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The rider behavior questionnaire to explore associations of motorcycle taxi crashes in Cartagena (Colombia)

Holman Ospina-Mateus[a,b,c] ![ORCID], Leonardo Quintana Jiménez[b] ![ORCID], and Francisco J. López-Valdés[c] ![ORCID]

[a]Department of Industrial Engineering, Universidad Tecnológica de Bolívar, Cartagena, Colombia; [b]Department of Industrial Engineering, Pontificia Universidad Javeriana, Bogotá, Colombia; [c]Instituto de Investigacion Tecnológica (IIT), ICAI Engineering School, Universidad Pontificia Comillas, Madrid, Spain

ABSTRACT

Objective: This study aimed to identify the association between behavioral factors and crashes of motorcycle taxi riders using the Motorcycle Rider Behavior Questionnaire (MRBQ).

Methods: This study was a cross-sectional survey of motorcycle taxi riders in Cartagena. The MRBQ was adapted to the socio-cultural context and contained 45 items. The survey was conducted between February 2019 and May 2019. The items of the MRBQ were processed using factor analysis. Four logistic regression models were used to analyze the association between behavioral factors and aspects of demographics, operating conditions, and experiencing near-crashes, crashes, traffic tickets, and at-fault crashes.

Results: Four hundred and thirty-eight motorcyclists participated. The exploratory factor analysis extracted five elements: stunts, speed violations, traffic errors, control errors, and safety, explaining 42% of the variance. The increase in riding per week showed significant differences with stunts, speed violations, and traffic errors. Riding experiences, traffic errors, control errors, and safety were significantly associated with crashes and near-crashes. Stunts were the strongest factors related to traffic tickets. Speed violations were the strongest factors associated with at-fault accidents.

Conclusions: The study showed recent results considering behavioral, exposure, and operational conditions in a group of motorcycle taxi riders. The study recommends some practical implications for the well-being of motorcyclists and road safety.
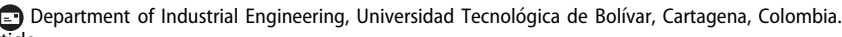
Introduction

According to the World Health Organization (WHO), motorcycle accidents account for more than 380,000 deaths worldwide (WHO 2018). The global number of motorcycles is estimated at 770 million, 90% in low-and middle-income countries (WHO 2018). In 2019, Colombia registered more than 8.3 million motorcycles. Colombia has a death rate of 9.7 motorcyclists per 100,000 population, ranking 10th worldwide and second in South America (WHO 2018). Between 2016 and 2019, motorcycle-involved unsafe outcomes constituted 52% of annual fatalities and 57% of injuries in Colombia (Ospina-Mateus et al. 2020).

This study was conducted in Cartagena, Colombia, considered among the lowest rated capital cities in road safety for motorcyclists in the last eight years, after Medellín, Cali, Bogotá, and Barranquilla (Ospina-Mateus et al. 2021). Between 2016-2019, the city had an annual average of 44 fatalities and 437 motorcyclist injuries. Cartagena presented an official registry of 68,000 motorcycles until March 2019 (ONSV 2012-2019). It is estimated that there are more than 75,000 motorcycles on roads, and approximately 60% are dedicated to informal transport.

Many individuals in Cartagena with low income or without job opportunities are self-employed as motorcycle taxi riders. Most motorcycle taxi riders work long hours to earn a daily income of approximately $13. Mobility and transport problems and poverty have encouraged this informal and illegal activity, which is generally accepted in Cartagena.

This study focuses on using self-reporting instruments to analyze motorcycle taxi riders' riding behavior. The effectiveness of self-reports is attributed to gathering information in different scenarios (Cheng and Ng 2010). This study aims to identify significant aspects of motorcycle taxi riders' behavior on Cartagena's roads using the self-report questionnaire, adapted to the socio-cultural context, using the self-report questionnaire known as the Motorcycle Rider Behavior Questionnaire (MRBQ). This study will help identify the association between motorcycle taxis characteristics and driving behavior when involved in crashes, near-crashes, traffic tickets, and at-fault crashes. In Colombia, this study was a pioneer in the analysis of the road safety of motorcyclists. The results may help understand the risky driving behaviors of motorcycle taxi drivers and propose countermeasures for the benefit of road safety.

