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Research Article

Poisson Regression: Influence Factors of Traffic Accidents in Algeria

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ABSTRACT

The objective of the study is to explain the effect of several factors on the increase or decrease in the number of traffic accidents. To achieve this objective, we used the Poisson regression model. We analyzed the road accident database in the JIJEL province in Algeria during the year 2022. This database was created by the national gendarmerie group in JIJEL. Statistical analyses were performed using the R statistical software to interpret the relationship between the occurrence of the accident and the responsible risk factor.

Keywords: Poisson regression, Counted data, Wilaya of JIJEL, Circumstances of the accident, Socioeconomic characteristics of the driver.

INTRODUCTION

Road accidents are a major issue in many countries around the world, including Algeria. They often result in serious injuries and even loss of human lives, significantly impacting individuals, families, and communities. Additionally, they can cause substantial property damage. According to the World Health Organization (WHO), more than 1.25 million people die due to road accidents each year. Prediction models for road accidents are crucial tools for transportation safety, as they effectively determine the frequency, severity level, and common factors responsible for traffic accidents.

To interpret the relationship between accident occurrence and the responsible risk factor, the Poisson regression model can be employed, known for its superior predictive capabilities compared to other models.

Poisson regression is a powerful tool for modeling count data. Its primary goal is to estimate model parameters to understand how independent variables influence the occurrence count of the studied event. It identifies relationships between independent variables and event frequencies, quantifies these relationships, and predicts future occurrences. The aim is to provide insights into factors influencing event count rates.

Our study primarily aims to explain the impact of various factors (such as gender, age, time, road condition, weather, location, lighting, and vehicle type) on the increase or decrease of traffic accidents in Jijel. Statistical analyses are conducted using the R statistical software.

1. DATABASE

The data used in this study are extracted from road accident reports that occurred in 2022 and were recorded by the National Gendarmerie Grouping of the Wilaya of JIJEL.

These reports list all traffic accidents (118 accidents) that occurred throughout the year 2022 in JIJEL across all municipalities, with a simplified description. This includes information about accident circumstances (date, time, location, type of vehicles involved), weather conditions, road conditions, and socio-economic characteristics of the driver (gender, age, etc.).

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The different explanatory variables used are as follows:

- **Sex**: Gender of the driver (Male (H) or Female (F)).
- **Age**: Age of the drivers
  - Between 19 and 39 years (Y)
  - Between 40 and 59 years (A)
  - 60 years and older (S)
- **Time**: Time of day when the accident occurred.
  - Between 6 am and noon (M)
  - Between noon and 6 pm (Am)
  - Between 6 pm and midnight (S)
  - Between midnight and 6 am (N)
- **Road**: Road condition (Good (B), Wet (H), Icy (Gl), Dry and Clean (SP), Unpaved (NG)).
- **Clm**: Weather conditions at the time of the accident (Clear (C), Rainy (P), Light rain (Pl), Cloudy (N), Strong wind (V)).
- **Eclrg**: Road lighting conditions (No lighting (Se), Sunny light (Es), Artificial lighting (Er), Adequate lighting (E)).
- **Vehic**: Vehicle used by the driver during the accident (Car (V), Truck (C), Semi-trailer (S), Motorcycle (M), Tractor (Trc), Train (Tr), Covered car (Vc), Bus (B)).
- **Ann**: Year of vehicle registration.
  - Before 2012 (A)
  - Between 2012 and 2017 (M)
  - Between 2017 and 2021 (N)
- **Lieu**: Location of the accident (Single-lane national road (R1), Dual-lane national road (R2), Cliff (Cr), Mountain road (M), Railway line (T), City center (Cv)).

2. DESCRIPTIVE STATISTICS OF THE DATA

Table 1 illustrates the descriptive statistics of the data.

