

Quantitative and Qualitative Study of Accidentology in Urban and Extra-Urban Areas in Morocco

M. El Gameh¹, D. Ennajih², H. Diafi¹, F. Loukdach¹, M. Aounae² & A. Echchelh^{1*}

¹Laboratory of Electrical Engineering and Energy System, Faculty of Science IbnTofail University, Kenitra, Morocco

²Laboratory of Applied Chemistry and Quality Control, Faculty of Science IbnTofail University, Kenitra, Morocco

***Corresponding Author:** A. Echchelh, Laboratory of Electrical Engineering and Energy System, Faculty of Science IbnTofail University, Kenitra, Morocco

ABSTRACT

Road safety is based on a combination of three well-known players, explicitly, the driver, the vehicle and the infrastructure, which includes its signaling, and security equipment. Traffic accidents take place on every continent, all over the world. Each year, it causes the killing of more than a million people and the injuring of millions more. The main focus of our work is to assess road safety in Morocco by applying a statistical study of the distribution of accidents and victims in urban and non-urban province over a period extending from 2006 to 2016, in addition to the distribution of victims by user category and by province, using the analysis method of the XLSTAT database.

INTRODUCTION

Safety or security indicates what is out of danger, damage or threat. The concept of road safety subsequently encompasses accident prevention on the road in order to protect people's lives. On the other hand, road insecurity represents all the malfunctions generated by road traffic including traffic accidents that may lead to material or physical damage. It is a war on the roads which causes thousands of casualties and wounded per year. It seems that nothing can put a stop to this menace, even the sensitization campaigns not to mention the severe contraventions prescribed to the culprits, which is why there is an absolute necessity to discover an efficient solution to stop this carnage.

According to the World Health Organization (WHO), road crashes worldwide kill about 1.3 million people each year and injure 25 to 50 million people, this is the reason behind the necessity to conduct a thorough study of the number and causes of this life-threatening road accidents in our country in order to minimize human damage.

For the purpose of improving road safety, it is essential to understand the preventable causes of road accidents. Police reports on the latter are the main source of data used to enrich the researches and policies. [4]

The contributing factors to road accidents such as inexperience, lack of skills and hazardous behaviors have been associated with young driver collisions. However, visual, cognitive and mobility disorders were associated with collisions of older drivers.

The main indicators of road safety are the number of injuries, the number of deaths, the number of deaths per 100,000 inhabitants and per 10,000 vehicles as well as the number of fatal accidents per traveled kilometers. [5-6]

These road safety indicators provide information on the frequency and severity of accidents. They are also based on exposure data that allows cross-country comparisons.

The fight against road safety is by definition a partnership, at both national and local level. The state is inevitably the guarantor of the citizens' security and must fully assume its responsibilities, but ensuring this security could only be achieved if it goes through the mobilization of the whole social body, including the civil society (companies, associations of users and victims, etc.). [7-8]

MATERIALS AND METHODS

The Kingdom of Morocco is one of the North African countries in the region known as the Maghreb. The country is bordered by Spain, Algeria, Mauritania, and Western

Sahara. Morocco stretches from the Atlantic Ocean through the mountainous regions into the Sahara Desert. The country, besides France and Spain, is the only one with both the Mediterranean and Atlantic coastline. It has a population of nearly 34 million (2014 census) and an area of 710,850 km².

Road safety in Morocco is still a real problem and a dangerous phenomenon, in a sense of having a large number of accidents recorded daily on the roads which causes considerable human and socio-economic damage.

The Ministry of Equipment and Transport collects and processes statistical forms of road traffic accidents. Thus forms are filled by the Royal Gendarmerie and services under the Directorate General of National Security, respecting the international definitions of victims.

The collection period of our data spread from 2006 to 2016, statistics on road accidents under the law were accomplished. On the one hand, the Royal Canadian Mounted Police collects data on suburban traffic accidents and on the other hand the National Security Directorate Committee collects data on traffic accidents in urban areas.

We will perform an analysis to track the evolution of accidents. We will also evaluate the impact of these accidents on the country and search for the first attempts to explain the origin of the accidents.

