the marginal distributions of the intended response variable in this study, it can be concluded that statistical data matching is a practically applicable technique that can help overcome the lack of additional information. In fact, Statistical Matching provides a way of including a larger number of potential contributing factors than originally envisaged or collected. Having a broader scope of the potential contributing factors in a study would result in more realistic claims, instead of raising scepticism about the contribution of absent factors in the phenomenon under study.

As illustrated by this study, in order to obtain integrated datasets that can be used for further investigations, different factors should be carefully taken into account. The first factor concerns the selection of a proper secondary dataset, which should contain more observations than the recipient dataset to serve efficiently as a donor. The second factor is the selection of adequate (in terms of the highest relevance with the intended response variable) matching variables from the common variables between the donor and recipient dataset. The third factor is the selection of the suitable categorical variables to serve as donor class. The fourth factor is the choice of the Statistical Matching technique. The fifth factor is the selection of the distance function based on the nature of the matching variables, for the techniques where the distance function plays a role. In this regard, it is surprising that despite the better performance of the Mahalanobis distance compared to other distance functions (Rosenbaum, 2002; Iacus & Porro, 2007), still the Manhattan distance function is used in most applications. An interesting avenue for further research in this regard is a sensitivity analysis considering different distance functions.

Whereas this study illustrated the clear potential of different non-parametrical Statistical Matching techniques to integrate different survey datasets, further research should focus on using the integrated datasets with an attempt of validating and extending previous research efforts. Expanding the scope of variables and explicitly testing for omitted variable bias are worthwhile research efforts, which can be initiated based on the integrated databases.

To aid other research groups to further investigate inequalities in traffic safety, an overview of the different data bases used within the INTRAS project is provided in TABLE XXVIII. For each of these databases the name of the database and the contact person and/or contact organisation is listed.

Table XXVIII: Databases used within the context of the INTRAS project

Database name	Contact Person	Contact Organisation
2010 Belgian National Household Travel Survey (BELDAM)	Eric Cornelis (eric.cornelis@unamur.be)	Université de Namur / FPS Mobility
2012 BRSI (Belgium Road Safety Institute) attitude survey	Uta Meesmann (uta.meesmann@vias.be)	Vias instiute
2015 BRSI (Belgium Road Safety Institute) attitude survey	Uta Meesmann (uta.meesmann@vias.be)	Vias instiute
2015 national road Unsafety Barometer (Nationale verkeersonveiligheidsenquête)	Katrien Torfs (katrien.trofs@vias.be	Vias instiute
2016 national road Unsafety Barometer (Nationale verkeersonveiligheidsenquête)	Peter Silverans (peter.silverans@vias.be)	Vias instiute
Georeferenced accident data	Pascal Lammar (pascal.lammar@mow.vlaanderen.be)	Flanders MOW (Mobility and Public Works)
2008 Flemish Travel Behavior Survey (OVG3)	Annelies Geussens (annelies.geussens@mow.vlaanderen.be)	Flanders MOW (Mobility and Public Works)
2001 Socio-economic survey (CENSUS 2001)	Paul Vanherck (Paul.Vanherck@economie.fgov.be)	FPS Economy
Road network data	N.N. (verkeerscentrum@vlaanderen.be)	AWV (Road and traffic agency)

Integration of results

Given the fact that socioeconomic status and culture both are related to traffic safety – a fact that is abundantly illustrated in the international literature – the questions arise why people of different countries and cultures are in a varying extent involved in traffic accidents and why lower socioeconomic groups and ethnic minorities are often significantly overrepresented in traffic accidents within a country. In other words: which are the mechanisms behind the differences in accident involvement? Possible mechanisms concern both extra- (e.g. living environment, access to travel modes, exposure) and intra-individual factors (e.g. attitudes, social norms, perceived behavioural control, intentions, behaviour). The search for these mechanisms was the first starting point for our project.

A second starting point was the exploration of possible socioeconomic or cultural inequalities in accident involvement in Belgium. In this exploration also special attention was devoted to mechanisms that could explain these associations. We incorporated above mentioned extra-individual factors (mainly in the studies on the neighbourhood level: Task 1.2.1 and Task 2.1, but also in the others) and the intra-individual mechanism of self-reported behaviours and attitudes (in Task 1.2.2 and 2.2). Socioeconomic status was operationalised in the different studies as income level, diploma or professional status (i.e. active or inactive), culture was equated with nationality or ethnic group.

Conclusions concerning socioeconomic inequalities in accident involvement in Belgium

In terms of income level, we can say that socioeconomic status has some influence on accident involvement in Belgium. In Task 1.2.1 (Inequalities in traffic safety in Belgium on neighbourhood level), we saw that income level had an effect on male traffic casualties in general and female car passenger casualties. Lower income level implied higher number of casualties. In terms of significance and size, the effect of income level on traffic casualties was subordinate to the effect of exposure and degree of urbanisation. However, in Task 2.2 (Differences in attitudes towards speeding), income level had no influence on self-reported accident involvement. So it seems difficult to come to sufficiently firm conclusions regarding the influence of income level on accident involvement in Belgium.

The same holds when socioeconomic status is operationalised as diploma. In Task 1.2.2 (Inequalities in traffic safety in Belgium on the individual level), across both surveys, exposure (km driven) was the only variable that significantly predicted self-reported car accidents. Diploma was a significant predictor for car accidents in the Attitude survey 2015, but not in the Unsafety Barometer 2015.

Professional status, in Task 2.2, neither seems to be an important predictor for the self-reported involvement in accidents. In this task, accident involvement was mainly dependent of age, gender, ethnic group, annual mileage and daily car use.

Conclusions concerning cultural inequalities in accident involvement in Belgium

The picture that emerges from the survey in Task 2.2 is that ethnic group is an important predictor for the self-reported involvement in accidents. Accident involvement was mainly dependent upon age, gender, ethnic group, annual mileage and daily car use.

Conclusions concerning possible mechanisms behind inequalities in accident involvement in Belgium

As previously mentioned, mechanisms behind inequalities in accident involvement can encompass extra- and intra-individual factors, via which socioeconomic status and culture are associated with accident involvement. The different studies in our project all incorporated several of these extra- and intra-individual factors, albeit not always in an alike position. In Task 2.1 (Differences in traffic exposure), travel time expenditure was the dependent variable for which the influence of independent variables – namely sociodemographics (including nationality), residential characteristics, transport options and temporal characteristics – was investigated. In the Tasks 1.2.1, 1.2.2 and 2.2 exposure, degree of urbanisation, age, gender, ethnic group, socioeconomic status… were firstly seen as independent variables, for which the influence they have on accident involvement, behaviour, fines or attitudes was investigated. But Task 2.2 had also an important focus on the TPB. In light of that, the behaviour speeding was analysed as a function of the other TPB concepts (intention, attitude, social norm and perceived behavioural control) and also the association between speeding and accident involvement was investigated. However, in none of the studies formal testing of the extra- and intra-individual factors mediating or moderating the association of socioeconomic status and culture with accident involvement was incorporated. Nonetheless, some interesting results from the point of view of future research were obtained.

In Task 1.2.1, the underlying mechanism explaining in which way income level influences (mostly male) traffic casualties, remained unclear.