Variable	Categories	Number	Percentage
Sex	H F	115 3	97% 3%
Age	J Ad V	73 30 15	62 % 25 % 13%
Time	M Am S N	19 50 41 8	16.10% 42.37% 34.75% 6.78%

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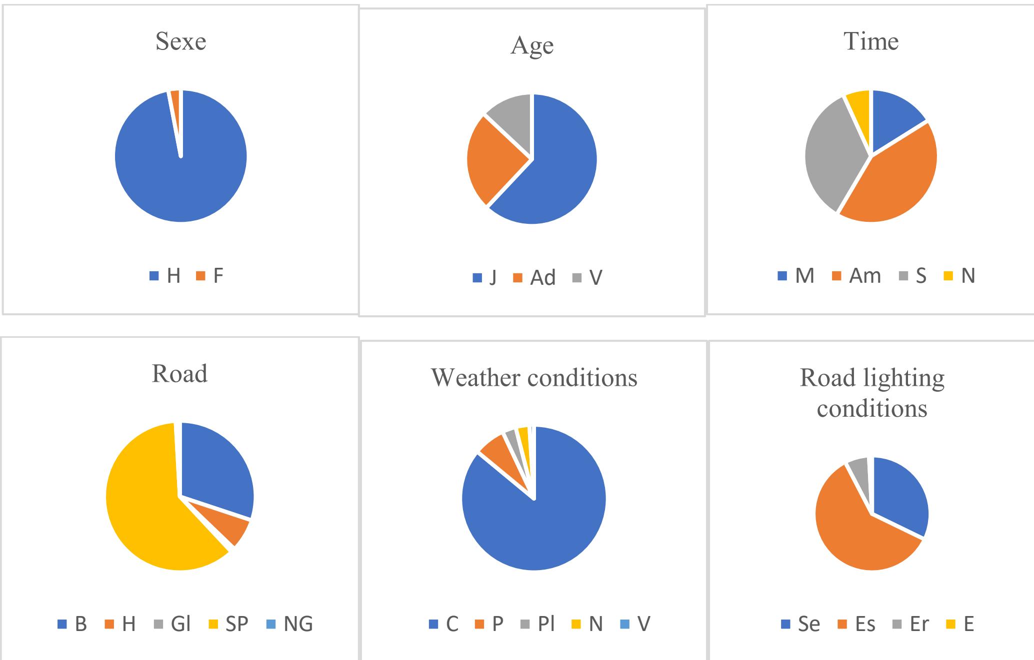
Road	B H Gl SP NG	34 8 1 69 1	30.1% 7.08% 0.88% 61.06% 0.88%
Clm	C P Pl N V	101 8 3 4 1	86% 7% 3% 3% 1%
Eclrg	Se Es Er E	38 71 8 1	32.20% 60.17% 6.78% 0.85%
Vehic	V S C M Trc Tr Vc B	79 6 5 14 2 5 4 3	67% 5.1% 4.2% 11.9% 1.7% 4.2% 3.4% 2.5%
Ann	A M N	54 31 24	49.54% 28.44 % 22.02%
Lieu	R1 R2 Cr Cv M T	17 42 29 9 15 6	14.4% 35.6% 24.6% 7.6% 12.7% 5.1%

Table 1: Summary statistics of explanatory variables

Figure 1 represents pie charts for each explanatory variable.



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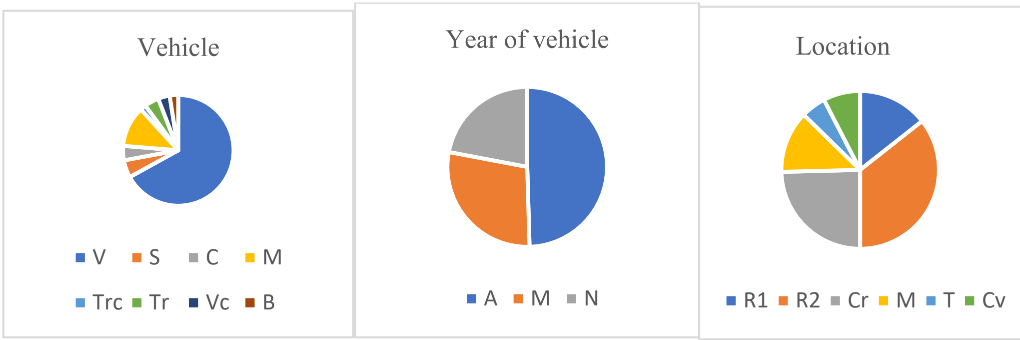

Figure 1: Graphical representation of explanatory variables

3. ESTIMATION OF PARAMETERS

We begin by estimating all parameters of the model (Table 2).