To ensure the statistical calculations the XLSTAT software has been retained. The choice fell on this software because of its good adequacy to the subject, its reliability and its simplicity due to its integration in the Excel 2007 spreadsheet.

The statistical study was based on principal component analysis PCA. The intermediate correlation matrix, the correlation coefficients between the variables and the projection of these variables in F1 and F2 axis space were obtained with the XLSTAT software version 2014 [9].

RESULTS AND DISCUSSION

From 2006 to 2015

To estimate the distribution of road fatalities in Morocco from 2006 to 2015, an analysis of the effect of road insecurity was carried out. The results of this analysis shown in Figure 1 illustrate that there is a very significant reduction between accidents in urban and extra-urban areas. The vast majority of accidents involving pedestrians occur in urban areas. There is also a dramatic evolution of accidents each year probably due to the increase in the number of vehicles in Morocco. The results also demonstrate that there are three times as many injuries in urban areas as there are in the suburbs and the number of non-serious injuries is higher. The number of deaths is twice as high in the suburban territories. (Figure 2)

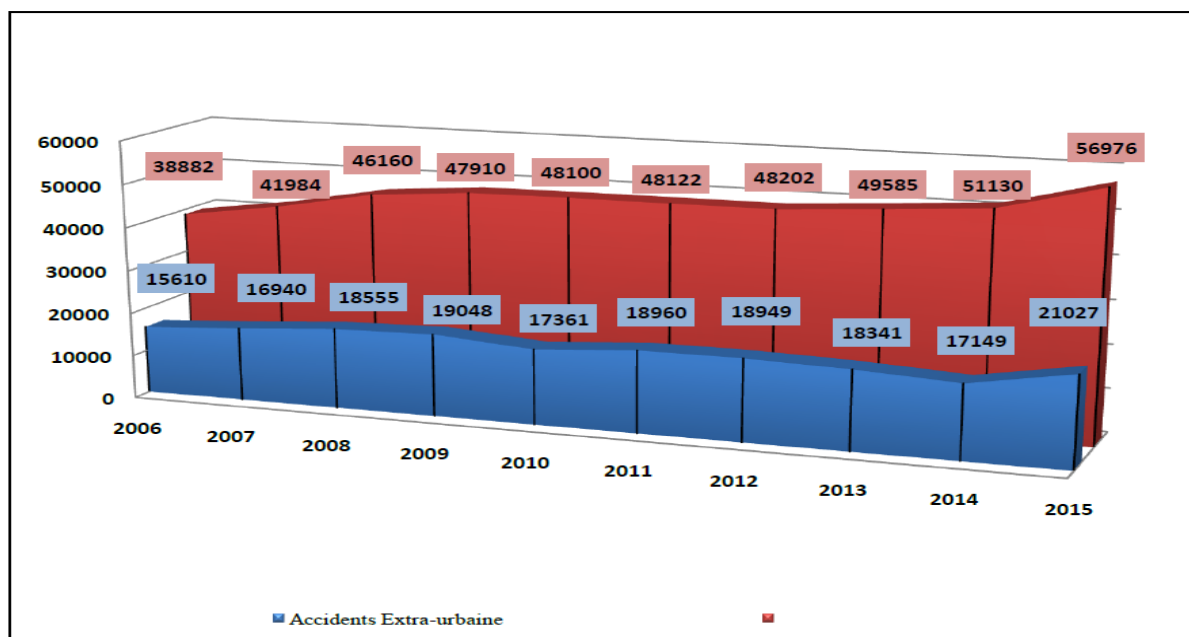


Figure 1. Evolution of accidents and victims from 2006 to 2015

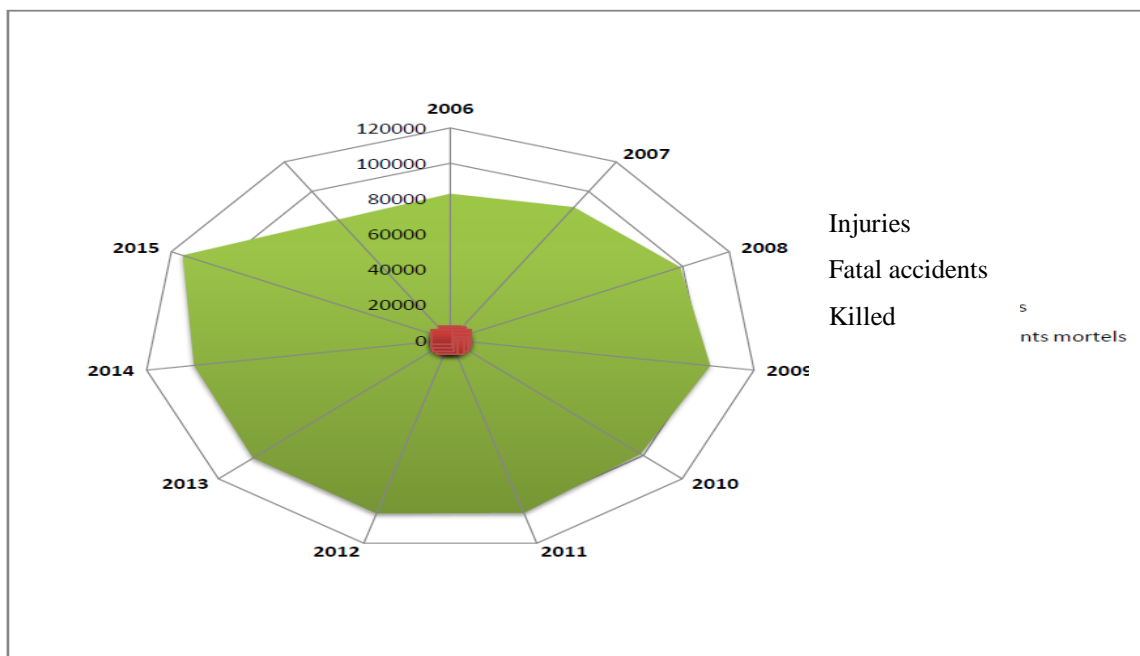


Figure 2. The rate of victim compared to years

The results proclaimed in the previous figures are especially confirmed in the representation of accidents and victims in comparison with the years on the factorial plane (Figure 3).

In addition, the combined projection makes it possible to highlight the following suggestions:

- Accidents resulting in injuries are highly

correlated with urban and suburban areas in 2015, along axis 1 on the positive side. We can clearly see that in urban areas the effects of accidents are less serious.

- On the other hand, the parameters “killed” and “fatal accidents” are strongly correlated with each other.