For Task 1.2.2, the overall picture that emerges is that diploma as an indicator of socioeconomic status is a factor of secondary importance at best when it comes to the prediction of car driving behaviour (i.e. alcohol impaired driving, speeding, distraction, seatbelt use, use of child safety systems) and attitudes concerning these behaviours. Age, gender and exposure appeared to be more important predictors. But, albeit limited to the Attitude survey 2015, we can conclude that for alcohol impaired driving, speeding, seatbelt use and child safety system use, the effect of diploma on the attitudes related to those behaviours is consistent with the effect of diploma on the frequency of those behaviours. Formal mediation or moderation testing is however required to come to the conclusion that the effect of diploma on these behaviours is (partially) operating via the attitudes concerning these behaviours.

The picture that emerges from Task 2.2 is that neither indicators for socioeconomic status nor ethnic group seem to be predictors of primary importance for the number of speeding fines. Professional status was the only SES-related significant predictor: professionally inactive persons reported higher number of speeding fines compared to professionally active persons. Number of speeding fines was mainly dependent upon annual car mileage, past speeding behaviour, gender and acceptance of a selection of risk-increasing car driving behaviours. Similarly, neither indicators for socioeconomic status nor ethnic group seem to be predictors of primary importance for the frequency of speeding itself. Net monthly household income and professional status were the only SES-related significant predictors: higher net monthly household income implied higher frequency of speeding behaviour and professionally active persons reported higher frequency of speeding behaviour compared to professionally inactive persons. Frequency of speeding was mainly dependent upon speeding-related attitudes, perceived behavioural control over speeding, the intention to speed, acceptance of a selection of risk-increasing behaviours, concerns related to pollution, congestion and traffic accidents, annual car mileage, social norm towards speeding, the main person influencing driving style, gender and age.

An important conclusion of Task 2.2 is that the results support the validity of the TPB, as all concepts were highly significant and explained a large part of the variability in the speeding behaviour. In turn, the speeding behaviour itself did significantly influence the number of speeding fines, but did not affect the number of accidents.

Attitudes towards speeding, perceived behavioural control over speeding, the intention to speed, acceptance of a selection of risk-increasing behaviours, concerns related to pollution, congestion and traffic accidents, and social norm towards speeding were the most important predictors for the frequency of speeding. Even though the SES-indicators net monthly household income and professional status were also significant predictors for the frequency of speeding, it might be reasonable to hypothesise that the direct effect of those two SES-related indicators (partially) operates via the attitudes, perceived behavioural control, intentions etc. Formal mediation or moderation testing is however required to confirm this hypothesis.

Ethnic group was not a significant predictor for the number of speeding fines obtained, nor for the frequency of speeding. The effect of ethnic group on attitudes, perceived behavioural control, intentions etc. was not investigated. It therefore remains difficult to explain the previous finding that ethnic group influences accident involvement. It is clear that the effect of ethnic group on accident involvement cannot be explained in function of speeding behaviour because ethnic group does not predict speeding behaviour and speeding behaviour does not predict accident involvement. One can only fall back on other research to speculate about possible mechanisms for the influence of ethnic group on accident involvement.

In Task 2.1, the overall conclusion was that nationality plays an important role in explaining differences in daily travel time expenditure (exposure), even after controlling for other contributing factors, such as other sociodemographics, residential characteristics, transport options and temporal characteristics. Maybe exposure is one of the mechanisms for the association between ethnic group and accident involvement?

Recommendations

Recommendations per project task

Task 1.2.1 Inequalities in traffic safety in Belgium on neighbourhood level

- The most important policy relevant finding concerns the gender inequality we observed in the developed casualty prediction models. This contributes to the general notion of gender unfairness in transportation accessibility. This finding implies the importance of mainstreaming gender difference considerations and incorporating gender equality into transport policy. This can be manifested by means of tailor-made policies targeting the population of interest exclusively.
- Government can utilize the knowledge of safety inequalities on the neighbourhood level to support priority setting in investments, such as road reconstruction, (re)design of infrastructure and awareness raising campaigns to name a few. Moreover, the macroscopic approach that has been followed in this study helps policy makers appropriately evaluate transport policies. Since the majority of transport policies concern relatively large geographical entities (e.g. a neighbourhood or a collection of them) rather than local road infrastructure, we should aim for a conforming model structure. The macroscopic characteristic of the developed models in our research is in compliance with this prerequisite.

Task 1.2.2 Inequalities in traffic safety in Belgium on the individual level

- Only 6% of the respondents in the Attitude survey 2015 and 2.6% of the respondents in the Unsafety Barometer 2015 indicated they were involved in a car accident the past 3 months. This results in a largely skewed variable which in turn can be assumed to have had an impact on the detection of effects. Future research of inequalities should at least partly focus on accident involved people.

- All the variables investigated were operationalised via self-report measures. This might have generated response biases, affecting the reliability of the results. Other operationalisations are also needed.

- In terms of validity, the operationalisation of the concept socioeconomic status was limited to the indicator diploma. Other indicators should be added in future research.

- These were cross-sectional surveys, which makes we cannot come to firm conclusions about the causal relationship between diploma on the one hand, and (1) self-reported involvement in car accidents, (2) self-reported frequency of a selection of behaviours related to car driving and (3) self-reported opinions related to those behaviours.

Task 2.1 Differences in traffic exposure

- In this study, nationality was used as an indicator of ethnic diversity. Although commonly used in ethnic research, other more refined indicators should be collected to more precisely refine the results. Moreover, future research should focus more on the underlying psychological constructs of why ethnic and cultural differences persist, even if one accounts for other determinants. In this context, the use of cultural dimension scales seems to be an interesting research direction.
- Information about the size of ethnic communities as well as information about activity locations can provide additional insights in the context of visit and shopping trips.

Task 2.2 Differences in attitudes towards speeding

- Taking into account (1) the fact that this survey was cross-sectional in terms of design, (2) the data collection was based on self-report measures and (3) the presence of a (very) strong interviewer effect, it is difficult to come to sufficiently firm conclusions regarding the question if (and to what extent) socioeconomic factors and ethnic group are causative factors for road safety inequalities in terms of speeding, number of fines and accident involvement. Self-reported behaviour and self-reported accident involvement are subject to several sources of bias (e.g. social desirability, response tendencies, ...). The present results do not allow to estimate the impact of the different predictor variables included in the models on these sources of bias. Due to this, the impact of the predictor variables included in the model on actual behaviour and accident involvement might not confirm the same relationships. Although self-reported and actual behaviour generally correlate well (see e.g. a comparison of observed drink-driving behaviour (DRUID) with self-declared drink-driving behaviour (ESRA) in Achermann Stürmer, 2016), other research shows a clear gap between (self-reported) attitudes and actual behaviour. Hence, the relationships revealed in the survey data need to be confirmed by similar research on a large set of real accident data and/or observations of behaviour in situ (road side surveys). Including the same type of predictor variables (e.g. socioeconomic status, ethnic background) in this type of research is a challenge way beyond the scope of the present study. However, the hypothesis that socioeconomic and ethnical characteristics would have similar effects on actual behaviour and accidents can only be tested by combining these data with personal information from other sources (e.g. data on offenders or persons suffering from accident injury gathered by the police or medical services).

