Evaluation of urban road safety policies

Vanco Florian, Hiron Benoît*, Ledoux Vincent*, Saint-Pierre Guillaume*, Carnis Laurent***

**Cerema, France*

*** UGE, France*

** Corresponding author: florian.vanco@cerema.fr*

Introduction

The challenge of reducing road accidents in urban areas in mainland France is important: two out of three injured in accidents and one killed in accidents in three concern urban roads, according to the latest ONISR accident report (2020). In addition, this report shows that vulnerable users (pedestrians, users of motorized two-wheelers and cyclists) represent two-thirds of road deaths in these agglomerated areas. These issues require the implementation of proactive urban mobility policies for improving the accident record and a posteriori evaluation for assessing the efficiency of road safety interventions.

The purpose of this work is to carry out an overall assessment of urban road safety policies through the measures listed in the mobility plans of French cities through a sample of 70 cities (Vanco et al. 2021). Below is the map of the cities considered in our work.

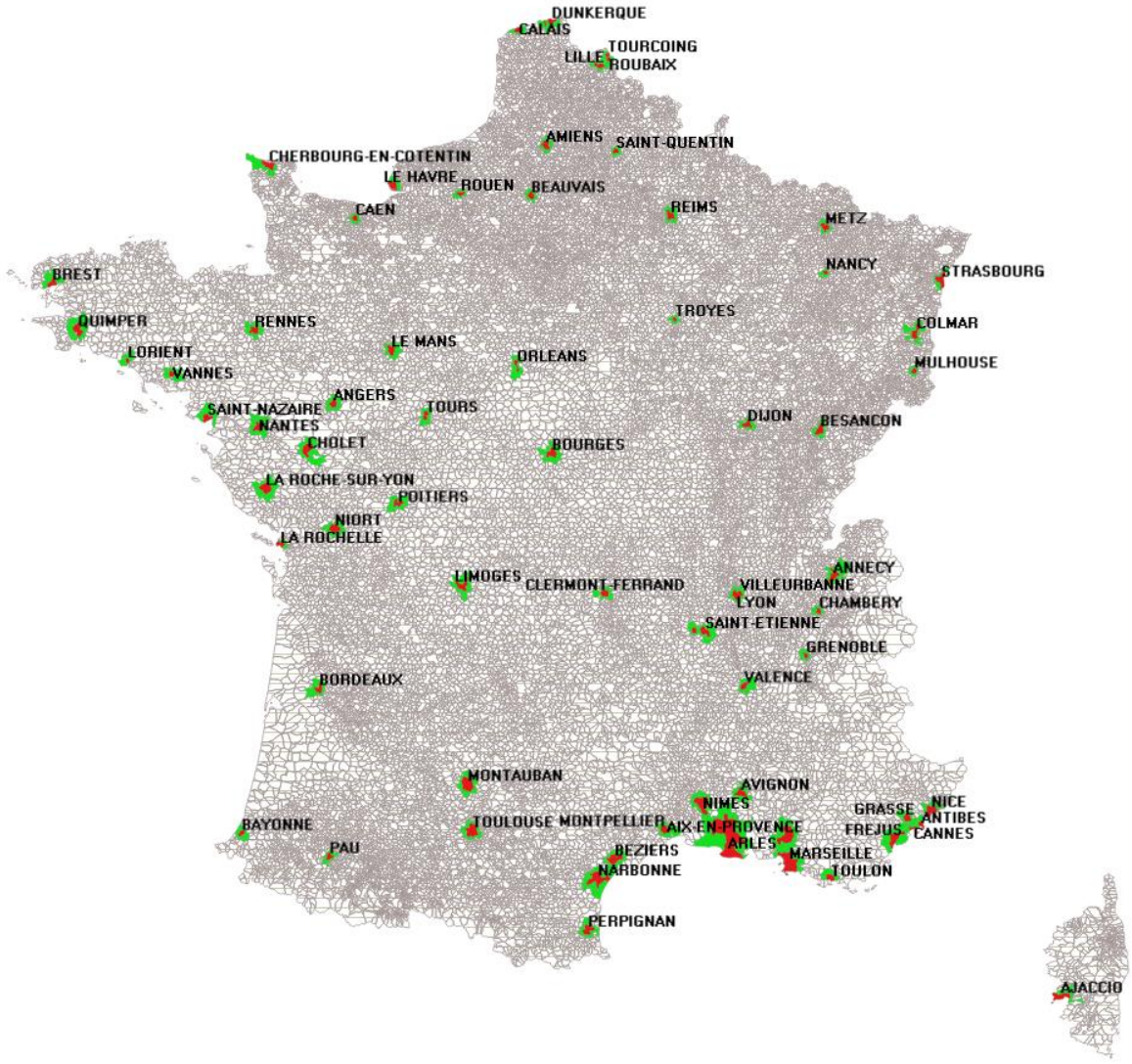

Figure 1 : cities included in the analysis

The objective of our research is to compare the urban policies of mobility and road safety displayed in the mobility plans and the evolution of accident rates over the last 30 years. We can thus identify, as far as possible, in relation to the policies displayed, those which seem the most effective for reducing road accidents in urban areas.

We try to identify the determinants of the evolution of road accidents in central cities in urban areas or the most important city inside a metropolitan area. This article focuses on the evaluation of the effects of mobility and road safety measures taken with mobility plans covering central cities through some correlations between the reduction in accident rates and the display of measurements, while taking into account variables relating to the characteristics of these cities.
We first present the development of a theoretical model to answer our research question. Then, we describe the variables used to feed this model, before presenting their estimated effects on urban road accidents occuring in central cities.

Theoretical framework and choice of variables

The model considers 5 dimensions influencing road accidents: local mobility and road safety policies, urban morphology, socio-demography, socio-economics and mobility. These dimensions can interact with each other, such as socio-economics and mobility, for example.

For each dimension, specific data series have been identified to feed the theoretical model. We can distinguish among these data those relating to the mobility plan which are essentially qualitative and some variables relating to the other dimensions which are mainly quantitative (level of employment for instance).

