A Cross-Sector Framework to Boost the Sustainable Implementation of Integrated Transport and Spatial Strategies to Improve Safety and Mobility of Moto-Taxi Riders

*Murungi Elizabeth Mwebesa, Chun-Chen Chou, Kento Yoh and Kenji Doi**

Department of Civil Engineering, Division of Global Architecture, Graduate School of Engineering, Osaka University, Osaka, Japan

Globally, motorcycle riders make up the biggest percentage of vulnerable road user fatalities. The percentages are higher in African cities where moto-taxi transport is not only the most readily available mode of transport but also a source of income for many especially the youth. Many African cities are re-strategizing on how to sustainably deal with problems like traffic congestion, unplanned development, flooding, air and noise pollution. The authors carried out a questionnaire survey targeting a variety of road safety stakeholders to identify road safety solutions that they think best fit the current situation. Another questionnaire survey targeting moto-taxi riders was carried out, and the data analyzed by SEM to identify how different solutions interact to affect the behavior of riders. Results show that education and training programs have the biggest effect on improving behavior of riders as they adapt to new city regulations such as zoning. Other aspects such as presence of customers, behavior of other road users, road environment were also explored. Currently, city authorities in some developing nations are looking to introduce spatial regulations such as zoning and traffic management strategies such as exclusive lanes. Therefore, the contribution of this study is a proposal of a combination of solutions that different road safety stakeholders in developing countries can contribute toward the sustainable improvement of the safety of riders.

Keywords: sustainable mobility, cross-sector, road traffic safety, boda boda transport (moto-taxi), spatial planning, traffic management

INTRODUCTION

In many parts of Africa, especially East Africa, motorcycles are owned as a source of income. Although ownership numbers are not clearly known, road accident fatalities, involving motorcyclists are approximately 33% in Uganda and 24% in Kenya (World Health Organization, 2018). It is reported that ownership of motorcycles will increase due to the high levels of unemployment among the youth and the increased traffic congestion in major cities in Africa. Entry into the trade has no strict restrictions especially at city authority level; this makes it difficult to monitor the riders' numbers and behavior. This poses a big problem for city planners who are currently grappling with a variety of development challenges such as poor drainage leading to floods, urban sprawl, traffic congestion, air and noise pollution.

In countries such as Uganda, motorcycle transport has spread across the country since the late 1990s. Boda bodas (motorcycle taxi) not only fill the public transport gap but also cater for the last mile. Boda bodas are fast, convenient and can access many remotes areas. Some individuals opt for boda bodas because of the security they provide. In Kampala, more women are reported to use boda bodas especially at night because they feel safer than if they use taxis (Kumar, 2011). Alonso et al. (2020) who pointed out that perceived safety and security between genders affects the choice of transport mode and behavioral choice patterns in both urban environments and public transport systems corroborate this. Looking at these advantages, boda bodas are instrumental especially in remote areas. However, their value rational in cities is only significant in the absence of proper public transport.

Many African transport managers (European Union, 2017) have argued that in order to ensure the sustainability of many African cities, an integration of public transport (buses and rail) and other forms of transport (cycling, walking, and motorcycle taxi) is inevitable. It is explicitly noted that the coverage of public transport would still be limited because feeder services would have to be connected to the main public transport routes (Tuan and Mateo-Babiano, 2013). As much as buses would be the first choice for these feeder services, motorcycle taxis would be a good choice to fill the gap in connecting communities to the buses and railway stations. Based on this, motorcycle taxi would still play a role in the transport ecosystem albeit auxiliary.

Background

Kampala is the capital city of Uganda, a country in East Africa (see **Appendix A** for the location of Kampala and its divisions). The biggest transport problems are; poor road conditions, traffic congestion, road accidents, air and noise pollution, and poor drainage (World Bank Group, 2015; Kampala Capital City Authority, 2017, 2018b; Mugisha, 2017; Oswald, 2018; Uganda Police Force, 2018, 2019, 2020; Anca, 2021; NuweAbine, 2021). In Uganda, accidents involving boda boda riders and their customers account for about 33% of all the annual fatalities (Uganda Police Force, 2020). Of these, more than 50% of fatalities are among people below the age of 35 years. The occurrence of these accidents not only leads to death of both boda riders and passengers but in some cases, loss of income to families when either death or amputation occurs.

According to Sebaggala et al. (2015), as of 2012 Uganda's economic burden due to boda boda accidents and deaths was; about 7 million ugx (about $2,800) to treat accident victims, economic loss of 3 billion ugx (about $1.2 m) due to loss in output and about 350 million ugx (about $140,000) in motorcycle repairs. Like in other parts of Africa, Kampala also cited boda boda riders as a source of insecurity as well as victims of insecurity (Diaz Olvera et al., 2012; Ukwayi et al., 2013; The Independent, 2019; Mugo, 2021; Tumusiime, 2021). This poses a huge social, economic and political burden on the country.