Method

The Motorcycle Rider Behaviour Questionnaire (MRBQ)

The MRBQ was established by Elliott et al. (2007) from the Manchester Driver Behavior Questionnaire (DBQ) designed by Reason et al. (1990). The MRBQ considers errors and violations as well as the use of riding safety equipment. The original questionnaire has 45 items related to five factors (i.e., traffic errors, speed violations, stunts, control errors, and safety). Traffic errors were defined as unintentional mistakes. Safety equipment is related to the actions, mechanisms, and protection elements of a motorcyclist. Stunts are intentional maneuvers (sensation-seeking behaviors) that generate high risks to motorcyclists. Speed violations are intentional acts (deliberate) that are more instrumental than maneuvers. Control errors are conscious or unconscious actions (failures) in motorcycle handling. Table A.1 shows studies related to the MRBQ instrument globally and evidences the factors, samples, individuals, and surveys considered.

Participants

A survey of motorcycle taxi riders was conducted between February and May 2019. The survey was administered personally by seven interviewers. Motorcyclists were approached at informal stations concentrated in corners or areas with high traffic density. Motorcyclists were randomly selected and invited to participate voluntarily in the study. The collection took place in 27 places in Cartagena (see Figure A.1). Motorcyclists authorized voluntary participation with informed consent. The information was processed anonymously, following the ethical and legal provisions of Colombia. The criteria for collecting the questionnaire are shown in Table A.2.

Application of Motorcycle Rider Behaviour Questionnaire (MRBQ)

Of the 34 original items in the MRBQ instrument, 28 were maintained, and six were modified. Eleven new items related to the socio-cultural context and adapted from studies by Motevalian et al. (2011), Sunday and Akintola (2011), and Hosseinpourfeizi et al. (2018) were included. Table A.3 lists the items and their references. Participants reported their behaviors on a six-point scale (1 = never, 2 = hardly ever, 3 = occasionally, 4 = quite often, 5 = frequently, and 6 = nearly all the time).

Socio-cultural adaptation relates to how motorcyclists identify their aberrant, erratic, and social behavior inside traffic systems (Rusli et al. 2020). Another critical element of modifying a questionnaire is the differences in traffic rules and their enforcement across jurisdictions (Oviedo-Trespalacios and Scott-Parker 2017). These adjustments have been considered in previous studies in Nigeria, Iran, and Brazil. Cultural adjustments should also consider translations or variants that include specific cultural aberrations (Xie and Parker 2002). These adaptations are presented in Table A.4. For example, items 13, 14, 23, 29, 39, 40, 44, and 45 were adjusted to understand motorcycle taxi drivers. In addition, items 32, 33, 34, 35, 37, and 38 were related to the social context of road safety in Colombia. Items 36 and 41 were behaviors related to the most frequent violations of motorcyclists in Colombia. A pilot study on 30 motorcyclists was conducted to validate the proposed modifications, including translating into Spanish (Table A.5).

Data collection

The questionnaire collected demographic information (gender, age, marital status, educational level, engine cylinder, maintenance, and riding experience) and history of traffic accidents as motorcycle taxi riders in the last 12 months. Information about the operating conditions (property, average daily income, and average daily passengers transported) was also included. Participants were questioned as to whether they had been involved in near-crashes ('only just avoiding a crash or a near-miss while riding') and crashes (injury or non-injury), and whether they had received a traffic ticket. Motorcycle taxi riders involved in crashes were consulted about their participation or fault (blame) to identify their involvement as active actors in the crash. A fault or blame was defined as the condition when the road actor was responsible or the cause for the road event, given that he carried out some imprudence or infraction. The analysis of these four aspects (near-crashes, crashes, traffic tickets, and at-fault crashes) focused on previous studies (Özkan et al. 2012, Sakashita et al. 2014, Stephens et al. 2017), where different results can be found. For example, near-crashes are more frequent and repetitive than crashes and yield more information (Theofilatos and Yannis 2015).

Data analysis

All analyses were performed using the statistical software SSPS ver. 25. The items of the MRBQ were explored using factorial analysis with the method of extraction of principal components and varimax rotation. Internal consistency was evaluated using Cronbach's alpha reliability coefficient. The value Kaiser-Meyer-Olkin measure and test of sphericity were calculated. Non-parametric tests (i.e., Mann –Whitney U and Kruskal-Wallis) were performed to compare the differences between demographic, riding, and operative conditions and traffic accidents with MRBQ factors. Four logistic regression models were proposed to analyze the association between near-crashes, crashes, traffic tickets, and at-fault crashes with riding and operating conditions, and the factors obtained with the MRBQ instrument. The models considered goodness of fit measures such as the Omnibus test, likelihood ratio chi-square, Hosmer & Lemeshow test, R2 Nagelkerke, and R2 McFadden.