- Based on the results of this study it can be concluded that road safety policy measures as well as further research on speeding and accident involvement should always consider age, gender and exposure differences in their activities. These three factors proved to be relevant predictors in all three models within our survey.
- Concerning ethnic background, the results clearly show that, regardless of the specific ethnic group of respondents, respondents with a foreign background report a higher accident involvement than Belgian respondents, even when controlled for sociodemographic and socioeconomic factors. Although this relationship needs confirmation in further research, this effect signals a possible source of social inequality which should be taken into account in policy measures.
- Furthermore, the results demonstrate that speeding is not the behaviour which can explain this difference in accident involvement. Possible alternative explanations are e.g. other risky behaviours, lack of knowledge of the Belgian highway code, differences in travel behaviour, infrastructure of the neighbourhood or the technical quality of the vehicles. Therefore, further research is needed to retrieve other potential factors determining this ethnic difference in road traffic accident involvement as e.g.:

  - repetition of the same survey focussing on other risky behaviours, such as e.g. seat belt use and the use of child safety systems
  - assessing the knowledge of the Belgian high way code of migrants in the licencing procedure
  - assessing additional information on differences in travel behaviour between Belgian citizens and citizens with foreign background
  - assessing the relationship between infrastructural differences and ethnic background on neighbourhood level
  - assessing the relationship between quality of the technical vehicle or vehicle equipment and the ethnic background
- Although the observed increased accident involvement of persons with a foreign background compared to the native Belgian population cannot yet be fully explained, this difference should be considered in general preventive measures such as e.g. traffic education, licencing procedure, awareness-raising campaigns, etc.
- Moreover, the results also show that self-declared speeding behaviour strongly depends on cultural believes such as e.g. opinions, attitudes, perceived behavioural control, acceptability of unsafe traffic behaviour, concern about traffic behaviour and perceived social norms. Therefore, these aspects should be considered when trying to influence speeding behaviour (e.g. education, awareness-raising campaigns, risk-communication).
- Concerning the effect of socioeconomic differences on traffic safety it is difficult to come to sufficiently firm conclusions. Most striking result is that drivers with higher

socioeconomic status report more speeding than drivers with lower socioeconomic status. Awareness-raising campaigns for speeding should take this factor into account. A possible explanatory factor for the higher frequency of speeding in high income groups is that fines for speeding are less deterring for higher income groups. This calls for an evaluation of the possible impact of fines based on income on speeding behaviour. On the other hand, the socioeconomic status does not seem to be a predictor of primary importance for number of fines and accident involvement. With respect to self-reported fines, we even observe a reverse effect: drivers with a lower socioeconomic status report more speeding tickets than people with a higher socioeconomic status. A possible explanation could be that people with a lower socioeconomic status get fined/caught more often for speeding than people with higher socioeconomic status, or that the socioeconomic status affects the memory of speeding fines. Further research is needed to explain this difference.

Global recommendations

As a kind of summary of above mentioned recommendations, we finally made a list of global recommendations. This list is complemented with some recommendations that we found in the international literature and that are considered relevant in light of this project.

- We experienced a lack of valid and complete data to answer all the questions asked in this project. The systematic collection of good quality data is extraordinarily important. Besides complete accident data, we need socioeconomic data and ethnic information incorporated in the traffic safety data (see also Plasència & Borrell, 2001). Statistical Matching as explained in Work package 3 can also be helpful in this respect.
- Socioeconomic data and cultural or ethnic information need to be as detailed as possible. We refer to the scientific results section of this report, particularly the conceptualisation phase of Task 1.1 (p. 38-39), where the measurement of socioeconomic status and culture is summarized. The complete literature review about this topic is found in the full report of Task 1.1.
- To investigate the exact nature of the association between socioeconomic status and culture on the one hand and traffic safety on the other hand, we need strong (e.g. longitudinal) research designs, which result in more solid conclusions than the ones we have today. In order to confirm theoretical models we found in the literature for the explanation of how socioeconomic status and culture relate to traffic safety (mechanisms), formal mediation and moderation testing is needed.
- Further research concerning the exact nature of attitudes and beliefs of different socioeconomic and cultural or ethnic groups is extremely relevant for policy making and campaign development. In the tasks concerning attitudes, we saw for instance that people with different diplomas (Task 1.2.2) have different attitudes towards risk-taking and impact-mitigating behaviours. Knowing the exact nature of these attitudes and the background factors that affect them, policy makers and campaigners could use this information to try to change dangerous behaviour.
- Traffic dangers should be minimised in neighbourhoods that are known to be more dangerous than others. This can be achieved by infrastructural interventions, provision of safe and accessible public transport, reduction of fast motorised traffic…

- Policymakers should be aware of macro variables that affect individual risk behaviour. Risk behaviour can be shaped by discrimination, lack of enforcement, degradation of neighbourhoods, errors in environmental planning etc. Injury prevention initiatives have also rarely addressed inequalities (age, gender, socioeconomic factors, culture and ethnicity, place) in a systematic manner. These factors merit greater attention from policymakers (Towner et al., 2005).
- There might be need of education in traffic rules and traffic safety for foreign road users. This education should be adapted to their own cultural beliefs and should try to alter beliefs that are dangerous in the new country the people live in.

5. DISSEMINATION AND VALORISATION

International conferences attended

- *14th International Conference of Travel Behaviour Research (IATBR)*, (July 2015, Windsor, UK).
- *IFSTTAR-meeting at Vias Institute (24*th November 2015, Brussels).
- *95th Annual Meeting of the Transportation Research Board* (10-14th January 2016, Washington D.C.).
- *17th Road Safety on 5 Continents Conference* (17-19th May 2016, Rio de Janeiro).
- International Advisory Board Meeting of Vias Institute (22nd November 2016, Brussels).
- *96th Annual Meeting of the Transportation Research Board* (8-12th January 2017, Washington D.C.).
- International Advisory Board Meeting of Vias Institute (13th February 2018, Brussels).
- *Transport Research Arena (TRA) Conference* (16-19th April 2018, Vienna).

National conferences attended

- *14e Vlaams Congres Verkeersveiligheid* (22nd March 2016, Antwerpen-Berchem).

INTRAS follow-up committees organised

- 1st INTRAS follow-up committee (5th March, 2015, Vias Institute, Brussels).
- 2nd INTRAS follow-up committee (29th June, 2015, Vias Institute, Brussels).
- 3rd INTRAS follow-up committee (22nd June, 2016, Vias Institue, Brussels).

Mini-symposia organised

- Inequalities in traffic safety: Mini-symposium (6th December, 2017, Hasselt).

6. PUBLICATIONS

Journal articles

Peer reviewed

- EFTEKHAR, H., CREEMERS, L., & COOLS, M. (2016). Assessing the effect of traveler's nationality on daily travel time expenditure using zero-inflated negative binomial regression models: results from the Belgian national household travel survey. *Transportation Research Record: Journal of the Transportation Research Board*, No 2565, Transportation Research Board, Washington D.C., 2016, pp. 65-77. DOI: 10.3141/2565-08.

- PIRDAVANI, A., DANIELS, S., VAN VLIERDEN, K., BRIJS, K., & KOCHAN, B. (2016). Socioeconomic and sociodemographic inequalities and their association with road traffic injuries. *Journal of Transport & Health*, 4, 152-161. http://dx.doi.org/10.1016/j.jth.2016.12.001i.

- TORFS, K., MEESMANN, U., SILVERANS, P., & COOLS, M. (Submitted). Assessment of socio-economic differences in road safety: an assessment of differences in speeding behaviour. *Accident Analysis and Prevention.*

Conference proceedings

Peer reviewed

- COOLS, M., & EFTEKHAR, H. (2015). Ethnic Differences in Travel Time Expenditure. *14th International Conference of Travel Behaviour Research (IATBR)*, Windsor, UK.