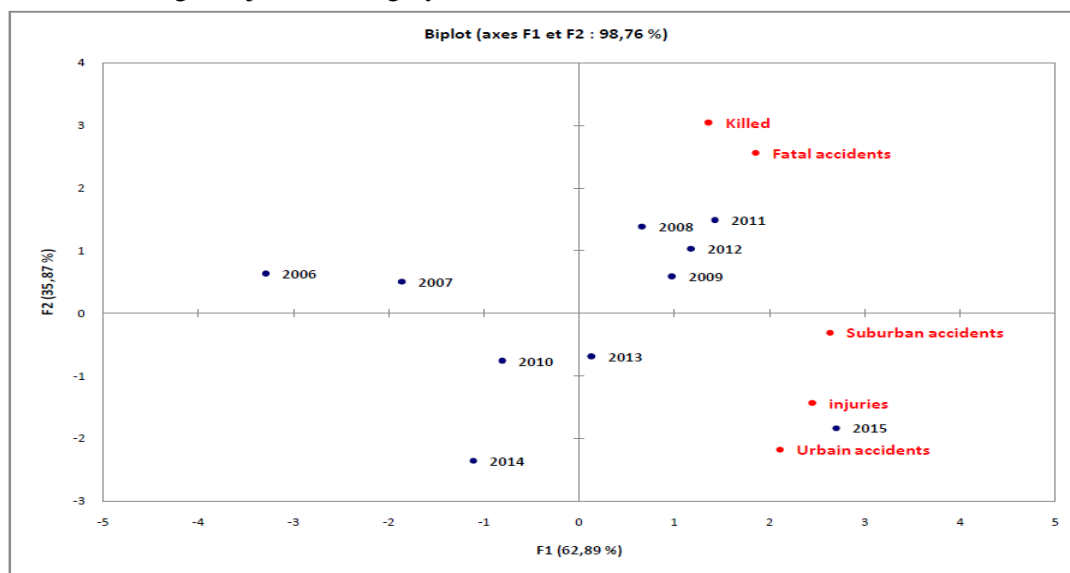


Figure 3. Representation of accidents and victims in comparison with years in factorial design

These accidents are mainly due to the inadvertence of the drivers and the pedestrians, the lack of priority, the speeding, the change of direction without signaling, the lack of vehicle’s control, the non-respect of the stop sign, the unauthorized change of direction, impaired driving, non-compliance with traffic lights, left-

lane traffic and driving in the prohibited direction.

Distribution of Accidents and Victims by Urban and Suburban Provinces in 2016

Figure 4 showcases changes in the values of the studied parameters: fatal accidents, non-fatal accidents, serious injuries, minor injuries and

killed. It can be noticed that minor injuries are the dominant parameter while the maximum value is observed in the province of Rabat-Sale-Kenitra and WILAYA of great CASABLANCA. This is due to the intense traffic of this area. In terms of accessibility and connectivity, the Rabat bypass motorway

includes several developments: a junction with the Casablanca-Rabat motorway, an interchange to serve the new city of Tamesna, an interchange at the town of Menzeh overlooking the Rabat-Ain Aouda road, an interchange at Sala Al Jadida and another at Technopolis.

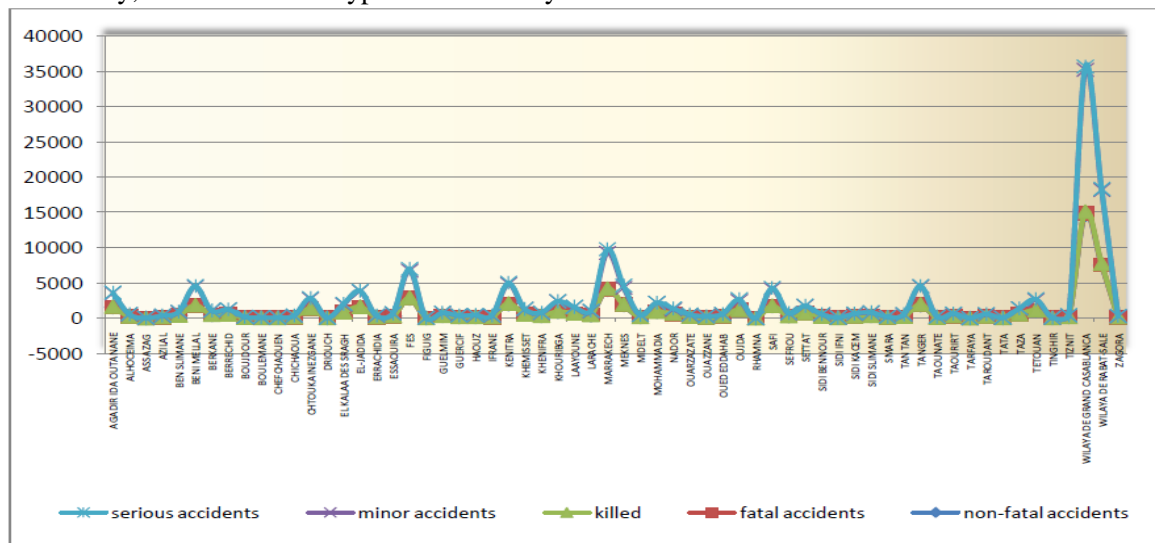


Figure 4. Evolution of accidents and victims in urban areas of different provinces of Morocco in 2016

The comparison of the evolution of accidents and victims in relation with suburban provinces in Morocco in 2016 (Figure 5) reveals that the suburban perimeter is characterized by a strong tendency of minor injuries and non-fatal accidents.

