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A case study analysis to examine motorcycle crashes in Bogota, Colombia

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ABSTRACT

Introduction: Contributory factors to motorcycle crashes vary among populations depending on several aspects such as the users' profiles, the composition and density of traffic, and the infrastructure features. A better understanding of local motorcycle crashes can be reached in those places where a comprehensive analysis is performed. This paper presents the results obtained from a case study analysis of 400 police records of accidents involving motorcycles in Bogota. *Method:* To achieve a deeper level of understanding of how these accidents occur, we propose a systemic approach that uses available crash data. The methodology is inspired by accident prototypical scenarios, a tool for analysis developed in France. *Results:* When grouping cases we identified three categories: solo motorcycle accidents, motorcyclist and pedestrian accidents, and accidents involving a motorcycle and another vehicle. Within these categories we undertook in-depth analyses of 32 groups of accidents obtaining valuable information to better comprehend motorcyclists' road crashes in a local context. Recurrent contributory factors in the groups of accidents include: inexperienced motorcyclists, wide urban roads that incite speeding and risky overtaking maneuvers, flowing urban roads that encourage high speed and increased interaction between vehicles, and lack of infrastructure maintenance. *Practical Applications:* The results obtained are a valuable asset to define measures that will be conveniently adapted to the group of accident on which we want to act. The methodology exposed in this paper is applicable to the study of road crashes that involve all types of actors, not only the motorcyclists, and in contexts different than those presented in Bogota.

1. Introduction

1.1. Motorcycles: use and accident rate

In Colombia, the representation of motorcycles in the total number of vehicles increased from 29.1% in 2003 to 49.6% in 2012 (RUNT, 2013). Some of the reasons that led to its growth are accessible prices, financing options, simple registration processes, work tools, the possibility of maneuvering in traffic jams, an alternative option to public transport in areas where coverage and frequency are deficient, and an alternative option in cities with circulation restrictions for private cars.

In 2010, motorcyclists represented 39% of the deaths from road crashes in Colombia, and in 2012 this percentage rose to 42% (INMLCF, 2013). On average, six motorcyclists died every day in Colombia. In 2011, fatalities collided mainly with a fixed object or the pavement (33.7%), car freight (18.2%), or a private vehicle (17.5%). The majority of motorcyclist fatalities (55%) occurred in urban areas (Universidad de los Andes y Corporación Fondo de Prevención Vial – CFPV, 2012).

The institutions that set road safety standards at rural and urban levels are municipal and urban offices, as well as the Ministry of Transportation. In Colombia, the National Transit Code (Ley 769 de, 2002), contains the regulations that motorcyclists must follow; and there are no specific differences regarding the cylinder capacity. There are two types of license: type A1 for driving motorcycles with a cylinder capacity of up to 125 c.c. or B1 for driving motorcycles, motorized bicycles and motorized tricycles with a cylinder capacity of more than 125 c.c. The average cylinder capacity in Colombia is comparatively minor than the capacity of the motorcycles circulating Spain or France. This aspect means that the types of hits that the motorcyclist receives, in case of accident or control loss, differ according to the context where they are studied.

According to official data of the motorcycles registered in Bogota, the number of motorcycles has a general growth trend; between 2002 and 2011 the number of motorcycles was multiplied by 20. Motorcycles currently represent 21% of the total number of motor vehicles in the capital city, while in 2003 motorcycles did not reach 3% of the total. There are 27 people per motorcycle in Bogota. Motorcycles in Bogota are relatively recent: 9.3% are before 2002, 20.8% are models from 2003 to 2007, and 69.8% are models from 2008 to 2013. In Bogota, 95.30% of the motorcycles have less than or equal to 250 c.c. cylinder capacity (*Alcaldía Mayor de Bogotá*, 2012). This is defined by its use as an everyday means of transportation and

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the possibility to use the vehicle as a work tool. One hundred percent of motorcyclists and passengers use a helmet in Bogota.

Current conditions in terms of infrastructure in Bogota are not adequate for safe mobility of motorcyclists. Thirty percent of 3.752 lane kilometers of the arterial road network is in regular or bad state, as well as 46% of 3150 lane kilometers of the intermediate road network, and 79% of 8496 lane kilometers of the local road network (*Instituto de Desarrollo Urbano IDU*, 2014; Fig. 1). Motorcyclists share the road with other users, including those roads in which cross-sections are over 10 meters wide. The city does not have an exclusive infrastructure for the circulation of motorcycles.

The particularities of motorcycle circulation in Bogota, from a perspective of human, vehicle, and environment as components, make those accidents involving these actors different from those occurring within other contexts (e.g., France). This aspect highlights the need to investigate recurring factors that contribute at a local level.