- EFTEKHAR, H., CREEMERS, L., & COOLS, M. (2016). Assessing the effect of traveler's nationality on daily travel time expenditure using zero-inflated negative binomial regression models: results from the Belgian national household travel survey. *95th Annual Meeting of the Transportation Research Board* (10-14th January 2016, Washington D.C.).

- PIRDAVANI, A., DANIELS, S., VAN VLIERDEN, K., BRIJS, K., & KOCHAN, B. (2016). Measuring the association of socioeconomic neighbourhood characteristics with traffic safety performance. *17th Road Safety on 5 Continents Conference* (17-19th May 2016, Rio de Janeiro).

- EFTEKHAR, H., & COOLS, M. (2017). A comparison of micro-objective non-parametric statistical matching techniques for the integration of different survey data. *96th Annual Meeting of the Transportation Research Board* (8-12th January 2017, Washington D.C.).

- TORFS, K., MEESMANN, U., & SILVERANS, P. (2018). Socio-economic differences in attitudes towards speeding. *Transport Research Arena 2018* (16-19th April, 2018, Vienna).

Conference presentations

Peer reviewed

- MEESMANN, U., TORFS, K., & SILVERANS, P. (2015). Le projet INTRAS. Les attitudes culturelles, vis-à-vis de la sécurité routière. (IFSTTAR-meeting, 24th November 2015, Brussels).

- MEESMANN, U., & SILVERANS, P. (2016). Socio-economische verschillen in snelheidsgedrag en in attitudes ten opzichte van snelheidsovertredingen. *14e Vlaams Congres Verkeersveiligheid* (22 maart 2016, Antwerpen-Berchem).

- TORFS, K., MEESMANN, U., & SILVERANS, P. (2016). INTRAS-survey TPB survey on speeding in 7 ethnic groups. (ISAB meeting, 22nd November 2016, Brussels).

- MEESMANN, U., TORFS, K., & SILVERANS, P. (2018). INTRAS-survey TPB survey on speeding in 7 ethnic groups. (ISAB meeting, 13th February 2018, Brussels).

- TORFS, K., MEESMANN, U., & SILVERANS, P. (2018). Socio-economic differences in attitudes towards speeding. *Transport Research Arena (TRA) Conference* (16-19 April, Vienna).

Project deliverables

Reviewed by Prof. dr Lucie Laflamme

- COOLS, M., & EFTEKHAR, H. (forthcoming). INTRAS-deliverable 3: Underlying mechanisms of inequalities in traffic safety: mobility-related inequalities, pp. 23.

- EFTEKHAR, H., & COOLS, M. (forthcoming). INTRAS-deliverable 5: Inequalities in traffic safety: data warehouse and methodological issues, pp. 17.

- PIRDAVANI, A., DANIELS, S., VAN VLIERDEN, K., BRIJS, K., & KOCHAN, B. (forthcoming). INTRAS-deliverable 2: Inequalities in traffic safety in Belgium at neighbourhood level, pp. 23.

- TORFS, K., MEESMANN, U., SILVERANS, P., & COOLS, M. (forthcoming). INTRAS-deliverable 4: Underlying mechanisms of inequalities in traffic safety: a multi-ethnic survey on speeding-related determinants and behaviour, pp. 24.

- VAN VLIERDEN, K., BRIJS, K., & DANIELS, S. (2017). INTRAS-deliverable 1: Literature review & conceptual framework, pp. 93. http://hdl.handle.net/1942/24447.

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ANNEXES

This annex to the final report applies to the study on inequalities in traffic safety in Belgium at the individual level (i.e. Task 1.2.2). As discussed in the final report, two data sets were used for this study, i.e. the Vias Attitude survey 2015 and the Vias Unsafety Barometer 2015. For both datasets, regression analysis techniques were used to explore which of a selection of independent variables – amongst others diploma as an indicator of SES – (for an overview, see Table VI, p. 18-19 of the report) were significant predictors of traffic safety. Traffic safety in turn was operationalised at three different levels: at the level of self-reported car accident involvement, at the level of self-reported driving behaviour (i.e. alcohol impaired driving, speeding, seatbelt use, use of child safety systems and distracted driving) and at the level of attitude statements related to those behaviours. For a detailed overview of the items used to measure each of these three levels of traffic safety we refer to Tables VII, VIII and IX or the report respectively.

The annex itself contains the statistical output tables with the results for the regression analyses, applied to each of the three levels of traffic safety (i.e. accident involvement, driving behaviours and attitudes related to those behaviours) for both datasets (i.e. the Attitude survey 2015 and the Unsafety Barometer 2015). We have limited ourselves to the output tables for the first analysis step, i.e. the step where we were interested in identifying significant main effects on the dependent variables. The output tables in this annex only contain significant main effects. Independent variables for which effects were not statistically significant, were not included due to space constraints. The output tables illustrating more in detail what the nature of identified main effects was like, are not included in order not to compromise readability of the annex. In what follows, we first focus on the results for the Attitude survey 2015. Next we list up results for the Unsafety Barometer 2015.

Results for Attitude survey 2015

Table I: Attitude survey 2015: Significant main effects for self-reported car accident involvement

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
region	2	21.6085	<.0001
Km1000	1	4.5521	0.0329
diploma	6	25.2172	0.0003
agecat	5	14.7712	0.0114

Significant predictors were: region, exposure (km driven), diploma, age. Concerning the variable diploma, further analysis indicated that higher diploma implied lower probability to be involved in an accident as car driver.

Table II: Attitude survey 2015: Significant main effects for self-reported frequency of alcohol-impaired driving

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
Gender	1	34.4409	<.0001
Region	2	22.9310	<.0001
Diploma	6	15.6332	0.0159
Km1000	1	9.3422	0.0022

Significant predictors were: gender, region, diploma, exposure (km driven). Concerning the variable diploma, further analysis indicated that higher diploma implies a higher probability to have driven above the legal alcohol limit (at least once in the past month).

Table III: Attitude survey 2015: Significant main effects for self-reported frequency of driving 140km/h on motorways (speeding-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Agecat	5	189.26	<.0001
Km1000	1	33.98	<.0001
Gender	1	35.02	<.0001
Driving frequency	4	29.07	<.0001

Significant predictors were: age, exposure (km driven), gender, exposure (driving frequency). Diploma was not a significant predictor.

Table IV: Attitude survey 2015: Significant main effects for self-reported frequency of driving 70km/h in built area (BIBEKO) (speeding-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Agecat	5	65.01	<.0001
Gender	1	26.25	<.0001
Province	10	40.85	<.0001
Km1000	1	17.73	<.0001

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Driving frequency	4	13.12	0.0107
Km1000*Gender	1	4.33	0.0374

Significant predictors were: age, gender, province, exposure (km driven), exposure (driving frequency), the interaction exposure (km driven)*gender. Diploma was not a significant predictor.

Table V: Attitude survey 2015: Significant main effects for self-reported frequency of driving 50km/h where 30km/h is allowed (speeding-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Agecat	5	78.33	<.0001
Km1000	1	11.83	0.0006
Province	10	29.96	0.0009
Diploma	6	20.08	0.0027
Driving frequency	4	15.16	0.0044
Gender	1	9.05	0.0026
Km1000*Gender	1	4.16	0.0414

Significant predictors were: age, exposure (km driven), province, diploma, exposure (driving frequency), gender, the interaction exposure (km driven)*gender. Concerning the variable diploma, further analysis indicated that higher diploma implies a higher probability for driving 50 km/h where 30 km/h is allowed.