With regard to the quantitative variables, the availability of data are crucial to build the variables of the model, they had to respect the constraint of covering the entire investigation period (1987 to 2017). Moreover, some variables were discarded due to lack of sufficiently exhaustive data on this period. Before performing the modelling, it was also necessary to correct any existing correlations between the selected variables using a descriptive analysis (through multiple correspondence analysis followed by an ascending hierarchical classification).

In the end, the variables selected for the formulation of the model are given by the figure 2.

Variable	Unity
population youth index	Number of young people per 100 seniors
employment coverage rate	Number of jobs per 100 active workers
unemployment rate	percentage
transport payment (tax on the payroll of companies in constant euros) reported to the population (1%)	Euros constants par habitant
Urban intensity	Number of jobs + inhabitants per hectare
Age of the existence of an accident observatory	years
Existence of an accident observatory	**No**: no observatory **Yes**: observatory
Level of programming of mobility plan actions (funding and monitoring indicators)	overall assessment in the form of a score between 0 and 2 (0; 0,5; 1;1,5;2) **No** : no plan or score less than 2 (low funding or imprecise indicators) **Yes** : score equal to 2
Measures in the plan to sustain/strengthen the existing accident observatory	**No** : no measures **Yes** : Measures to sustain the observatory / develop the missions of the observatory (mapping, road safety club, broader analyzes than soft mode accidents) / Creation of new partnerships to feed the observatory (insurers, firefighters, police) / Change of scale of the observatory, transition to an agglomeration scale with more SR indicators
Measures in the mobility plan for a better knowledge of road safety issues in the territory	**No** : no measures or simple monitoring of a few road safety indicators without additional analyzes or studies **Yes** : Regular production of road safety studies and reports. Analysis of specific issues (pedestrians, motorized two-wheelers, etc.)
Measures in the mobility plan to strengthen or improve control by law enforcement	**No** : no measures **Yes** : parking and / or speed control measures
Measures in the mobility plan for securing dangerous areas and black spots	**No** : no measures **Yes** : measure to identify and treat areas and axes identified as dangerous
Measures in the mobility plan for pedestrian safety	**No** : no measures **Yes :** measures in favor of pedestrian safety with the production of technical guides for pedestrian facilities
Measures in the mobility plan for the safety of motorized 2-wheelers	**No** : no measures **yes :** measures for the safety of motorized two-wheelers relating to the reduction of speed, prevention among young people. Production of technical guides on developments related to the safety of motorized two-wheelers
Measures in the mobility plan for the youth safety	**No** : no measures **yes** : awareness-raising measures for young people AND securing of road facilities around schools

