

## Forensic intelligence as a useful tool for reducing traffic fatalities: the Brazilian Federal District case

W.X. Camargo Filho <sup>a</sup>, B. Telles <sup>a</sup>, C.A. Andrade <sup>a</sup>, M.S. Sercheli <sup>a</sup>, N.M. Kawano <sup>a</sup>,  
R.M. Soares <sup>a</sup>, A.N. Vicente <sup>a</sup>, R.S. Corrêa <sup>a</sup>, J.A. Gomes <sup>a,\*</sup>

<sup>a</sup> Forensic Institute, Civil Police of the Brazilian Federal District (PCDF), Brasília (DF), Brazil

\* Endereço de e-mail para correspondência: [perito.juliano@gmail.com](mailto:perito.juliano@gmail.com). Tel.: +55-61-99278-3020.

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### Resumo

Os acidentes de trânsito no Brasil já mataram mais de 40.000 pessoas por ano e feriram outros 400.000, em grande parte com sequelas permanentes. Para alterar esse cenário, este trabalho propõe o uso de Inteligência Pericial, um campo da Ciência Forense que é capaz de converter dados forenses em informações úteis, como meio para apoiar pacotes e medidas políticas, a fim de evitar acidentes. A área de estudo escolhida foi um pequeno trecho em uma rodovia federal (BR-040), onde quatro acidentes fatais ocorreram no início de 2012. Esta rodovia tinha uma boa condição de trafegabilidade e não tinha problemas que poderiam ser correlacionadas com estes quatro eventos fatais, embora o excesso de velocidade, abuso de álcool e/ou desatenção de motorista estavam presentes nos eventos. Algumas intervenções possíveis são propostas aqui, como o uso de campanhas publicitárias, o fortalecimento da aplicação da lei de trânsito, a redução da velocidade máxima permitida para a via e a instalação de dispositivos de controle eletrônico de velocidade, a fim de evitar acidentes de trânsito futuros.

*Palavras-Chave:* Inteligência Pericial; Acidentes de Trânsito; Campanhas publicitárias; Fortalecimento da aplicação da lei de trânsito; Redução de velocidade.

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### Abstract

Traffic accidents in Brazil kill more than 40,000 people a year and injure another 400,000, with largely permanent health impacts. This paper proposes the use of Forensic Intelligence, a field of Forensic Science that is able to convert forensic data into useful information, as a means to support policy measures and strategies, in order to prevent accidents. The selected study site was a small stretch on a Federal Highway (BR-040), where four fatal crashes occurred at the beginning of 2012. This highway had good mobility conditions and had no problems that could be correlated with these four fatal events, although speeding, alcohol abuse, and/or driver inattention were present in the crashes. We propose some possible interventions here, such as the use of advertising campaigns, strengthening traffic law enforcement, reduction of the speed limit, and the installation of electronic speed control devices in order to avoid future traffic accidents.

*Keywords:* Forensic Intelligence; Traffic Accidents; Advertising campaigns; Strengthening traffic law enforcement; Speed reduction.

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### 1. INTRODUCTION

Forensic Science, also known as Criminalistics, is a knowledge set that brings together contributions from various sciences in order to solve crimes and identify and locate perpetrators. It makes use of tools from Chemistry, Anthropology, Psychology, Legal Medicine, Psychiatry, Fingerprinting and other fields considered auxiliary Criminal Law sciences [1].

Amongst the various fields of Forensic Science, Forensic Intelligence is an emerging discipline. Its fundamental principle is based on the use of a number of similar cases to structurally and systematically explore evidence of crimes to produce findings that can guide public policy in various areas of endeavor [2,3].

One example that can illustrate the use of Forensic Intelligence is road traffic safety. In this area, it was possible to organize information concerning traffic accidents to allow a better understanding of the problem,

in particular, how, when, and why accidents are happening, aiming to proactively use public resources to protect human life [4-6].