Table VI: Attitude survey 2015: Significant main effects for self-reported frequency of driving up to 10km/h above the legal speed limit (speeding-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Agecat	5	61.60	<.0001
Km1000	1	6.76	0.0093
Driving frequency	4	52.59	<.0001
Gender	1	14.32	0.0002

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Diploma	6	24.57	0.0004
Km1000*Agecat	5	12.49	0.0287

Significant predictors were: age, exposure (km driven), exposure (driving frequency), gender, diploma, the interaction exposure (km driven)*age. Concerning the variable diploma, further analysis indicated that higher diploma implies a higher probability for driving up to 10 km/h above the legal speed limit.

Table VII: Attitude survey 2015: Significant main effects for self-reported frequency of using the seatbelt as a car driver (seatbelt-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Km1000	1	33.35	<.0001
Gender	1	13.80	0.0002
Weekday	6	18.84	0.0044
Diploma	6	13.58	0.0347
Gender*Diploma	6	15.86	0.0145

Significant predictors were: weekday, diploma, the interaction gender*diploma. Concerning the interaction gender*diploma, further analysis indicated that lower education implies lower use of seatbelt as a car driver, with car driver seatbelt use frequencies for each of the different education levels being systematically lower for males than for females.

Table VIII: Attitude survey 2015: Significant main effects for self-reported frequency of using the seatbelt as a front seat passenger (seatbelt-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Km1000	1	1.87	0.1713
Gender	1	10.11	0.0015
Diploma	6	24.67	0.0004
Province	10	26.22	0.0035
Agecat	5	12.53	0.0282

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Km1000*Diploma	6	13.01	0.0429

Significant predictors were: exposure (km driven), gender, diploma, province, age, the interaction exposure (km driven)*diploma.

Table IX: Attitude survey 2015: Significant main effects for self-reported frequency of using the seatbelt as a back seat passenger (seatbelt-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Km1000	1	10.72	0.0011
Region	2	8.22	0.0164

Significant predictors were: exposure (km driven), region. Diploma was not a significant predictor.

Table X: Attitude survey 2015: Significant main effects for self-reported frequency of using the correct child safety system while driving with a child in the car (child safety system-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Province	10	33.40	0.0002
Diploma	6	22.38	0.0010
Agecat	5	14.47	0.0129
gender	1	6.05	0.0139

Significant predictors were: province, diploma, age, gender. Concerning the variable diploma, further analysis indicated that the effect of diploma was not totally internally consistent: lowest diploma implied lowest child safety system use frequency, but highest education did not imply highest child safety system use frequency.

Table XI: Attitude survey 2015: Significant main effects for self-reported frequency of talking on hands-free mobile phone while driving (distraction-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Agecat	5	135.73	<.0001
Km1000	1	43.36	<.0001
Diploma	6	42.86	<.0001
Driving frequency	4	32.34	<.0001
Province	10	24.42	0.0066
Gender	1	7.56	0.0060
Km1000*Province	10	20.58	0.0242

Significant predictors were: age, exposure (km driven), diploma, exposure (driving frequency), province, gender, the interaction exposure (km driven)*province. Concerning the variable diploma, further analysis indicated that lower diploma implies less frequent hands-free calling while driving.

Table XII: Attitude survey 2015: Significant main effects for self-reported frequency of talking on hand-held mobile phone while driving (distraction-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Agecat	5	154.54	<.0001
Km1000	1	13.01	0.0003
Region	2	18.97	<.0001
Driving frequency	4	13.68	0.0084

Significant predictors were: age, exposure (km driven), region, exposure (driving frequency). Diploma was not a significant predictor.

Table XIII: Attitude survey 2015: Significant main effects for self-reported frequency of reading sms, message or e-mail while driving (distraction-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Agecat	5	308.71	<.0001
Km1000	1	33.10	<.0001
Diploma	6	51.05	<.0001
Driving frequency	4	26.26	<.0001
Region	2	7.88	0.0194

Significant predictors were: age, exposure (km driven), diploma, exposure (driving frequency), region. Concerning the variable diploma, further analysis indicated that even though differences in function of diploma are statistically significant, they are not practically meaningful.

Table XIV: Attitude survey 2015: Significant main effects for self-reported frequency of sending sms, message or e-mail while driving (distraction-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Agecat	5	296.50	<.0001
Km1000	1	31.95	<.0001
Diploma	6	34.65	<.0001
Gewest	2	16.93	0.0002
Diploma*Gewest	12	21.34	0.0456

Significant predictors were: age, exposure (km driven), diploma, region, the interaction diploma*region. Concerning the interaction diploma*region, further analysis indicated that lower diploma implies less frequent sending of text messages while driving, with frequency of sending text messages for each of the different diploma levels varying across regions. In Flanders and Wallonia, people with primary school degrees show the safest behaviour in terms of sending messages behind the wheel. In Brussels these people behave less safe, at the same level of higher secondary degrees and higher non-university degrees. In Brussels, people with lower secondary degrees behave safer and send messages less frequently.

Table XV: Attitude survey 2015: Significant main effects for self-reported attitude towards the statement that driving under the influence of alcohol seriously increases the risk for an accident (alcohol impaired driving-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
gender	1	8.17	0.0043
agecat	5	8.76	0.1192
gender*agecat	5	7.70	0.1733
km1000	1	0.61	0.4343
km1000*gender	1	0.06	0.8011
km1000*agecat	5	3.29	0.6552
km1000*gender*agecat	5	13.12	0.0223

Significant predictors were: exposure (km driven), two-way interactions gender*age, exposure (km driven)*gender, exposure (km driven)*age, the three-way interaction exposure (km driven)*gender*age. Diploma was not a significant predictor.

Table XVI: Attitude survey 2015: Significant main effects for self-reported attitude towards the statement that most of my friends find driving under influence of alcohol unacceptable (alcohol impaired driving-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
agecat	5	86.69	<.0001
region	2	32.69	<.0001
gender	1	4.05	0.0442

Significant predictors were: age, region, gender. Diploma was not a significant predictor.

Table XVII: Attitude survey 2015: Significant main effects for self-reported attitude towards the statement that driving under the influence of alcohol makes it difficult to react correctly in a dangerous situation (alcohol impaired driving-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
gender	1	27.38	<.0001
km1000	1	18.40	<.0001
diploma	6	17.30	0.0082

Significant predictors were: gender, exposure (km driven), diploma. Concerning the variable diploma, further analysis indicated that lower diploma implies more agreement with the opinion that it is difficult to react correctly in a dangerous situation when driving under the influence of alcohol.