Results

Characteristic of the motorcyclists

Four hundred and thirty-eight motorcyclists participated in the study and completed all the MRBQ items. The demographic characteristics, riding conditions, operative conditions, history of crashes, and traffic tickets are shown in Table A.6. Most participants were men (99.5%). The average age was 33.53 years.

67% of motorcyclists had more than six years of experience. The average riding experience was 9.9 years. The average number of riding hours per week was 61.3, and 73% of motorcyclists had more than seven passengers daily. The average daily income was 46,000 Colombian pesos (COP:3725 COP = US $1). Of the participants, 46% reported involvement in more than one traffic infraction, 19% had a near-crash, and 17% of motorcyclists were involved in crashes. Of this set, 31% were users who accepted their responsibility or fault in the crash.

Analysis of MRBQ items and factor analysis

The scores obtained for each of the 45 MRBQ items (means, standard deviations, and Cronbach's alpha reliability) are shown in Table A.7. Cronbach's alpha reliability coefficients were greater than 0.75, indicating good reliability. The behavior "Riding with helmet-(motorcyclist)" is more reported. The four items with the highest scores were related to the riding safety elements. The items that were least scored were related to maneuvers (tricks and acrobatics). Five factors were derived from the exploratory factor analysis. All items were considered with cutoff points greater than 0.30. The five factors accounted for 42% of the variance. Kaiser-Meyer-Olkin's measure of sampling adequacy was 0.86, and Bartlett's test of sphericity was significant (chi-square = 7327.52, p-value < 0.001). The factors declared were stunts, speed violations, traffic errors, control errors, and safety. The most frequently reported factors were control errors (M = 3.24, SD = 0.51), safety (M = 2.74, SD = 1.05), and traffic errors (M = 2.30, SD = 0.70). Stunts were the least frequently reported factors (M = 1.72, SD = 0.60).

MRBQ factors, demographic aspects, crashes, and traffic tickets

Inferential analysis was performed for the independent variables with the Chi-square test of Kruskal-Wallis and Mann-Whitney tests, and the results are shown in Table A.8. The MRBQ scores of stunts and speed violations were higher for motorcycles in low-quality conditions. The MRBQ score of stunts was higher for riders with fewer years of riding experience. The average number of hours riding per week and the average weekly kilometers showed significant differences with stunts, speed violations, and traffic errors. The MRBQ score of the stunts was higher in individuals who rented a motorcycle to work. Motorcyclists with fewer than four daily passengers presented fewer traffic errors. An increase in daily income increases the frequency of traffic errors. The MRBQ scores of stunts, speed violations, traffic errors, and control errors were higher for those involved in near-crashes and crashes. Finally, the safety scores showed significant differences in at-fault crashes.

Exploration of associated factors

Four binary logistic regression (Logit) models were applied to explore the association of being involved in near-crashes, crashes, at-fault crashes, and receiving a traffic ticket, with the MRBQ factors and some demographic aspects. The independent variables considered were age, riding experience, average driving hours per week, ownership, daily passenger transport, daily income, and MRBQ factors. Multicollinearity was not present for any of the independent variables included in the models. All variables showed correlation values of less than 0.5, as shown in Table A.9. Table 1 presents the results of the logistic models. The Hosmer-Lemeshow test showed that the models had a good fit (p < 0.05). The R2 values of Nagelkerke indicated that the proposed models could explain between 60% and 90% of the variance of the dependent variables. The McFadden R2 value ranged from 0.49 to 0.86, which is considered a good fit.

Less riding experience and a decrease in control error or safety increased the likelihood of being involved in crashes, while an increase in daily income and traffic errors increased the probability of being involved in crashes. Motorcyclists who rented motorcycles were more likely to be involved in crashes. Less riding experience or decrease in safety factors increased the likelihood of having been involved in near-crashes. An increase in traffic and control errors increased the probability of being involved in near-crashes.

Age, ownership, stunts, control errors, and safety elements were significant aspects of self-reported traffic tickets. A decrease in age or safety factor and being the motorcycle owner increased the likelihood of receiving a traffic ticket. An increase in stunts or control errors was also found to increase the probability of receiving a traffic ticket. Age, ownership, speed violations, control errors, and safety elements were significant aspects of self-reported at-fault crashes. A decrease in the score of control error or safety increased the likelihood of being involved in at-fault crashes. An increase in age or speed violations increased the probability of being involved in at-fault crashes. Motorcyclists who rented motorcycles were more likely to be involved in at-fault crashes.