In Brazil, the number of traffic deaths in 2000 (29,645) matched 65% of homicide cases (45,360). In 2011, this percentage increased to 85%, reaching 44,553 deaths on Brazilian roads [7]. Most traffic fatalities are foreseeable and therefore preventable. In this sense, the main purpose of this paper is to present a case study of how we can use traffic accident data to identify critical crash sites and propose solutions that may save lives.

This case study considers a small stretch on the Brazilian Federal Highway BR-040, an important arterial road that provides access to Brazil's central area. Four fatal accidents occurred at the study site at the beginning of 2012.

## 2. MATERIALS AND METHODS

### 2.1. Traffic situation in the Brazilian Federal District

The Brazilian Federal District – BFD is the smallest federal region in Brazil with an area of 5,814 km<sup>2</sup> located in the country's center, where Brasília was built in 1960 as Brazil's administrative capital. Several important highways begin in the BFD to connect Brasília with the major Brazilian cities, which results in one of the country's major road junctions [8]. The current road transport system in the BFD generates a framework of reduced urban mobility, inefficient bus services, and an infrastructure that favors individual modes of transport. Such a scenario leads to an increase in the number of cars and motorcycles on roads and streets beyond that for which the city was designed [9].

Brasília provides 70% of the employment for the numerous satellite-towns in the BFD, while 90% of the region's population lives in these towns or ones nearby the BFD. This creates a strong oscillation during regular peak periods, with a high degree of individual rather than collective transport use. Outside daily peak periods, straight, wide roads, usually unobstructed by crossings enable the drivers to travel at high speeds under the influence of alcohol and other drugs.

### 2.2. Main study

Due to the high number of deaths from traffic accidents, with 417 deaths in 2012 [10], forensic scientists from the Civil Police of the Brazilian Federal District (PCDF) and prosecutors from the Prosecution Service of the Federal District and Territories (MPDFT) signed a technical cooperation agreement. The purpose of this agreement was to pursue a reduction in traffic accidents in the BFD and reduce the number of deaths as a result.

A survey of fatal traffic accidents on BFD roads and highways in 2012 was carried out based on data from

PCDF and the local Traffic Department (Detran/DF). The most serious and critical collision spots were identified and contributing factors were studied to propose corrective measures and prevent new occurrences. Previous results were handed over to MPDFT and then forwarded to the competent authorities, for information, evaluation and implementation of practical solutions, with the aim of reducing the number of traffic accident victims in the BFD.

They identified nine critical spots, two related to vehicle pedestrian accidents and seven related to vehicle collisions [11]. One of these spots is on the Federal Highway BR-040, close to the access for the satellite-town of Santa Maria, the object of this study. Along a short stretch of this highway, four fatal crashes happened within four months. Data on geographic coordinates, day of the week, hour, speed limit, speed and features of the vehicles, age of drivers, root cause and the use or not of alcohol and/or other illegal drugs were gathered for this study.

### 2.3. The Federal Highway BR-040

The Federal Highway BR-040 starts in the BFD and is the main road going towards southeastern Brazil. In addition, the BR-040 also links Brasília to the densely populated towns within the BFD and other towns in the neighboring state of Goiás (see Figure 1).

The object of this study is a 2.5 km stretch on the BR-040 (highlighted in Figure 1). The site is near to the access for the town of Santa Maria, a highly populated area in the BFD. In 2012, the BR-040 consisted of two covered lanes of opposing traffic. Lanes were well lit, without damage, straight, and separated by a central reservation. Highway lanes were interconnected at some points, with single and double returns, which were always built with deceleration accessing devices. Acceleration lanes to enter opposing traffic streams are absent at intersections. The four fatal accidents investigated in this study occurred along this 2.5 km stretch on the BR-040 between April and July 2012. The speed limit at that time was 80 km/h. At the beginning of August 2012, it was reduced to 60 km/h and electronic speed control devices and road signs were installed along the highway.