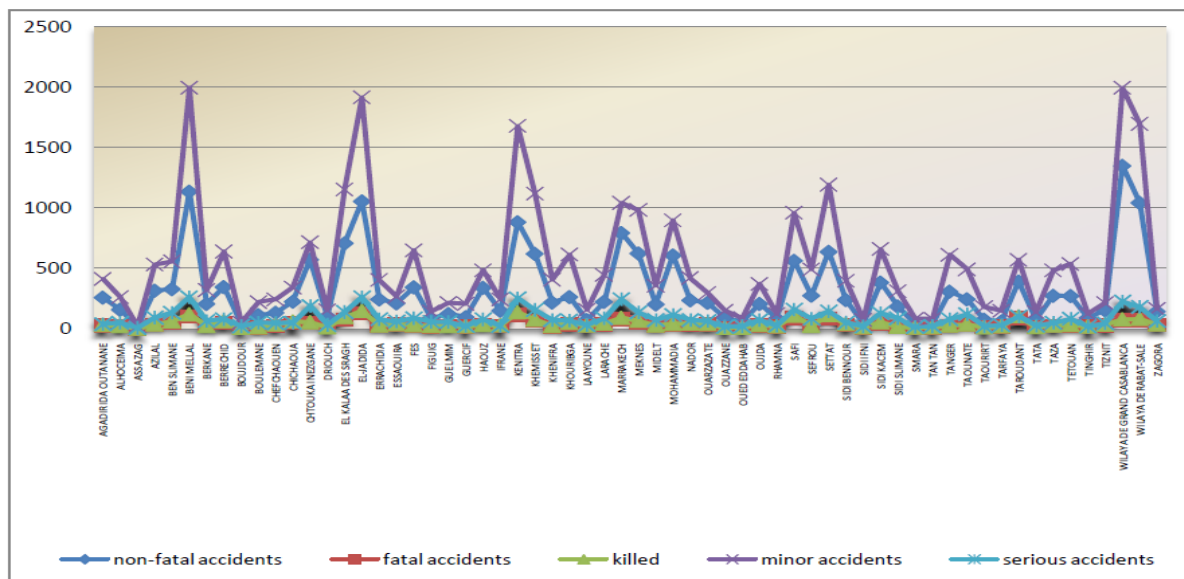


Figure 5. Evolution of accidents and victims in extra-urban areas of different provinces of Morocco in 2016

The provinces of Kenitra, El Jadeda, Errachidiadelineates high values of accidents rate (whether fatal or non-fatal, resulting from a minor or serious injury or killed) compared to the other provinces.

This can be explained by the fact that the suburban areas suffer from the presence of a bad infrastructure thus resulting in a great risk for a

pedestrian to be injured or killed, taking into account that studies have shown that accidents' victims are 3 to 4 times higher in the suburban area.

But, concerning the non-fatal accidents, minor injuries and serious injuries, they are highly correlated with each other and also correlated with the provinces of Rabat-Sale-Kenitra,

Casablanca, BeniMellal, Mohammadia and Marrakech.