Discussion

Eighty-five percent of motorcycle deaths occur in low-to-middle-income-countries (LMICs), with victims being between 15 and 35 years of age (WHO 2018). In this study, approximately 60% of motorcyclists related to crashes and near-crashes were in this age range, and 83% of riders with less than a year of experience were young adults. Younger riders were more likely to engage in unsafe riding behaviors (Truong et al. 2018; Nguyen-Phuoc et al. 2020). Many young people with family obligations take up motorcycle taxis as their first option without any riding experience (Gutierrez and Mohan 2020). Mototaxism is considered an alternative to formal employment in LMICs (Nguyen-Phuoc et al. 2019).

Motorcycle taxi drivers develop their first skills by stabilizing the vehicle with passengers and packages, getting used to the traffic and the roads, and identifying new routes and locations. These elements generate high fatigue for someone who is not accustomed to working long hours (Truong et al. 2020). Motorcyclist taxi drivers seek to develop informal work activities in the greatest amount of time and as fast as possible to increase their income. Motorcyclists who rent motorcycles, work longer to pay the rentals. These individuals are more exposed to crashes and fault crashes. Likewise, motorcyclists

Table 1. Logistic Regression coefficients of MRBQ behaviors for near-crashes, crashes, traffic violations, and at-fault crashes.

Variable		Crash Beta (S.E.)	Near Crash Beta (S.E.)	Traffic tickets Beta (S.E.)	At-fault Crashes Beta (S.E)
Demographics	Age	−0.06 (0.10)	0.09 (0.13)	−1.10 (0.14) ****	0.62 (0.24) **
Exposure	Year's riding	−0.95 (0.17) ****	−2.89 (0.34) ****	−0.01 (0.18)	0.49 (0.42)
	Hours of riding in an average week	0.32 (0.17)	−0.25 (0.23)	−0.01 (0.18)	−0.67 (0.45)
Operative	Ownership	−0.64 (0.33) *	−0.66 (0.46)	1.07 (0.39) **	−2.57 (0.80) ****
	Passengers daily	0.11 (0.08)	−0.01 (0.10)	0.16 (0.08)	−0.22 (0.17)
	Daily income	0.26 (0.13) *	0.21 (0.17)	−0.23 (0.14)	0.06 (0.27)
MRBQ factors	Stunts	−0.42 (0.28)	0.32 (0.34)	2.85 (0.40) ****	−0.60 (0.58)
	Speed violations	0.27 (0.20)	0.11 (0.26)	0.37 (0.23)	2.52 (0.50) ****
	Traffic errors	1.34 (0.31) ****	0.78 (0.40) *	0.01 (0.30)	0.76 (0.48)
	Control errors	−0.78 (0.26) ***	1.16 (0.35) ***	0.77 (0.26) ***	−2.87 (0.67) ****
	Safety	−0.48 (0.15) ***	−0.42 (0.21) *	−2.16 (0.25) ****	−0.82 (0.27) ****
Goodness-of-fit measures	Omnibus Test-Chi-squared	299.56 (Df:11) ****	417.07 (Df:11) ****	318.854 (Df:11) ****	519.767 (Df:11) ****
	Hosmer & Lemeshow test	4.624 (Df:8) Sig: 0.80	12.431 (Df:8) Sig: 0.13	5.477 (Df:8) Sig: 0.69	2.719 (Df:8) Sig: 0.95
	−2 Log (Likelihood)	307.635	190.129	288.343	87.43
	R2 Nagelkerke	0.64	0.82	0.69	0.93
	R2 McFadden	0.49	0.69	0.53	0.86

β: Estimate coefficient, S.E: Standard Error.
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; **** $p < 0.0001$.

who rent motorcycles avoid getting into infractions because they affect the rental agreement and impact their income.

The most frequently reported behaviors are related to the safety elements. Riders do not want to receive financial penalties that impact their income because of safety elements, as evidenced by the model in traffic tickets. The control errors were those with the highest scores in the analysis of involuntary actions. Control errors can be linked to inexperienced driving, lack of balance or stability under different conditions, and physical skills. The most common control errors occur when a motorcyclist loses his concentration. Usually, motorcyclists slow down unexpectedly when they spot a potential customer, or suddenly step on the pedal to reach them. Control errors increase the possibility of being involved in near-crashes.

Speeding was the most frequently reported violation. Riders usually exceed speed limits to accelerate their trips or to overtake other vehicles (Nguyen-Phuoc et al. 2020). Motorcyclists believe that these behaviors allow them to transport more passengers and receive more income. Additionally, riders admitted to increasing speed to avoid friction with other road users. Motorcyclists aware of their active responsibility in a crash admit to violating speed limits, as evidenced in the model of at-fault crashes.