Variable	Estimate	Pr (>|z|)
Sex	2.232	0.135
	38.873	0.000 ***
Age	76.280	0.000 ***
	39.745	0.000 ***
Time	33.075	0.000 ***
	31.898	0.000 ***
Road	3.080	0.079 *
	68.107	0.000 ***
Clm	6.402	0.011 *
	129.165	0.000 ***
Eclrg	0.001	0.970
	53.620	0.000 ***
Vehic	12.642	0.000 ***
	173.949	0.000 ***
Ann	107.084	0.000 ***
	12.997	0.002 **
Lieu	6.453	0.011 *
	39.706	0.0 *

Table 2 : Parameter estimation of the model

From Table 2, we notice that all variables are statistically significant (P-value < 5%), indicating that each variable is important in the model. Next, we estimate the parameters of the categories within each variable, which are presented in Tables 3 to 11.

3.1. Interpretation and discussion of the variable Sex

Le paramètre	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	-1.3863	0.5773	-2.401	0.0163 *
SexH	3.6463	0.5848	6.235	4.5e-10 ***

Table 3 : Parameter estimation of the Sex variable

- The coefficient for the male category "SexH" of the sex variable increases by 3.6463 when the driver is male compared to females (reference level). Since OR = exp(3.6463) = 38.333, the number of accidents among males is 38 times higher than among females.

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These numbers are explained by the 'dark' relationship that men still have with driving and the car: ego, speed, alcohol, drugs, fatigue. Whereas for women, the car represents a simple means of transportation. It is a tool of narcissism and virility for men. The sociologist Cyrille Dupré-Gazave, who conducted a study on masculinity behind the wheel for road safety, says: "Masculinity discovers the car from a young age, as a toy, and therefore acquires very early on the status of an identity object" men then show excess confidence.

3.2. Interpretation and discussion of the Age variable

Paramètre	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	0.9163	0.1826	5.019	5.20e-07 ***
AgeJ	0.8893	0.2169	4.100	4.12e-05 ***
AgeV	-0.6931	0.3162	-2.192	0.0284 *

Table 4 : Parameter estimation of the Age variable

- The coefficient for "AgeJ" indicates that when moving from an adult class (reference level) to a young class, η increases by 0.8893. Since OR = exp(0.8893) = 2.433, the number of accidents among young people is twice that among adults.
- The coefficient for "AgeV" indicates that when moving from an adult class to an old class, η decreases by 0.6931. Since OR = exp(-0.6931) = 0.5000, the number of accidents among the elderly decreases by 50% (1 - OR = 0.50) compared to adults.

We have noticed through the results of the R that the rate of traffic accidents among young people will multiply by adults, i.e. young drivers are the most involved in accidents because of their imprudence and lack of physical and emotional maturity. It is also noteworthy that the rate of traffic accidents among older people decreases by 50% compared to adults, i.e. the older the driver, the less likely they are to have accidents.

3.3. Interpretation and discussion of the Time variable:

Paramètre	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	1.4271	0.1414	10.091	< 2e-16 ***
TimeM	-0.9676	0.2695	-3.590	0.00033 ***
TimeN	-1.8326	0.3808	-4.813	1.49e-06 ***
TimeS	-0.1985	0.2107	-0.942	0.34624

Tableau 5: Parameter estimation of the Time variable

- The coefficients for "TtimeM" and "TimeN" indicate that when moving from these periods to the afternoon (reference level), η decreases by 0.9676 and 1.8326 respectively. The number of accidents during the morning and night periods decreases by 62% (1 - OR = 1 - exp(-0.9676) = 0.62) and 84% (1 - OR = 0.84) respectively compared to the afternoon.
- For the "TimeS" category, P-value > 0.05 indicates that there is either no difference between the afternoon and evening periods, or there is a decrease that is not significant.