Table XVIII: Attitude survey 2015: Significant main effects for self-reported attitude towards the statement that driving fast is socially unacceptable (speeding-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
agecat	5	46.51	<.0001
DrivingFrequency	4	18.08	0.0012
region	2	9.69	0.0079
gender	1	7.89	0.0050
diploma	6	6.78	0.3417
agecat*diploma	30	48.08	0.0195
region*diploma	12	32.23	0.0013

Significant predictors were: age, exposure (driving frequency), region, gender, diploma, the two-way interactions age*diploma and region*diploma. Regarding the interaction age*diploma, even though not totally consistent, in general the trend for diploma seems to indicate that, across different age groups, lower diploma implies more agreement with the belief that driving fast is socially unacceptable. This is clearly the case for age categories 18-29 ; 50-62 ; 63-76 and +77 while it is less clear (i.e. internally inconsistent in a sense that the lowest diploma is lowest in agreement (instead of highest) but that lower diplomas are higher in agreement than the higher diplomas) for age categories 30-38 and 39-49. For the interaction region*diploma, further analysis indicates that the differences in opinion that driving fast is socially unacceptable between the different diplomas is quite dependent on the three regions. Nonetheless, across the different regions, the general basic trend seems to indicate that lower diplomas imply more agreement with the opinion that driving fast is socially unacceptable. In Flanders the lowest percentage of people agreeing is in those with a higher non-university degree, followed by university degrees and higher secondary degrees. In Wallonia, globally percentages agreeing are lower than in Flanders with a very low percentage for those with a lower secondary degree. In Brussels, globally percentages agreeing are highest of the 3 regions. Also, the differences between the diplomas are the largest, with the lowest percentage agreeing for those with a higher professional degree and the largest percentage for those with lower secondary degrees.

Table XIX: Attitude survey 2015: Significant main effects for self-reported attitude towards the statement that driving fast is putting your own life and that of others in danger (speeding-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
agecat	5	20.73	0.0009
gender	1	14.65	0.0001
province	10	31.56	0.0005
km1000	1	1.76	0.1852
diploma	6	14.48	0.0247
km1000*agecat	5	14.24	0.0141
agecat*diploma	30	64.65	0.0002
gender*province	10	21.67	0.0169
km1000*diploma	6	21.32	0.0016

Significant predictors were: age, gender, province, exposure (km driven), diploma, the two-way interactions exposure (km driven)*age, age*diploma, gender*province and exposure (km driven)*diploma. Regarding the interaction age*diploma, there is no clearly consistent trend. Even though not totally consistent, in general the trend for diploma seems to indicate that, across different age groups, lower diploma implies more agreement with the belief that driving fast is putting your own life and that of others at risk. This is clearly the case for age categories 18-29 ; 50-62 ; 63-76 and +77 while it is less clear for age category 30-38 and totally not the case for the age category 39-49.

Table XX: Attitude survey 2015: Significant main effects for self-reported attitude towards the statement that one has to drive fast in order not to get the impression to waste time (speeding-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
agecat	5	118.69	<.0001
Province	10	31.79	0.0004
DayOfWeek	6	17.90	0.0065
gender	1	7.27	0.0070

Significant predictors were: age, province, day of week, gender. Diploma was not a significant predictor.

Table XXI: Attitude survey 2015: Significant main effects for self-reported attitude towards the statement that if one drives faster than the speed limit, it is difficult to react in a dangerous situation (speeding-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
agecat	5	35.62	<.0001
gender	1	19.00	<.0001
region	2	17.38	0.0002
km1000	1	12.80	0.0003

Significant predictors were: age, gender, region, exposure (km driven). Diploma was not a significant predictor.

Table XXII: Attitude survey 2015: Significant main effects for self-reported attitude towards the statement that most of my friends think that speed limits should be respected (speeding-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
agecat	5	65.18	<.0001
region	2	24.66	<.0001
km1000	1	0.57	0.4496
gender	1	11.21	0.0008
agecat*region	10	33.35	0.0002

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
km1000*agecat	5	16.39	0.0058
km1000*gender	1	4.65	0.0311

Significant predictors were: age, region, exposure (km driven), gender, the two-way interactions age*region, exposure (km driven)*age and exposure (km driven)*gender. Diploma was not a significant predictor.

Table XXIII: Attitude survey 2015: Significant main effects for self-reported attitude towards the statement that speed limits are usually set at acceptable levels (speeding-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
km1000	1	16.49	<.0001
agecat	5	10.41	0.0645
gender	1	7.46	0.0063
diploma	6	13.03	0.0426

Significant predictors were: exposure (km driven), age, gender, diploma. Concerning the variable diploma, further analysis indicated that lower diploma implies more agreement with the opinion that speed limits are usually set at acceptable levels.

Table XXIV: Attitude survey 2015: Significant main effects for self-reported attitude towards the statement that if you increase your speed by 10km/h you have a seriously higher chance to have an accident (speeding-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
DrivingFrequency	4	33.83	<.0001
agecat	5	29.81	<.0001
km1000	1	0.12	0.7292
province	10	18.56	0.0462
km1000*agecat	5	14.52	0.0126

Significant predictors were: exposure (driving frequency), age, exposure (km driven), province, the two-way interaction exposure (km driven)*age. Diploma was not a significant predictor.

Table XXV: Attitude survey 2015: Significant main effects for self-reported attitude towards the statement that it is not necessary to wear a seatbelt in the back (seatbelt-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
region	2	18.15	0.0001
gender	1	4.67	0.0306

Significant predictors were: region, gender. Diploma was not a significant predictor.

Table XXVI: Attitude survey 2015: Significant main effects for self-reported attitude towards the statement that I always ask my passengers to wear a seatbelt (seatbelt-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Gender	1	21.71	<.0001
Diploma	6	21.34	0.0016
Province	10	22.84	0.0114
Agecat	5	13.73	0.0174

Significant predictors were: gender, diploma, province, age. Concerning the variable diploma, further analysis indicated that lower diploma implies less agreement with the opinion that one should ask passengers to wear their seatbelt. More in detail, people with a primary school degree show the lowest percentage of asking their passengers to wear a seat belt, followed by lower professional degrees and higher non-university degrees. The highest percentage occurs for persons with a university degree.

Table XXVII: Attitude survey 2015: Significant main effects for self-reported attitude towards the statement that the instructions for using a child safety system are unclear (child safety system-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
region	2	23.56	<.0001
agecat	5	18.25	0.0026

Significant predictors were: region, age. Diploma was not a significant predictor.

Table XXVIII: Attitude survey 2015: Significant main effects for self-reported attitude towards the statement that it is dangerous to drive a child that is not correctly attached (child safety system-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
region	2	17.18	0.0002
agecat	5	19.65	0.0015
DrivingFrequency	4	12.09	0.0167

Significant predictors were: age, exposure (driving frequency). Diploma was not a significant predictor.

Table XXIX: Attitude survey 2015: Significant main effects for self-reported attitude towards the statement that for short trips, it is not really necessary to use the correct child safety system (child safety system-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
km1000	1	7.07	0.0079
diploma	6	18.06	0.0061
region	2	7.36	0.0252

Significant predictors were: exposure (km driven), diploma, region. Concerning the variable diploma, further analysis indicated that lower diploma implies more agreement with the opinion that it is not really necessary to use the correct child safety system for short trips. More in detail, persons with a primary school degree have the highest percentage saying that they agree with the statement that it is not necessary to use the correct child's safety system for short trips, followed by lower professional degrees. The other diplomas are at about the same level.

Table XXX: Attitude survey 2015: Significant main effects for self-reported attitude towards the statement that your attention for traffic decreases when you are calling hands-free while driving (distraction-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
agecat	5	95.00	<.0001
km1000	1	12.91	0.0003
DrivingFrequency	4	13.73	0.0082
region	2	10.66	0.0048

Significant predictors were: age, exposure (km driven), exposure (driving frequency), region. Diploma was not a significant predictor.