Stunts among motorcycle taxi drivers are related to reckless behavior. Motorcyclists take risks with alternative routes to reduce travel time, travel in the opposite direction of one-way roads, exceed the capacity of the motorcycle, talk on cell phones, and move in prohibited areas and times (Cheng and Ng 2010). These types of behaviors are easy for traffic agents to establish an infraction. This factor was highly significant in the frequency of traffic tickets in novice riders. Novice motorcyclists like to explore maneuvers during their initial experiences, and this finding was also identified in previous studies (Oviedo-Trespalacios and Scott-Parker 2017). Motorcyclists regard maneuvering as an advantage of motorcycles in avoiding congested routes.

Traffic errors in motorcycle taxi drivers were a significant factor in collisions (crashes and near-crashes). The behaviors evidenced in this error are related to a low level of training and road education (Sakashita et al. 2014). Many

motorcyclists admitted to driving without minimum compliance with the training courses because they do not have sufficient financial resources. These elements show that motorcycle taxi drivers present difficulties in taking on the challenges of traffic and the environment, exacerbated when they do not have experience and skills (Berrones-Sanz 2018).

The adaptation of the MRBQ instrument made it possible to identify changes adjusted to the culture, enforcement, and respect for traffic rules and mobility dynamics. These changes in behavior differ by territory and are noticeable when contrasting high-income countries and LMICs (Oviedo-Trespalacios and Scott-Parker 2017; Rusli et al. 2020). In summary, 64% of the items (n = 29) were sufficiently related to the factors defined in other studies that applied the MRBQ instrument (see Table A.10). The variables of the four models proposed in the present study were compared with reference research (see Table A.11). Variations with reference studies may also be related to motorcycle taxi drivers' riskier behaviors in road safety being different from regular motorcyclists (Wu and Loo 2016).

In Colombia, there is laxity in respect for and control of traffic regulations by road actors (Ospina-Mateus et al. 2020). The simplest motorcyclist infraction is traffic signal violation. The most complex is driving without a license; motorcyclists were the most common repeat offenders, and speeding was among the most probable causes of accidents. The lack of control and penalization of traffic infractions and the lack of culture among road actors in Cartagena make it a hostile driving scenario. For example, 27% of traffic tickets self-reported by motorcyclists were related to compliance with legal requirements (e.g., licenses, insurance, documentation).

Applying the MRBQ instrument adapted to the socio-cultural context and focusing on motorcycle taxi drivers is significant in identifying problems and thus proposing effective countermeasures. The phenomenon of Motorcyclist taxi drivers reflects social, economic, and mobility problems, which are growing in LMICs (Truong and Nguyen 2019). Informality must be controlled to improve motorcycle safety standards, fierce competition, and increased vehicle fleets (Gutierrez and Mohan 2020). Other studies of motorcyclists

in LMICs also recommend delving into risky behaviors such as those mentioned, including alcohol, smoking, and cell phone use while riding (Nguyen-Phuoc et al. 2019; Truong and Nguyen 2019; Nguyen-Phuoc et al. 2020).

An important limitation of self-reports is that instruments are often vulnerable to socially desirable responses. Data collection can be distorted by how respondents judge and perceive their actions. The motorcyclists were informed that they would be anonymised. Likewise, the interviewers were trained to interpret the questions and avoid bias. Language adaptation is a crucial feature in avoiding ambiguities. Finally, the survey was conducted during the day. This could exclude motorcycle taxi riders who work only at night.

In future research, it is proposed that occupational motorcyclists, non-occupational, and motorcycle taxi riders be also included. Additionally, direct observational research on the conflicting behaviors of motorcyclists on roads should be carried out. These studies provide reliable information, and research on this scenario is limited.

The study suggests that the instrument helps to understand risky behavior and its relationship with traffic accidents. The riders who engage in this informal activity are young adults, poorly educated, and with little or no driving experience. Moreover, they work long hours a week, have family responsibilities, and have low socio-economic conditions. The service is currently provided with low-quality vehicles that are poorly maintained, and sometimes rented. Inadequate riding experience, traffic errors, control errors, and safety neglect are significantly associated with crashes and near-crashes. Stunts are strongly associated with traffic tickets, and speed violations are strongly associated with at-fault crashes. Finally, this study recommends some practical implications and countermeasures focused on motorcycle taxi riders' well-being and road safety in Table A.12.

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ORCID

Holman Ospina-Mateus http://orcid.org/0000-0002-2385-774X
Leonardo Quintana Jiménez http://orcid.org/0000-0001-5625-0111
Francisco J. López-Valdés http://orcid.org/0000-0003-3167-5732

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