The decrease in accidents during the morning and night periods compared to the afternoon is due to traffic congestion and driver fatigue during this period: it corresponds to the period when the majority of working people return home.

3.4. Interpretation and discussion of the Road variable

Paramètre	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	1.0415	0.1715	6.073	1.26e-09 ***
RoadGl	-3.5264	1.0143	-3.477	0.000508***

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RoadNG	-3.5264	1.0143	-3.477	0.000508***
RoadH	-1.4469	0.3929	-3.682	0.000231***
RoadSP	0.7077	0.2095	3.378	0.000731***

Table 6: Parameter estimation of the Road variable

- The coefficients for "RoadGl", "RoadNG", and "RoadH" decrease when moving from a good road condition (reference level) to icy, unpaved, or wet conditions. The number of accidents when the road is icy, unpaved, or wet decreases by more than 70% compared to a good road condition.
- Conversely, the coefficient for "RoadSP" indicates that when moving from a good road condition to dry and clean condition, η increases by 0.7077. Since OR = exp(0.7077) = 2.029, the number of accidents when the road is dry and clean is double compared to when the road condition is good due to speed and overconfidence.

Therefore, it is important to note that even on a clean and good road, this speed is a reflection of overconfidence that the driver can feel when the road seems safer.

3.5. Interpretation and discussion of the Clm variable:

Paramètre	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	2.1302	0.0995	21.408	< 2e-16 ***
ClmN	-3.0057	0.4582	-6.560	5.36e-11 ***
ClmP	-2.5357	0.3673	-6.904	5.06e-12 ***
ClmPl	-3.9220	0.7141	-5.492	3.97e-08 ***
ClmV	-4.6151	1.0049	-4.592	4.3e-06 ***

Table 7: Parameter estimation of the Clm variable

- The coefficients for 'ClmN', 'ClmP', 'ClmPl', and 'ClmV' decrease when the weather is cloudy, rainy, light rain, or windy compared to clear weather (reference level), meaning the number of accidents decreases by more than 90% in bad weather conditions.

This indicates that when the weather is clear, drivers tend to drive faster, which can lead to an increase in the number of accidents. In such situations, clear visibility may give drivers a false sense of security and encourage them to exceed the permitted speed limits.

3.6. Interpretation and discussion of the Eclrg variable

Paramètre	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	-2.485	1.000	-2.485	0.01296 *
EclrgEr	2.079	1.061	1.961	0.04994 *
EclrgEs	4.263	1.007	4.233	2.31e-05 ***
EclrgSe	3.638	1.013	3.591	0.00033 ***

Table 8 : Parameter estimation of the Eclrg variable

- The coefficients for 'EclrgEr', 'EclrgEs', and 'EclrgSe' increase by 2.079, 4.263, and 3.638 respectively compared to 'EclrgE' (reference level). The number of accidents when the lighting conditions are: artificial, sunny, or no lighting is respectively 8, 38, and 71 times more compared to adequate lighting.

  Driving without proper lighting poses numerous risks to road safety. Road lighting is essential to ensure the safety of drivers and other road users, especially at night. Vehicle lights, particularly front and rear headlights, are crucial for visibility of the driver and other road users, especially in low-light conditions or at night.

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Additionally, it is important to note that sunlight can also pose challenges for drivers, potentially increasing accident risks in certain situations. Here are some factors related to sunny conditions that can influence road safety:

1. **Glare:** When the sun is low on the horizon, it can create intense glare that reduces driver visibility. Glare can make it difficult to perceive obstacles, pedestrians, traffic lights, and other vehicles, thereby increasing the risk of accidents.

2. **Shadow areas:** The combination of shaded and sunny areas can result in rapid changes in lighting, making it challenging for drivers to adapt to visibility changes.

3. **Reflections:** Reflective surfaces such as building windows or car windshields can create blinding reflections under direct sunlight. These reflections can disrupt the driver's vision.