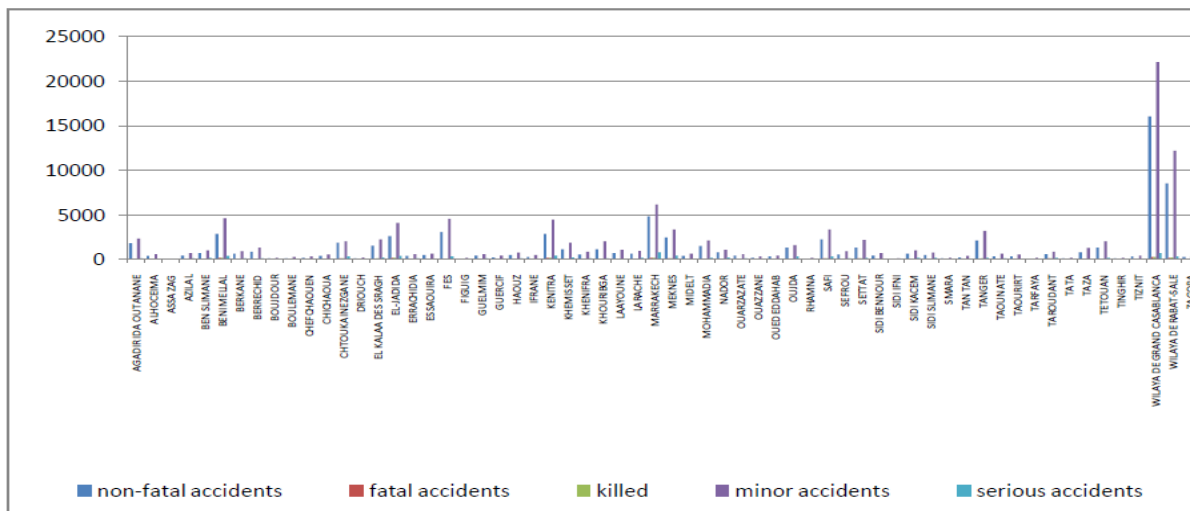


Figure 6. Total accident and victim rates in Morocco in 2016

The distribution of accidents and casualties by province in urban and non-urban areas is shown in Figure 6. Non-fatal and minor injuries are the most noticeable.

Graphs of average deaths, fatalities and serious injuries confirm that the maximum value is present in the province of Marrakech, yet non-fatal accidents and minor injuries are more noticeable in the province of Rabat-Salé-Kenitra.

Indeed, the road between Marrakech and Ouarzazate is characterized by a winding and dangerous course which is accentuated between the localities of Tazlida and Aguelmous about 40 km and especially at the section between Taddart 2 and the Tichka pass on 13, 5 km with a long profile with ramps that exceed 9%. It is the only national route from Marrakech to Ouarzazate, Zagora and Tinghir.