## 3. ANALYSIS OF THE FATAL ACCIDENTS

In 2012, there were four fatal traffic accidents along the stretch of highway near the Santa Maria access, with three happening on the northbound stream and one in the opposite direction. This stretch of about 2.5 km, is located between the GPS coordinates 16° 00' 35,62" S, 47° 58' 56,94" W and 16° 02' 0,55" S, 47° 58' 44,23" W. The traffic accidents will be presented in chronological order.



**Figure 1.** Section of the Brazilian Federal District map, extracted from Google Earth, highlighting the stretch of the BR-040. The upper insert shows the Brazil map (the red arrow indicates the BFD – the little black rectangle).

### 3.1. Traffic accident on April 17<sup>th</sup> 2012 (absence of driver's reaction)

The first traffic accident selected for this study occurred on Tuesday, 17<sup>th</sup> of April 2012 on the south bound lane, at approximately 3 am. In this accident, a 51-year-old man was driving a Toyota/Corolla and another, 35-year-old man, a Fiat/Uno. Because of the collision, two passengers in the Fiat/Uno were killed. A breathalyzer test carried out on the Toyota/Corolla driver indicated 0.79 mg of alcohol per liter of breath and the deceased Fiat/Uno passengers had a blood alcohol reading of 0.44 and 1.22 g/L respectively.

The forensic report on this crash indicated that the Toyota/Corolla was going at 100 km/h. The root cause established by forensic experts was the absence of response from the Toyota/Corolla's driver in relation to the Fiat/Uno, which preceded the first vehicle in traffic (rear-end collision). Such a type of root cause for the accident is strongly determined by the driver's lack of attention. The driver was also drunk in this case. Alcohol significantly decreases driver attention levels. So, in this case, we verified the role of alcohol in the collision.

### 3.2. Traffic accident on March 3<sup>rd</sup> 2012 (absence of driver reaction)

The second traffic accident occurred on Sunday, March 3<sup>rd</sup> 2012 on the north bound lane at approximately 3 pm and involved three vehicles. A 42-year-old man was

driving a Fiat/Strada, another 62-year-old man was driving a Fiat/Siena, and a third 40-year-old man was driving a bus. The two passengers in the Fiat/Strada were killed and alcohol testing indicated that the bus driver had a 0.28 mg reading of alcohol per liter of his breath.

The case's forensic report indicated vehicle speeds of 40 km/h for the Fiat/Strada, less than 30 km/h for the Fiat/Siena and 80 km/h for the bus. Since the accident was made up of two distinct collisions, it was possible to establish two root causes: the first one was the absence of reaction from the Fiat/Strada driver in relation to the Fiat/Siena that preceded it. The second cause was the delayed reaction from the bus driver in relation to the Fiat/Strada that preceded it. These root causes are also related to the drivers' lack of attention. The bus driver was found to be drunk, and again alcohol played a role in the occurrence of the collisions.

### 3.3. Traffic accident on July 19<sup>th</sup> 2012 (direction deviation and runaway excursion)

The third traffic accident occurred on Thursday, July 19<sup>th</sup>, 2012 on the north bound lane at approximately 11:30 am. In this event, a 24-year-old man was driving a VW/Gol and was killed by a collision with a tree. The driver was clean of alcohol and drugs.

The case's forensic report indicated that the VW/Gol was travelling at 100 km/h and the root cause established by experts was a wide swerve to the left for reasons



unknown. The collision was also linked to the driver's poor attention. Although it was not possible to ascertain with certainty, the collision was probably tied to factors such as sleep, cell phone use, handling the vehicle's radio or something else that may have distracted the driver.

### **3.4. Traffic accident on July 22<sup>nd</sup> 2012 (direction deviation and runaway excursion)**

The fourth and last traffic accident studied was similar to the third. It also occurred on the northbound lane on Sunday the 22<sup>nd</sup> of July, 2012 at approximately 3 pm. A 29-year-old man was driving a VW/Fox when the passenger of his vehicle was killed. He tested positive for alcohol (0.64 mg of alcohol per liter of breath) while the fatality in the accident had a blood alcohol reading of 0.76 g/L.