Over the years, the government has put in place various measures to improve mobility and safety. There have also been interventions specifically targeting the safety of boda boda riders (see **Appendix B** for interventions implemented in Kampala). However, many of these measures have been implemented in isolation, at the convenience of the responsible stakeholder. To maximize the impact of the measures where economic and human resources are limited, cross-sector cooperation is important (Mwebesa et al., 2018). Therefore, the synergistic effects of the previous traffic safety measures should be examined to encourage cross-sector cooperation and hybrid measures that come from it.

Kampala Capital City Authority (KCCA), a body mandated by the Uganda parliament to plan for and develop the city, launched the Kampala Capital City strategic plan as part of Uganda's Vision 2040 (Kampala Capital City Authority, 2020a). The strategies to improve mobility and safety include the introduction of Mass Rapid Transport (MRT) and Non—Motorized Transport (NMT) in the city (Kampala Capital City Authority, 2018a, 2021). Although a pilot NMT route has been implemented in Kampala City, a fully functional MRT system will take a relatively longer time to realize.

In July 2020, KCCA announced the implementation of the Boda Boda Free Zone (BBFZ) (Kampala Capital City Authority, 2020b; Mutabazi, 2020; The Independent, 2020a,b) (see **Appendix A** for proposed boda boda free zone in Kampala City). The authorities gave the following reasons for its implementation;

a) To reduce pedestrian accidents by reducing the chances of boda boda riders mixing with pedestrians
b) To encourage walking and cycling within the zoned off area
c) To encourage the public to use the bus system that will be introduced in this zone
d) This is a pilot project for the introduction of a decongestion fee for private vehicle users.

The BBFZ is expected to reduce traffic accidents involving boda boda riders in a designated area; however, the boda boda riders are anticipated to spread out to other areas because they are still an important mode of transport. This highlights the importance of boosting the safety of riders and their customers. On the other hand, many researchers have over the years proposed the implementation of exclusive lanes for boda bodas. This has not yet been considered by the authorities. The proposed exclusive lanes would separate the riders from other road users in the road space. This would reduce the risk of riders getting involved in accidents with vehicles and pedestrians. Therefore, there remains a need for examination of the synergistic impact of these spatial strategies alongside other road safety measures as well as the impacts of the respective measures.

Study Framework

This study aims to identify factors that would aid the introduction of spatial planning strategies (i.e., zoning) and traffic management (i.e., exclusive lanes) in cities with underdeveloped public transport systems from the viewpoint of riders' safe riding intention. To better understand the unique characteristics of moto-taxi riders and examine synergistic effects of different road safety measures in Uganda, this study focuses on the interactions between latent constructs including social environment, human influence, road furniture, traffic conditions, enforcement, zoning, and exclusive lanes. A combination of solutions involving various

stakeholders will be proposed as a way to create a sustainable framework to bridge spatial planning and traffic management especially in cities with high rates of moto-taxi riders.

To identify the factors, an in-depth literature review was done followed by a questionnaire survey targeting boda boda riders. The survey aims to specify what motivates boda boda riders to ride safely and the extent of this motivation. This study applied the Structural Equation Modeling (SEM) analysis to identify how different solutions interact to affect riders' behavior by investigating and assessing the strength of the causal relationships between variables. SEM method is appropriate for statistical analysis of self-reported data to further derive suitable empirical findings for managerial implications. It has been employed in various study fields including transport psychology and safety (Sukor et al., 2017; Yoh et al., 2019; Abbas and Haghighi, 2020). The empirical results of this study include a comparison of six models; these will be the basis of discussion in the following sections. In addition, some managerial suggestions were proposed in the conclusion.

LITERATURE REVIEW

Traditionally, Education, Enforcement and Engineering (3Es) or its combination improve road safety situation including drivers' or riders' behaviors. First, the studies on perceptual factors of safe riding behavior were reviewed. Then, the literature explaining how different factors affect the behavior of riders on the road were also considered. This covered aspects including education, enforcement, engineering (road environment), spatial strategies such as exclusive lanes and zoning, and the effect of customers/passengers.

Riders and Other Road Users Perceptions

A study conducted in Australia assessed the psychosocial factors influencing motorcycle riders' intentions to perform both safe and risky riding behaviors (Tunnicliff et al., 2012). The intention for riders to engage in safer behaviors such as better awareness of traffic and road environment, and refusal to ride when tired, were consistently predicted by the theory of planned behavior. That is, riders' perceived control influences their engagement in safer behavior. When it came to engaging in riskier behaviors, attitudes and sensation seeking were better predictors of riders' intentions. The authors further noted that not only does presence of other riders influence their intention to engage in either safe or risky behavior, but their relationship also plays an important part.