Figure 2:variables selected for the model

Consequently our theoretical framework takes the following form:

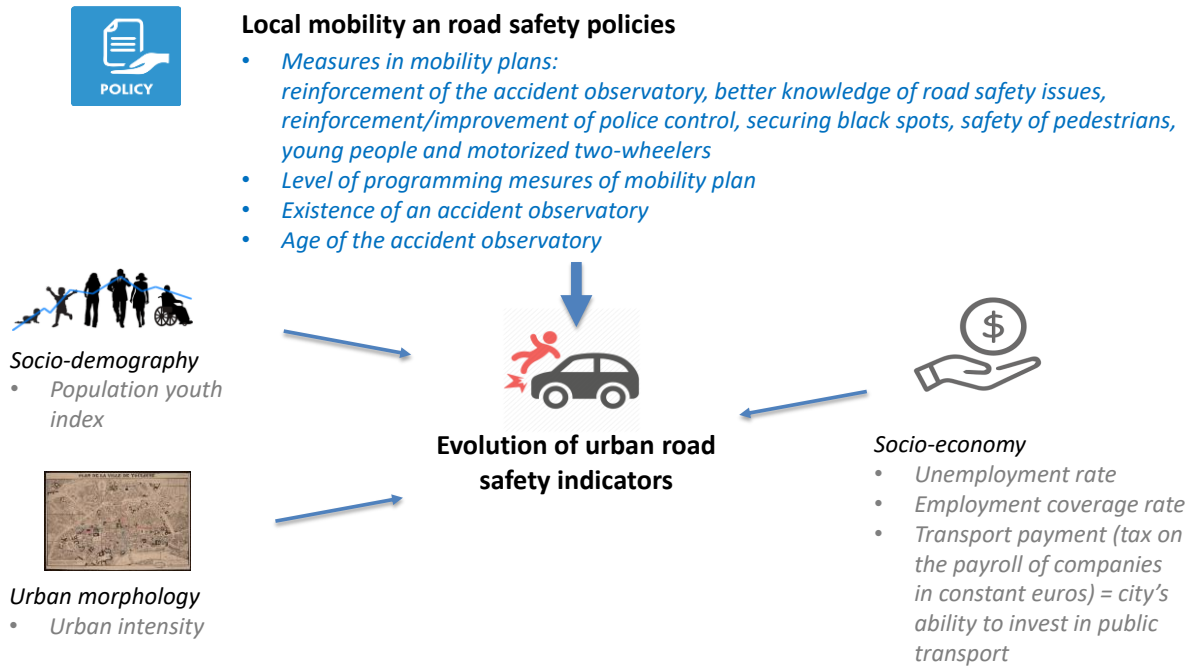

Figure 3: Theorical framework

Estimated model

The Poisson regression, a generalized linear model (GLM) adapted for the estimation of two "counting" type variables, namely the number of accidents and the number of people killed in built-up areas in central cities, were selected. This type of regression was tested with the two sets of data (64 central cities to estimate the number of accidents and 70 central cities to estimate the number of people killed) from the 15 variables selected, 6 quantitative variables and 9 qualitative variables. It should be noted here that for the modelling of the number of accidents, 6 cities were withdrawn from the sample because the accidents were poorly recorded.