Table XXXI: Attitude survey 2015: Significant main effects for self-reported attitude towards the statement that your attention for traffic decreases when you are calling hand-held while driving (distraction-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
agecat	5	63.87	<.0001
diploma	6	20.81	0.0020
region	2	12.09	0.0024
km1000	1	4.31	0.0379
gender	1	4.21	0.0402

Significant predictors were: age, diploma, region, exposure (km driven), gender. Concerning the variable diploma, further analysis indicated that lower diploma implies less agreement with the opinion that your attention for traffic decreases when you call hand-held while driving. More in detail, people with a university degree, higher non-university and higher secondary degree show the highest agreement with the statement that your attention for traffic decreases if you call hand-held. People with a lower professional degree show the lowest percentage of agreement.

Table XXXII: Attitude survey 2015: Significant main effects for self-reported attitude towards the statement that almost every car driver now and then calls hand-held while driving (distraction-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
region	2	25.16	<.0001
diploma	6	32.32	<.0001
gender	1	6.44	0.0112

Significant predictors were: region, diploma, gender. Concerning the variable diploma, further analysis indicated that lower diploma implies more agreement with the observation that almost all car drivers every now and then call hand-held while driving. More in detail, the lowest percentage of agreement with the statement that almost all car drivers every now and then call hand-held while driving occurs for people with a university degree and the highest percentage for those with a primary school degree.

Table XXXIII: Attitude survey 2015: Significant main effects for self-reported attitude towards the statement that people who call hand-held while driving run a higher risk of getting involved in an accident (distraction-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
agecat	5	40.31	<.0001
region	2	22.17	<.0001
km1000	1	0.34	0.5580
agecat*region	10	22.71	0.0119
km1000*agecat	5	27.84	<.0001

Significant predictors were: exposure (km driven), the two-way interactions age*region and exposure (km driven)*age. Diploma was not a significant predictor.

Results for the Unsafety Barometer 2015

For the prediction of self-reported accident involvement, logistic regression resulted in a final model that had as only significant effect the distance driven over the past 6 months. Diploma was not a significant predictor.

Table XXXIV: Unsafety Barometer 2015: Significant main effects for self-reported number of days driven above the legal BAC-limit

Type 3 Analysis of Effects			
Effect	**DF**	**Wald Chi-Square**	**Pr > ChiSq**
Gender	1	21.4811	<.0001
Region	2	6.3849	0.0411
Agecat	4	10.8053	0.0288

Significant predictors were: gender, region, age. Diploma was not a significant predictor.

Table XXXV: Unsafety Barometer 2015: Significant main effects for self-reported frequency of driving after consuming alcohol

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Gender	1	23.11	<.0001
Km1000	1	6.42	0.0113

Significant predictors were: gender, exposure (km driven). Diploma was not a significant predictor.

Table XXXVI: Unsafety Barometer 2015: Significant main effects for self-reported frequency of driving faster than the speed limit on motorways (speeding-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Driving frequency	2	13.95	0.0009
Agecat	4	45.87	<.0001
Gender	1	27.38	<.0001
Province	10	25.80	0.0040
Agecat*Province	39	58.75	0.0220
Gender*Province	10	24.95	0.0054

Significant predictors were: age, gender, province, the two-way interactions age*province and gender*province. Diploma was not a significant predictor.

Table XXXVII: Unsafety Barometer 2015: Significant main effects for self-reported frequency of driving faster than the speed limit in built area (BIBEKO) (speeding-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Agecat	4	20.52	0.0004
Km1000	1	0.93	0.3355
Region	2	12.61	0.0018
Driving frequency	2	7.50	0.0235
Km1000*Region	2	8.08	0.0176

Significant predictors were: age, exposure (km driven), region, exposure (driving frequency), the two-way interaction exposure (km driven)*region. Diploma was not a significant predictor.

Table XXXVIII: Unsafety Barometer 2015: Significant main effects for self-reported frequency of driving faster than the speed limit outside built area (BUBEKO) (speeding-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Agecat	4	50.39	<.0001
Gender	1	14.49	0.0001
Driving frequency	2	13.12	0.0014

Significant predictors were: age, gender, exposure (driving frequency). Diploma was not a significant predictor.

Table XXXIX: Unsafety Barometer 2015: Significant main effects for self-reported frequency of wearing a seatbelt while driving as a car driver (seatbelt-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Gender	1	5.36	0.0206

The only significant predictor was gender. Diploma was not a significant predictor.

Table XXXX: Unsafety Barometer 2015: Significant main effects for self-reported frequency of wearing a seatbelt while driving as a passenger in the front (seatbelt-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Gender	1	5.28	0.0215

The only significant predictor was gender. Diploma was not a significant predictor.

Table XXXXI: Unsafety Barometer 2015: Significant main effects for self-reported frequency of wearing a seatbelt while driving as a passenger in the back (seatbelt-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Agecat	4	11.81	0.0188
Gender	1	3.86	0.0494

The only significant predictors were age and gender. Diploma was not a significant predictor.

Table XXXXII: Unsafety Barometer 2015: Significant main effects for self-reported frequency of having used the correct child safety system while driving with a child under 150cm (child safety system-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Diploma	3	12.22	0.0067
Gender	2	9.36	0.0093

Significant predictors were: diploma, gender. Concerning the variable diploma, further analysis indicated that higher diploma implies more frequent use of correct child safety system while driving a child under 150cm.

Table XXXXIII: Unsafety Barometer 2015: Significant main effects for self-reported frequency of talking on a hands-free mobile phone while driving (distraction-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Km1000	1	8.86	0.0029
Agecat	4	40.01	<.0001
Gender	1	24.31	<.0001
Driving frequency	2	18.86	<.0001

Significant predictors were: age, gender, exposure (driving frequency). Diploma was not a significant predictor.

Table XXXXIV: Unsafety Barometer 2015: Significant main effects for self-reported frequency of talking on a hand-held mobile phone while driving (distraction-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Agecat	4	64.41	<.0001
Gender	1	8.80	0.0030
Driving frequency	2	10.07	0.0065

Significant predictors were: age, gender, exposure (driving frequency). Diploma was not a significant predictor.

Table XXXXV: Unsafety Barometer 2015: Significant main effects for self-reported frequency of reading a text message or e-mail while driving (distraction-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Agecat	4	114.27	<.0001
Km1000	1	10.64	0.0011
Driving frequency	2	6.82	0.0330

Significant predictors were: age, exposure (km driven), exposure (driving frequency). Diploma was not a significant predictor.

Table XXXXVI: Unsafety Barometer 2015: Significant main effects for self-reported frequency of sending a text message or e-mail while driving (distraction-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Agecat	4	113.80	<.0001
Km1000	1	11.99	0.0005

Significant predictors were: age, exposure (km driven). Diploma was not a significant predictor.

Table XXXXVII: Unsafety Barometer 2015: Significant main effects for self-reported attitude towards the statement that driving under influence of alcohol seriously increases the risk for an accident

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Gender	1	26.93	<.0001
Age_5category	4	30.68	<.0001
Rijfrequentie	2	8.73	0.0127

Significant predictors were: gender, age, exposure (driving frequency). Diploma was not a significant predictor.

Table XXXXVIII: Unsafety Barometer 2015: Significant main effects for self-reported attitude towards the statement that most of my friends find driving under influence of alcohol unacceptable

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Gender	1	10.63	0.0011
Age_5category	4	40.26	<.0001

Significant predictors were: gender, age. Diploma was not a significant predictor.

Table IL: Unsafety Barometer 2015: Significant main effects for self-reported attitude towards the statement that if you drive under the influence of alcohol, it is difficult to react correctly in a dangerous situation.