1.2. Approaches to analyzing motorcyclist road crashes

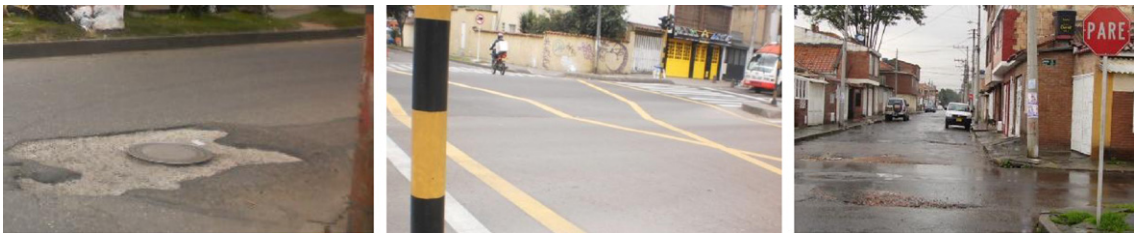
Motorcycle crashes have gained interest in research. International projects such as the OCDE/ITF project have focused on the motorcycle user's safety. Accident scenarios and contributory factors, the development and implementation of an integrated road safety strategy for motorcyclists, and the critical situation in low- and middle-income countries are issues addressed by the project (Van Elslande, 2012). Some studies examine past research related to specific topics about riders' motorcycle safety; for example, automobile-motorcycle accidents that occur when a driver violates a motorcyclist's right of way (Chih-Wei Pai, 2011).

Techniques based on deductive analyses, primarily psychological, have been developed to study motorcycle road crashes. Research examines motorcyclist behavior and risk perception by analyzing components related to experience and training, speeding, use of safety equipment, traffic and control error, and stunts (Di Stasi, Contreras, Cándido, Cañas, & Catena, 2011; Maestracci, François, Aurélie, & Florian, 2012; Özkan et al., 2012; Perez-Fuster, Rodrigo, Luisa, & Jaime, 2013; Tunnicliff et al., 2012). It was found that the combination of low age, low experience, risky behavior and "unsafe" attitudes constitutes a risk factor (Bjørnskau, Tor-Olav, & Juned, 2012); riding during the night, on weekends, for leisure purposes, and along roads in perfect conditions are predictor factors of offences among motorcyclists (Perez-Fuster et al., 2013); motorcyclists perceive a greater risk when faced with other drivers changing lanes, while more accidents are caused by left-turn, right-turn, and U-turn maneuvers (Maestracci et al., 2012); inexperienced riders are prone to accidents because of a lack of awareness of the impending dangers, not necessarily because of a tendency to drive faster (Di Stasi et al., 2011); drivers who also held a motorcycle license did not perform better when presented with a motorcycle braking event (Ohlhauser, Shaunna, & Caird, 2011); the detection of a motorcycle depends on how much contrast there is between the motorcycle and its surroundings—the denser the surroundings, the more difficult it is to generate a contrast (Clabaux, 2006; Hole & Tyrrel, 1995).

Techniques focused on inductive analyses have been used to analyze accident crash data. Studies state that the risk is bigger when motorcycle users are 20 years old and live in urban areas (Keall & Newstead, 2012); riders were more likely to be at fault when they were under the influence of alcohol, riding without insurance, or not wearing a helmet, and they were less likely to be at fault when the crash occurred at night and near signalized intersections (Schneider, William, Savolainen, Dan, & Rick, 2012); among motorcycle accidents, nearly 43% involve a single motorcycle on an open road with dry surfaces with the main cause being excessive speed (Sraml, Tomaz, & Marko, 2012); factors attributed to a higher risk of death over time for motorcycle drivers are older age, crashing into trees, night-time driving, driving on curved roads, and driving on local roads (Huang & Lai, 2011); night-time conspicuity of motorcycles, riding on wet surfaces, specific hazardous interactions, and the influence of speed differentials affect motorcycle safety (Haque, Hoong Chor, & Ashim Kumar, 2012). With regard to crash consequences, it was demonstrated that lower extremities are the most commonly affected and that there are different levels of severity depending on the time variable and the number of vehicles involved (Formana et al., 2012; Wilson, Begg, & Ari, 2012).

One concept for addressing road crashes is the systems theory approach (Emmerik, 2001; Larsson, Dekker Sidney, & Claes, 2010; Leveson, 2004; Salmon, Rod, & Stanton, 2012). The systems approach solves the limitations of traditional approaches to managing road safety and provides opportunities for improvement to the whole system of road safety (Emmerik, 2001). Road and transport systems are considered a complex system composed of elements that continuously interact, though not simple interactions. Road safety measures from this approach integrate human, vehicle, and environment components and take into account combined effects among components. From the systems theory approach, road crashes constitute an emergent property of the system resulting from its malfunction.

The goal of this paper is to study motorcyclist crashes in Bogota in order to improve understanding of how accidents happen among these particular users. This leads to dealing with road crashes from a systemic approach in a context in which crash data exist but are not complete, as in the case of Bogota. This goal could be achieved by a methodological proposition that includes: an inductive approach that uses crash information from local police records, a qualitative approach based on case studies that aims to explain "how" the crashes occur, and a multifactorial approach that allows the identification of a multiplicity of accident factors that interact within an accident group. In a context like Colombia, crash information is available but lacks some details; several characteristics of crashes are known but not linked to the understanding of the accident as a whole. Road safety programs are established but are usually focused on only one of the human, vehicle, and environment components, and the combined effects produced with other programs carried out are unknown. Based on this, the added value of this paper is to examine that through the proposed methodology, it is possible to



Source: own photographic record

Fig. 1. Photographic record of the roads in Bogota. Source: own photographic record.