Correlations between Variables and Factors

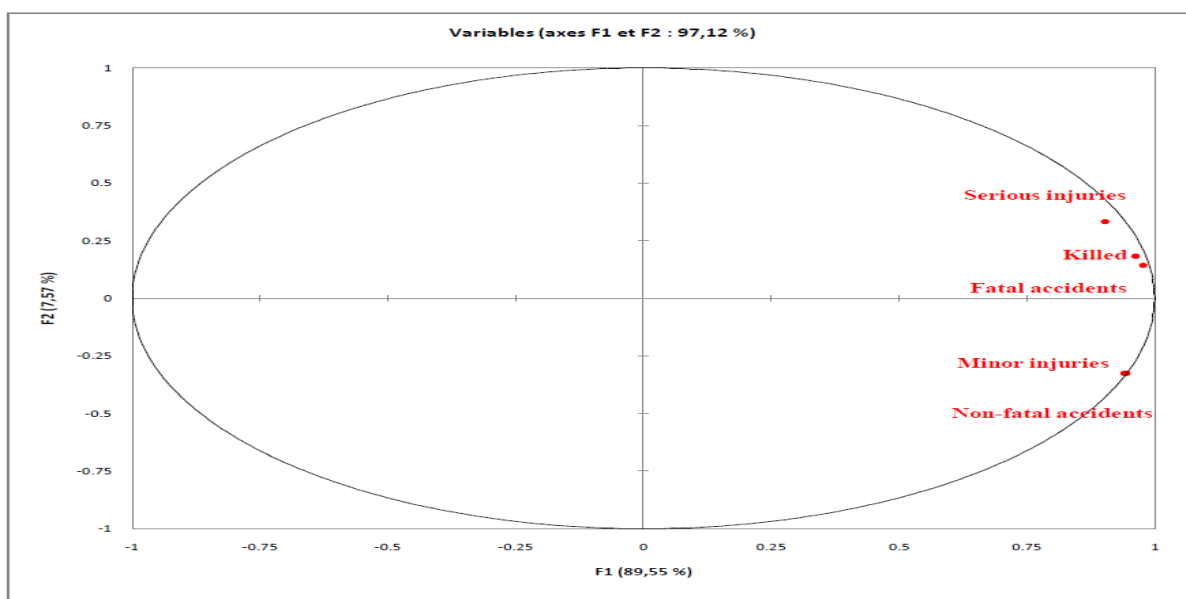


Figure 7. Projection of the distribution variables on the circle of correlations

With respect to the F1 axis (89.55%) the correlation between the five previously mentioned variables is strongly positive. Regarding the F2 axis, serious injuries, killed, and fatal accidents are positively correlated, but

minor and non-fatal injuries are negatively correlated.

From these results we can deduce that the variables are highly correlated with each other

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thus indicating that all these variables have an influence on the other.

It is clear that all distributions are close to the edge of the circle, which means that they are

well represented by the factorial plane, and that the five stochastic distributions are well correlated with the two factors. (Figure 7)

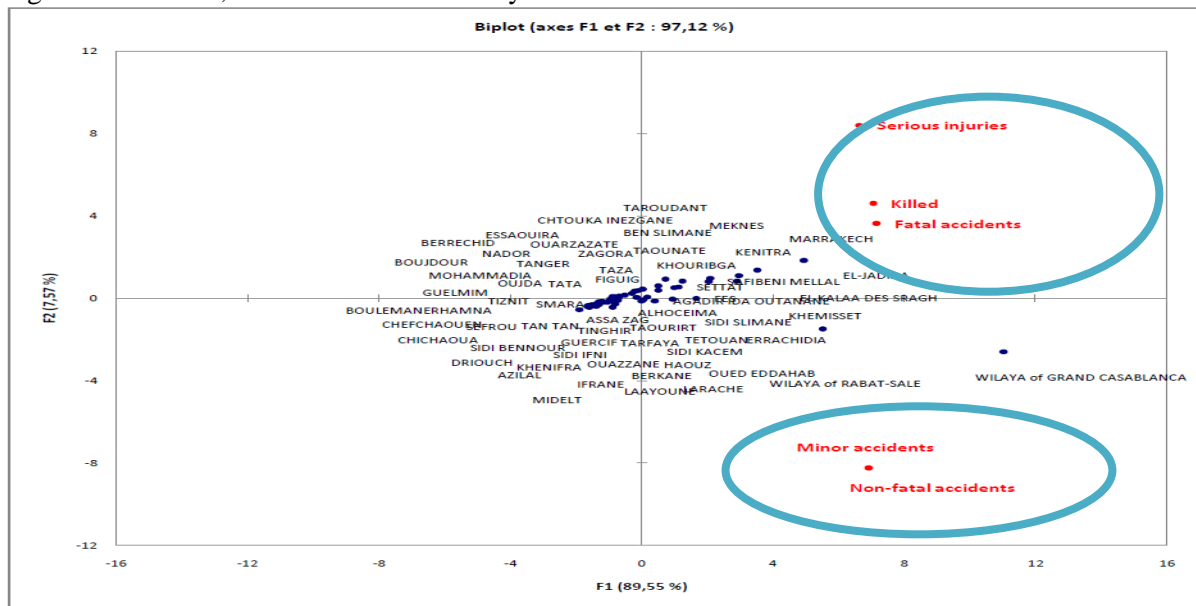


Figure 8. Representation of total accidents and victims in Morocco in terms of factor

Furthermore, the combined projection of the accident and victim variables with respect to the provinces according to axis 1 and 2 makes it doable to highlight the subsequent suggestions:

- Nonfatal injuries and minor injuries are strongly correlated with Rabat-Sale-Kenitra province, along axis 1 on the positive side.

- Parameters killed, fatal accidents and serious injuries are correlated with the province of Marrakech (Figure 8).

The representation of the structure of the modalities on the factorial plans makes it possible to synthesize a perfectly negative correlation between the accidents and the victims compared to the urban and suburban provinces (figure 9).