The results of all of our modelling come from iterative calculations aimed at removing insignificant variables. In the end, the following results are obtained (see Figure 4).

		Model 1 (number of accidents)		Modèle 2 (number of deaths)	
Variable	**Type**	**effect**	**IC 95 %**	**effect**	**IC 95 %**
Year	**time variable**	-6%	[-6;-5]	-5%	[-6;-5]
Police control	**qualitative variables related to mobility plans**	-12%	[-20;-4]	-18%	[-26;-8]
Measures for securing dangerous areas and black spots		21%	[10;33]	25%	[12;40]
Measures for pedestrian safety		-20%	[-26;-14]	-14%	[-23;-4]
Measures for the safety of motorized 2-wheelers		*NS*	*NS*	24%	[11;39]
Measures for a better knowledge of road safety issues in the territory		-23%	[-30;-17]	-11%	[-21;0]
Measures to sustain/strengthen the existing accident observatory		*NS*	*NS*	-23%	[-34;-10]
Measures for the youth safety		28%	[18;40]	*NS*	*NS*
unemployment coverage rate	**Quantitative variables**	*NS*	*NS*	*NS*	*NS*
urban intensity		*NS*	*NS*	-0,39%	[-0,48;-0,31]
population youth index		-0,45%	[-0,53;-0,37]	-0,33%	[-0,38;-0,27]
Age of the existence of an accident observatory		0,76%	[0,25;1,27]	1,37%	[0,68;2,04]
employment coverage rate		-0,24%	[-0,34;-0,13]	*NS*	*NS*
transport payment (tax on the payroll of companies in constant euros) reported to the population (1%)		0,15%	[0,08;0,23]	*NS*	*NS*

Figure 4 : Results of the estimated models for the number of accidents and the number of deaths

Discussion

Temporal effect

The temporal effect, considered annualized and constant in the model, is characterized by an average annual decrease of 6% in the number of accidents in built-up areas for the 64 central cities between 1987 and 2017, all other things being equal. For mortality, the estimated average annual decrease is 5% in agglomerations for the 70 central cities, all other things being equal. This annual decrease is explained by all the collective measures taken at national level which are also enforced in the cities (50 km/h in conurbations, improvement of infrastructures, etc.)

Effects of variables linked to the mobility plan

For the accidents, 3 measures are significantly associated with favourable results in agglomerations with the 64 city centres. Aa fourth one is identified for the road fatalities:

- Central cities covered by a mobility plan with measures to strengthen or improve the control exercised by the police have a 12% lower number of accidents and 18% lower mortality, compared to those have not taken these measures;

- Central cities covered by a plan with strong measures for pedestrian safety have a 20% lower number of accidents and 14% lower mortality, compared to those that have not taken these measures or taken less strong measures;
- Central cities covered by a plan with strong measures for a better knowledge of the road safety issues on the territory have a lower number of accidents by 23% and a lower mortality by 11%, compared to those which do not have not taken these measures;
- Central cities covered by a plan with measures to perpetuate or strengthen the existing accident observatory have a lower mortality rate on average of 23% compared to those which have not taken these measures.

On the other hand, 3 other measures in the estimated models are associated with unfavourable results on accidentality and mortality. This concerns the existence of measures for the identification and treatment of black spots, the existence of strong measures for the safety of young people and finally the existence of measures for motorized two-wheelers.

To explain these results, several interpretations are possible.

The measure on the treatment of black spots consists in identifying the places of accumulation of accidents requiring treatment by the urban authorities. This measure is more often present in urban areas with high accident rates. These urban authorities often treat these black spots locally but they are not planned by considering the overall conditions of mobility and potential interactions, in particular for the roads near the black spot. This can lead to favouring the occurrence of an accident (accident migration) on a nearby road which has not been considered for the treatment (reduction of speed for example).