3.7. Interpretation and discussion of the Vehic variable

Paramètre	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	-1.3863	0.5774	-2.401	0.0163 *
VehicC	0.5108	0.7303	0.699	0.4843
VehicM	1.5404	0.6362	2.421	0.0155 *
VehicS	0.6931	0.7071	0.980	0.3270
VehicTr	0.5108	0.7303	0.699	0.4843
VehicTrc	-0.4055	0.9129	-0.444	0.6569
VehicV	3.2708	0.5882	5.561	2.69e-08 ***
VehicVc	0.2877	0.7638	0.377	0.7064

Table 9 : Parameter estimation of the Vehic variable

- According to the table, drivers of cars and motorcycles are most responsible for accidents compared to buses (reference level) since their coefficients are higher.
- For other categories, where p-value > 0.05, it indicates that other types of vehicles are not significant.

Cars and motorcycles may pose greater risks compared to other vehicle types due to their intrinsic characteristics and higher numbers. Motorcycles are smaller and more vulnerable, which can make them harder to see on the road. Additionally, their maneuverability and speeds can be additional risk factors if not used responsibly and in accordance with traffic rules.

3.8. Interpretation and discussion of the Ann variable

Paramètre	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	1.5041	0.1361	11.053	< 2e-16 ***
AnnM	-0.5550	0.2253	-2.463	0.013779 *
AnnN	-0.8109	0.2453	-3.306	0.000948***

Table 10 : Parameter estimation of the Ann variable

- We notice that the coefficients for 'AnnN' and 'AnnM' are negative, indicating that older cars (reference level) are most involved in road accidents.

Older cars may pose certain risks due to their design, technology, and maintenance. Here are some factors that could contribute to a potential increased involvement of older cars in accidents:

-Outdated safety technology: Older cars may lack advanced safety features found in newer vehicles, such as advanced driver assistance systems, anti-lock braking systems (ABS), electronic stability control (ESP), and more sophisticated airbags.

- Inadequate maintenance: Older cars may be more prone to mechanical issues and increased wear and tear. If not properly maintained, they could have technical faults such as faulty brakes, worn-out tires, or defective suspension systems.

-Lack of current safety standards: Over the years, automotive safety standards have evolved to enhance occupant protection in accidents. Older cars may not meet the same safety criteria as newer models.

3.9. Interpretation and discussion of the Lieu variable

Paramètre	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	0.8824	0.1857	4.752	2.02e-06 ***
LieuCv	-1.1701	0.3816	-3.066	0.002166 **
LieuM	-0.6592	0.3180	-2.073	0.038187 *
LieuR1	-0.5341	0.3055	-1.748	0.080386
LieuR2	0.3704	0.2414	1.534	0.125022
LieuT	-1.5755	0.4485	-3.513	0.000443***

Table 11 : Parameter estimation of the Lieu variable

- The categories 'LieuR1' and 'LieuR2' are not significant because their P-value > 0.05.
- For the other categories, we notice that the coefficients for 'LieuCv', 'LieuM', and 'LieuT' are negative, indicating that the reference category 'LieuCr' is the most significant and responsible for accidents.

It is important to note that certain roads may be considered more dangerous due to factors such as topography, road conditions, driver behavior, and other environmental factors. Coastal roads, especially those along cliffs or steep slopes, may present additional challenges in terms of road safety.

DISCUSSION

Several factors contribute to road accidents, some related to driver behavior, such as non-compliance with traffic laws, speeding, driving under the influence, driver fatigue, failure to wear seat belts, and using mobile phones while driving. Others are related to external factors such as unfavorable road conditions, inadequate road infrastructure, ineffective road signage, and inadequate safety measures.

To address this issue, numerous measures are being implemented. Some focus on **drivers**, including road safety awareness campaigns, strict enforcement of traffic rules, driver training, and enhanced speed control. It is crucial for drivers to adopt responsible driving habits by respecting traffic laws and adjusting their driving to external conditions, regardless of weather or road conditions. Drivers must exercise caution even on well-maintained roads and clear, sunny days.