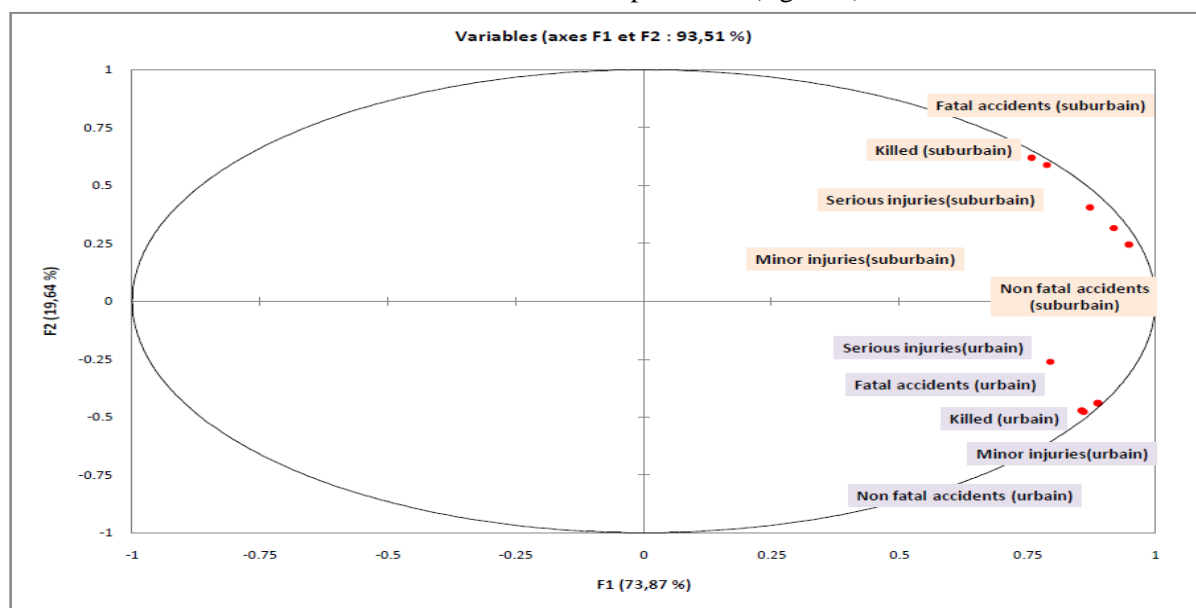


Figure 9. Projection of the distribution variables on the circle of correlations

In Morocco, vehicles kill 14 times more than in France, 18 times more than in Sweden, 17 times

more than in the United Kingdom and 11 times more than in the United States. In ten years, the

automotive park grew by 43.5%, traffic increased by 55.2% and the road network grew by 16.7%. In 2003 in Morocco, with an automotive park 18 times smaller than France and 12 times smaller than Spain, Morocco already records a percentage of killed ten times larger. Over the period between 1995 and 2004, the accident report in Morocco indicates that 80.76% of the vehicles involved in accidents are over five years old.

Moreover, public transport has bad press with a part of the population. Accidents are often numerous and deadly on Moroccan roads. They are not only explained by the obsolescence of the vehicles but also by the behavior of the users and the state of the road's infrastructures. Accidents and serious consequences can be explained by a combination of factors related to driver, vehicle, traffic conditions, technical control, driving license, etc.

Over the last ten years, we can see the evolution of the various indicators. However, other factors or combinations of factors responsible for accidents must be studied to identify the risk factors for serious accidents and to classify the driver, vehicle, road, alcohol, speed, drowsiness quantitatively. [10-11-12-13]

CONCLUSION

Any road system is complex and dangerous for human health. These include motor vehicles, roads and road users and their economic and social environment. Road traffic collisions are an immense public health and development problem.

This work has displayed the current state of knowledge about the human damage due to traffic accidents and the measures to be taken to tackle the problem.

We presented the results obtained from this research. They could be of interest to analyzers whose task it is to improve the road safety, as well as the designers of software specialized in this task. This study will provide a model for studying the reconstruction of accidents that we will develop in the next work.

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