The measure on raising awareness among young people and securing access to schools also produces unexpected y results. With regard to the safety of access to schools, studies show that accidents mainly take place on the way to school near the home rather than in the immediate proximity of the school. This pleads for an overall consideration of road safety on a perimeter much wider than the surroundings of schools and to avoid overconfidence in sage interventions limited for the proximity of schools

Finally, concerning motorized two-wheelers, the presence of the concernedmeasures shows a significant use of motorized two-wheelers in the urban areas concerned. All research shows that motorized two-wheelers are vulnerable users whose road risk is much higher than all other travelling modes. Consequently, the presence of a greater number of motorized two-wheelers trips translates into higher accident rates for the towns concerned. The negative result on the motorized two-wheeler prevention variable also shows that the measures taken in favour of their safety in the mobility plans are not significant enough. These measures show more awareness of the accident problems of motorized two-wheelers on the territory than the actual implementation of measures capable of reducing the number of accidents.

Effects of quantitative variables

5 quantitative variables are significantly associated with the number of accidents or mortality in central cities. The estimated effect can be interpreted as an average change for an increase of one or more units, all other things being equal, as follows:

- For 10 additional jobs for 100 active workers in a central city, the number of accidents would be 2.4% lower on average;
- For 10 additional cumulative jobs and inhabitants of a central city per square hectare, road mortality would be nearly 4% lower on average;

- For 10 additional young people for 100 seniors in a central city, the number of accidents would be 4.5% lower on average and mortality would be 3.3% lower on average;
- For an additional year of seniority of an accident observatory covering a central city, the number of accidents and its road mortality would be respectively 0.76% and 1.37% higher;
- For an additional 10 euros of the net transport payment received by the AOM (to which the central city belongs) per inhabitant of the territorial jurisdiction, the number of accidents would be 1.5% higher on average;

How to explain these results?

A greater density of jobs and inhabitants generally favours travel at lower speeds for a large part of the day for cars and trucks (congestion). Because speed is a central element in road mortality, its reduction is an indirect effect of an increase density of traffic, that logically favour a lower level of mortality.

The presence of a greater proportion of young people compared to seniors confirms the initial hypothesis on accident rate and mortality. Young people are often more risk-taker. However the youth are more reactive to danger and more resistant when a crash occurs. The accidents involving the youth therefore have lower severity rates. As evidenced by the data on pedestrian mortality in urban areas (National Road Safety Report, 2021), seniors are physically vulnerable users, having with advancing age a decrease in their responsiveness to the difficulties encountered and reduced diagnostic capacity. This result encourages, in a context of aging of the country's population, to strengthen road safety interventions for seniors.

Some results do not meet the initial expectations with the operational model, in particular for the age of the creation of an accident observatory and for the financial capacity of cities to invest in public transport.

For the age of the creation of an accident observatory, it is possible that it is the urban areas in which the accident and mortality rates are the highest, which set them up first. Which would mean that it is not the seniority of the involvement in road safety that alone allows the best results to be obtained. Moreover, to observe the road safety record does not necessarily the implementation of effective intervention. If it is essential to observe as provided by the SRU law since 2001, it is not an enough measure.

With regard to the transport payment, on the panel of central cities concerned, it is above all a question of reserved corridors and trams. Whether for trams or buses on reserved lanes, the literature shows that the road safety dimensions are insufficiently considered for through these transport projects. In particular, these investigations do not consider vulnerable users living near these facilities and who are not direct users of public transport, but exposed to a new risk. Moreover, the assessments do not consider the perverse effects linked to the transfer of car traffic to adjacent roads involved with the change of land use

Conclusion

The results of this study show that certain local mobility and road safety measures, included in mobility plans, are correlated with a lower number of accidents and/or lower mortality in the central cities studied. These effects are complement to the general measure captured by the trend identified for the reduction in accidents and fatalities occurring on the urban roads between 1987 and 2017. On the other hand, other measures have shown unexpected effects. Analyses show that road safety in an urban environment requires comprehensive treatment on the scale of a district or a city, as well as better specific arrangements to lower the speed of certain modes such as motorized two-wheelers.

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