Other measures aim to improve **external road conditions**, such as lighting. Ensuring adequate and well-maintained street lighting is essential to enhance driver visibility, reduce accident risks, and promote overall road safety. Local authorities are responsible for installing and maintaining public lighting along roads. Lamp posts should be strategically positioned to uniformly illuminate the road surface and surrounding areas. The use of road reflectors and catadioptric devices, which are reflective devices marking road edges, obstacles, and traffic signs, is necessary.

Vehicle headlights are designed to illuminate the road ahead and enhance visibility at night or in low-light conditions. Therefore, it is imperative to ensure all vehicle lights function properly and use them appropriately in all circumstances.

While sunny lighting conditions can improve road visibility, drivers must be aware of potential challenges such as glare and reflections. By adapting their driving to these conditions, drivers can help reduce accidents related to sunny lighting by following these measures:

- Use sunglasses to reduce glare.

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- Regularly clean both the interior and exterior windshields to avoid reflections.

- Maintain a safe distance from other vehicles.

- Use sun visors to block direct sunlight.

Promoting road safety involves encouraging responsible driving, regularly maintaining vehicles, checking brakes, tires, lights, and other essential components, and encouraging upgrades to newer vehicles with improved safety features where possible.

Finally, it is important to note that certain roads, such as the JIJILIENNE coast, may be considered more dangerous. To reduce accident risks on such roads, drivers should adjust their speed to road conditions, adhere to posted speed limits, reduce speed in curves and areas with reduced visibility, stay focused on the road, and avoid distractions such as using mobile phones or engaging in other activities that could divert attention from driving. It is also advisable to familiarize oneself with local recommendations and regulations concerning road safety specific to the JIJILIENNE coast.

In summary, there are numerous factors contributing to an increase in accidents, categorized into three main areas:

1. **Human factors:** Driving errors, distracted driving, fatigue, excessive speed, driving under the influence of alcohol or drugs are human factors contributing to road accidents.

2. **Infrastructure-related factors:** Defective road infrastructure, poorly placed traffic signs, inadequate lighting, dangerous intersections, or poor road conditions can also contribute to increased accidents.

3. **Vehicle-related factors:** Mechanical failures, inadequate vehicle maintenance, or the use of outdated safety technologies can play a role in accidents.

In conclusion, it is essential for authorities, drivers, and society as a whole to work together to reduce the number of accidents. This can be achieved through strict enforcement of laws and regulations, public awareness, improvement of road infrastructure, adoption of advanced safety technologies in vehicles, and effective prevention campaigns. It is crucial for everyone to play an active role in preventing road accidents by respecting driving rules, being attentive to other road users, and practicing responsible driving.

Remember, these insights are general, and accident trends may vary based on countries, regions, and specific circumstances.

REFRENCES

[1] Aloulou. F et Naouar. S., *Analyse microéconométrique des accidents routiers en Tunisie*, Presses de Sciences Po, (2016).
[2] Cameron. A et Trivedi. P., Regression Analysis of Count Data, Cambridge University Press, (2013).
[3] Chavent. M., *Régression linéaire multiple*, Université de Bordeaux.
[4] Cyrille. D et Alain. M., *Masculinités et risques routiers.Sécurité Routière*, France, (2023).
[5] Guyader. A., *Régression linéaire*, Université Rennes 2, (2012).
[6] Houde. L., *Lois De Probabilité*, Université du Québec à Trois-Rivières, (2014).
[7] Houde. L., *Tests d'hypothèses*, Université du Québec à Trois-Rivières, (2014).
[8] Myers.R, Montgomery.D, Vining.G et Robinson.T., *Generalized Linear Models with Applications in Engineering and the Sciences*, Wiley, (2010).
[9] Rivest. A., *La régression de Poisson multiniveau généralisée au sein d'un devis longitudinal: un exemple de modélisation du nombre d'arrestations de membres de gangs de rue à Montréal entre 2005 et 2007*, Université de Montréal, (2012).
[10] Ruch. J., *Statistique : Estimation*, l'Agrégation Bordeaux 1, (2012).
[11] Veilleux. L., *Modélisation de la trajectoire criminelle de jeunes contrevenants à l'aide de modèles linéaires généralisées mixtes*, Université Laval Qubec, (2005).