The forensic report indicated that the vehicle was travelling at 90 km/h, and the root cause established by forensic experts was a drastic swerve to the left for reasons unknown. Once again, alcohol played a part in the occurrence of the accident.

## **4. DISCUSSION**

### **4.1. Contributing factors**

The stretch of highway studied on the BR-040 presented good mobility conditions and showed no problems that could in themselves explain the accidents. From the analysis of the accidents, some factors became evident as follows:

- all drivers were male;
- three quarters of the vehicles that were involved in traffic accidents were above the 80 km/h speed limit;
- three quarters of drivers involved in traffic accidents had consumed alcohol;
- 100% of accident root causes were related to a lack of driver attention.

Studies show that men pose a higher risk of being involved in fatal accidents compared to women [12,13] and the findings of this case study in which all drivers were male corroborate this. Several reasons may be attributed, such as the fact that male drivers tend to be more susceptible to social influence than female drivers, as well as gender specific differences such as competitiveness and attraction to a certain level of risk [14-16]. Young male drivers have been shown to be involved in a proportionally higher number of traffic accidents due to motivational factors, compared to young female drivers [17]. Males generally drive more frequently than females which increases the chance of being involved in traffic accidents as well [18,19]. Male drivers are also more aggressive and self-centered than women in traffic. They have certain personality characteristics that make them under-estimate danger and

take more risks – higher rates of pleasure seeking and lower sensitivity to punishment [20,21].

Male drivers, especially young, have proportionally more chances to be involved in accidents connected to higher levels of driving behavior, like aggressiveness. Speeding and alcohol consumption are widely present in accidents caused by male drivers [17]. In terms of vehicle speed, three out of the four male drivers were over the speed limit and one was driving at the speed limit – 80 km/h. The faster a vehicle travels the greater the kinetic energy when involved in a collision, and the more severe the damage caused to the vehicle, passengers, and driver.

Drinking and driving is associated with high rates of traffic accidents and fatalities, and such behavior is considered a serious public health problem [22,23]. Alcohol is a general central nervous system depressant that adversely affects many components of driving behavior [24], reducing muscle coordination, increasing reaction time, impairing judgment, increasing aggression and the likelihood of risk-taking behaviors. Alcohol also adversely affects vision, slows pupil reaction (accommodation), reduces peripheral vision and causes double vision [25-27]. In this study, it was found that three quarters of the drivers were under the influence of alcohol, which probably contributed to the occurrence of traffic accidents. Blood alcohol concentrations found in drivers correspond to mild euphoria, talkativeness, decreased inhibitions, decreased attention, impaired judgment, increased reaction time [28], constituting a set of physiological effects that negatively influence driving skills and judgment.

There is cumulative evidence that driver distraction and inattention are leading causes of vehicle crashes and incidents [29], corroborating our results, as all root causes investigated in this study were associated with lack of driver attention. A previous research review [30] showed, for example, that distraction disrupts natural driving performance variation leading to action errors, as well as disrupting visual scanning behavior and situational awareness leading to observational errors. Further distraction disrupts both cognitive processing leading to information encoding and retrieval errors, and disrupts decision-making leading to cognitive and decision-making errors.

Abuse of speed limits and alcohol consumption prior to driving motor vehicles are factors that have been considered determinants of origin and severity of traffic accidents [31]. In addition, when combined with a male inattentive driver, it has a highly favorable environment for the occurrence of these events. However, with this valuable information, we believe that the government can implement consistent public policy in order to control specific problems, such as the ones presented here.

## 4.2. Some possible government interventions

### 4.2.1. Use of advertising campaigns

The premise of awareness and education campaigns is to: a) raise awareness of the problem; b) educate the public regarding actions they can take; and c) develop social norms to change behavior. In general, such measures have been effective to address road safety issues [32]. According to the findings of this research, at least two different kinds of publicity campaigns could be useful: anti-drinking driving and anti-speeding, especially focused on male drivers who form the primary target group.