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Gender	1	29.14	<.0001
Age_5category	4	22.97	0.0001

Significant predictors were: gender, age. Diploma was not a significant predictor.

Table L: Unsafety Barometer 2015: Significant main effects for self-reported attitude towards the statement that driving under the influence of alcohol increases the risk for an accident seriously

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
gender	1	12.75	0.0004
Age_5category	4	24.55	<.0001
Diploma	3	9.38	0.0246
km1000	1	11.94	0.0006

Significant predictors were: gender, age, diploma, exposure (km driven). For diploma, further analysis indicated that lower diploma implies more agreement with the statement that driving under the influence increases the risk for an accident seriously.

Table LI: Unsafety Barometer 2015: Significant main effects for self-reported attitude towards the statement that driving fast is putting your own life and that of others at risk (speeding-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Gender	1	12.79	0.0003
Age_5category	4	4.73	0.3163
Gender*Age_5category	4	15.14	0.0044
km1000	1	2.70	0.1004
km1000*Gender	1	1.62	0.2035
km1000*Age_5category	4	5.85	0.2108
km1000*Gender*Age_5cat	4	12.59	0.0135

Significant predictors were: gender, age, exposure (km driven), the two-way interactions gender*age, exposure (km driven)*gender, exposure (km driven)*age, the three-way interaction exposure (km driven)*gender*age. Diploma was not a significant predictor.

Table LII: Unsafety Barometer 2015: Significant main effects for self-reported attitude towards the statement that I have to drive fast, otherwise I get the impression of losing time (speeding-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Gender	1	4.90	0.0269
Age_5category	4	73.54	<.0001
km1000	1	8.96	0.0028

Significant predictors were: gender, age, exposure (km driven). Diploma was not a significant predictor.

Table LIII: Unsafety Barometer 2015: Significant main effects for self-reported attitude towards the statement that driving faster than the speed limit makes it more difficult to react correctly in a dangerous situation (speeding-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Gender	1	22.99	<.0001
Age_5category	4	22.18	0.0002
Rijfrequentie	2	9.33	0.0094
km1000	1	6.63	0.0100
Diploma	3	9.58	0.0225

Significant predictors were: gender, age, exposure (driving frequency), exposure (km driven), diploma. For diploma, further analysis indicated that lowest diploma implies most agreement with the statement that driving faster than the speed limit makes it more difficult to react correctly in a dangerous situation, followed by highest diploma (i.e. master’s degree or higher), and then by secondary education and bachelor’s degree or similar respectively.

Table LIV: Unsafety Barometer 2015: Significant main effects for self-reported attitude towards the statement that most of my friends think that speed limits should be respected (speeding-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Gender	1	19.74	<.0001
Age_5category	4	53.38	<.0001
km1000	1	4.90	0.0268
Diploma	3	8.38	0.0387

Significant predictors were: gender, age, exposure (km driven), diploma. For diploma, further analysis indicated that lower diploma implies more agreement with the statement that most of my friends think that speed limits should be respected.

Table LVI: Unsafety Barometer 2015: Significant main effects for self-reported attitude towards the statement that speed limits are usually set at acceptable levels (speeding-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Gender	1	15.89	<.0001
Age_5category	4	19.42	0.0006
Rijfrequentie	2	9.03	0.0109

Significant predictors were: gender, age, exposure (driving frequency). Diploma was not a significant predictor.

Table LVII: Unsafety Barometer 2015: Significant main effects for self-reported attitude towards the statement that if you increase your speed by 10km/h, you have a seriously higher chance to have an accident (speeding-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Gender	1	14.93	0.0001
Age_5category	4	13.55	0.0089
Rijfrequentie	2	18.19	0.0001

Significant predictors were: gender, age, exposure (driving frequency). Diploma was not a significant predictor.

Table LVIII: Unsafety Barometer 2015: Significant main effects for self-reported attitude towards the statement that it is not necessary to wear a seatbelt in the back (seatbelt-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Gender	1	7.23	0.0072
Age_5category	4	18.55	0.0010
Gender*Age_5category	4	9.74	0.0450

Significant predictors were: gender, age, the two-way interaction gender*age. Diploma was not a significant predictor.

Table LIX: Unsafety Barometer 2015: Significant main effects for self-reported attitude towards the statement that I always ask my passengers to wear their seatbelt (seatbelt-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Gender	1	24.54	<.0001
Age_5category	4	32.59	<.0001

Significant predictors were: gender, age. Diploma was not a significant predictor.

Table LX: Unsafety Barometer 2015: Significant main effects for self-reported attitude towards the statement that the instructions for use of child restraints are unclear (child safety system-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Age_5category	4	11.94	0.0178
Province	10	23.86	0.0080
Diploma	3	11.02	0.0116

Significant predictors were: age, province, diploma. For diploma, further analysis indicated that lower diploma implied more agreement with the statement that instructions for use of child restraints are unclear.

Table LXI: Unsafety Barometer 2015: Significant main effects for self-reported attitude towards the statement that it is dangerous to drive a child that is not attached in the correct way (child safety system-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Age_5category	4	12.43	0.0144

The only significant predictor was age. Diploma was not a significant predictor.

Table LXII: Unsafety Barometer 2015: Significant main effects for self-reported attitude towards the statement that for short trips, it is not really necessary to use the correct child safety system (child safety system-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Gender	1	8.51	0.0035
Diploma	3	9.17	0.0272

Significant predictors were: gender, diploma. For diploma, further analysis indicated that lower diploma implies less disagreement with the statement that it is not really necessary to use the correct child safety system for short trips.

Table LXIII: Unsafety Barometer 2015: Significant main effects for self-reported attitude towards the statement that attention for traffic decreases when calling hands-free while driving (distraction-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Gender	1	5.20	0.0226
Age_5category	4	56.28	<.0001
Rijfrequentie	2	16.42	0.0003

Significant predictors were: gender, age, exposure (driving frequency). Diploma was not a significant predictor.

Table LXIV: Unsafety Barometer 2015: Significant main effects for self-reported attitude towards the statement that attention for traffic decreases when calling hand-held while driving (distraction-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Age_5category	4	45.69	<.0001

The only significant predictor was age. Diploma was not a significant predictor.

Table LXV: Unsafety Barometer 2015: Significant main effects for self-reported attitude towards the statement that almost all car drivers occasionally call hand-held while driving (distraction-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Diploma	3	10.21	0.0168
Rijfrequentie	2	3.24	0.1976
Diploma*Rijfrequentie	5	11.29	0.0460

Significant predictors were: diploma, exposure (driving frequency), the two-way interaction diploma*exposure (driving frequency). For the two-way interaction diploma*exposure (driving frequency), further analysis indicated that lower diploma in general implies more agreement with the statement that almost all car drivers occasionally call hand-held while driving, and that this is more the case for individuals that drive more days per week (i.e. at least 4 days a week vs. 1 to 3 days a week).

Table LXVI: Unsafety Barometer 2015: Significant main effects for self-reported attitude towards the statement that people who call hand-held while driving run a higher risk to be involved in a car accident (distraction-related)

LR Statistics For Type 3 Analysis			
Source	**DF**	**Chi-Square**	**Pr > ChiSq**
Gender	1	11.92	0.0006
Age_5category	4	58.95	<.0001

Significant predictors were: gender, age. Diploma was not a significant predictor.