Previous studies have found the use of anti-drinking driving advertising campaigns to reduce serious crashes to be effective, as well as changing drink-driving behavior, and changing viewers' attitudes and intentions. On the other hand, anti-speeding publicity campaigns suffer from low response efficacy or a lack of suitable coping strategies, which is the most important characteristic for a successful message that relies on the appeal to the emotion of fear [33].

Based on these results, we only suggest the launching of an anti-drinking driving campaign, since it proves more effective and affects another critical point found in this research: lack of attention. Although we do not find in the literature studies that measure the effectiveness of anti-inattention campaigns, we suggest that the anti-drinking driving advertising campaigns can also address the problem of driving inattention. For example, one of the educational campaigns should focus on the premise that alcohol reduces the drivers' attention and this may impair driver ability, condition *sine que non* expected for a driver.

### 4.2.2. Strengthening traffic law enforcement

In general, road traffic crashes and injuries are preventable. In high-income countries, an established set of interventions have contributed to significant reductions in the incidence and impact of road traffic injuries. These include, amongst others, the enforcement of legislation to control speed and alcohol consumption and the safer design and use of roads and vehicles [34].

In Brazil, driving a vehicle faster than the maximum speed allowed is punishable by a fine, besides a driver's license suspension. Drivers who are found to be drunk may be also arrested [35]. However, there is a lack of traffic enforcement agencies on public roads and people are not always punished for these behaviors – favoring speeding behavior and drunk drivers.

Several studies have proven that strengthening traffic law enforcement is efficient to reduce traffic accidents [36,37]. Thus, we believe that more intense surveillance and effectiveness in the investigation of offenses, and a more effective application of penalties can encourage reckless drivers to take their foot off the accelerator and

do not drive under the influence of alcohol. Consequently, we will have safer traffic for all of us.

### 4.2.3. Reduction of the speed limit and installation of electronic speed control devices

Higher speeds increase the likelihood of crashes and the severity of their consequences. Speed reduction initiatives can lead to a significant fall in transit incidents. In urban areas, where pedestrians and cyclists are numerous, speed reduction measures are critical for the safety of road users [34]. The speed limits on rural arterial roads in Australia were reduced from 110 km/h to 100 km/h, causing a 19.7% reduction in crashes [38].

The stretch studied on the BR-040 can be considered an urban road because it crosses high-density urban areas. Under these circumstances, the 80 km/h speed limit seems inconsistent with local safety. In this way, setting the speed limit to a lower value (60 km/h, for example); can be an effective measure to reduce road traffic fatalities.

Additionally, electronic speed control devices can be installed to curb speeding, so that drivers would be forced to slow down vehicles. An article, which evaluated the speed camera program implemented in France in 2003, revealed significant reductions in traffic injuries along the whole road network [39]. The Brazilian Federal District traffic authorities installed eight electronic surveillance cameras along a local 12 km stretch of highway (DF-085) in 2012. This measure was enough to reduce significantly the number of fatal traffic accidents involving vehicles and pedestrians: 14 in 2010, 7 in 2012 and 3 in 2013 [9]. Speed enforcement cameras have also been very effective in reducing road fatalities.

## 5. FINAL CONSIDERATIONS

In August 2012, the government implemented two interventions in the study stretch on Federal Highway BR-040: the first one was the reduction of the speed limit from 80 km/h to 60 km/h; the second one was the installation of electronic speed control devices. Both initiatives are corroborated by this research.

It is noteworthy that after the adoption of these measures there were no fatal accidents on the studied highway stretch, demonstrating the effectiveness of these solutions. However, an extensive study (from 2013 to 2016, for example) in the region to verify whether these measures alone have been sufficient will be necessary, or whether there is a need to adopt other measures suggested in this paper such as the use of advertising campaigns and strengthening traffic law enforcement.

Nevertheless, a report was given to the BFD traffic authorities showing the importance of adopting the four possible interventions outlined in this research along other stretches of the same highway, as well as on other roads with high numbers of collisions.

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