In terms of risk-taking intentions, Cordellieri et al. (2019) suggested that motorcyclists complied with road rules depending on the specific driving context; however, they were more prone to violating traffic rules than drivers. This was attributed to riders' lower concern for risk compared to drivers. In contrast, Nguyen-Phuoc et al. (2020) found that riders and drivers, whose perception of getting in an accident or paying a fine was high, were more likely to increase the frequency of using the turn signals. In addition, riders tended to follow the traffic rules and regulations more strictly if a rider thought they were prone to penalties.

For some riders, riding is a form of identity and expression or freedom hence the tendency to over speed, weave in and out of traffic, and take other risks on the road (Musselwhite et al., 2012). However, riders actually recognize the risks and try to prioritize this in all they do. It has also been found that sensation seeking is the strongest predictor of riders' aggression. Overall, how riders perceive their identity or skill affects the way they will behave on the road. Many of the negative perceptions can be changed through experience and different forms of education and training (Rowden et al., 2016).

It should also be noted that the safety of vulnerable road users increases as traffic composition becomes diverse (Papadimitriou et al., 2019). Therefore, other road users' perception affects the safety of motorcycle riders. To ascertain the blameworthiness of crashes at intersections, Robbins et al. (2018a) carried out a survey considering both drivers' and motorcyclists' opinions about junction crashes. Both drivers and riders agreed that the driver would be at blame because riders have a stronger awareness of dangers at intersections. This corroborated a viewpoint from a previous study that there was a problem with the way other road users viewed motorcyclists (Clarke et al., 2007). At junctions, drivers "looked-but-failed-to-see" the riders, this is as a result of the drivers' "poor perceptual schema for motorcycles." That is to say, drivers did not see motorcyclists as "dangerous obstacles." Therefore, the risk of collision increased in situations where drivers missed seeing the rider or miscalculated how fast the rider was moving. Based on this, it was suggested that engaging riders in defensive riding and engaging the drivers in more empathic driving would reduce these crashes.

Regarding the collision risks of motorcycles, Robbins et al. (2018b) concluded that motorcycle accidents at unsignalized junctions resulted from the fact that drivers accept smaller and riskier maneuver gaps with motorcycles as compared to four-wheelers. On the other hand, a study conducted in Paris found that the main causes of motorcycle accidents were falling or skidding due to avoidance of other road users and pedestrians crossing haphazardly on the road (Maestracci et al., 2012). The latter is regarded as a common occurrence in Uganda and is, therefore, a big concern for riders. To improve the safety of riders, it is important to consider the behavior of other road users because this directly affects how riders act or react.

The Role of Education

The accumulation of on-road experience enhances not only motorcyclists' riding skills but also their hazard perception abilities. These include the abilities to recognize obstacles, pay attention to other road users, and adapt to road furniture (Underwood, 2007; Rosenbloom et al., 2008; Crundall et al., 2014). Lack of experience is mostly addressed formally through a range of rider training and education programs.

Many studies have confirmed that the provision of knowledge and riding practice is an effective way to promote road safety. To examine the effectiveness of a pc-based training program, Di Stasi et al. (2011) compared first-time riders before and after training in different riding scenarios to advanced motorcycle riders. Although the authors noticed that novice riders' inability

to adjust speed to the different road conditions would increase the probability of having a crash, their riding ability improved to match the performance of experienced riders after taking part in the training.

Regarding riders' adjustment to road speed limitation, it was found that rider training enabled the riders to adapt speed or position when need arose (Boele-Vos and de Craen, 2015). Riders were more likely to recognize hazards and react appropriately. Another study showed that the advanced riders reported fewer traffic errors and speed violations than novice and experienced riders in the MRBQ survey (Crundall et al., 2014). On the road, the advanced riders drove more slowly in 40 kph areas and stayed closer to the centerline as compared to novice riders. The authors attributed this to the riders' ability to adjust as the road environment and other road users' situations changed.

In terms of risk identification, training helps riders identify and react to hazardous situation much faster when driving on the road (Crundall et al., 2010). Chapman et al. (2002) emphasized that driver's ability to scan the roadway scene increases with experience while training can improve the scanning behavior. Similarly, a study conducted by Underwood (2007) showed that expert drivers scanned the scene of roadways more than experienced drivers, while novice drivers scanned the scene less than experienced drivers did.

In Uganda, Muni et al. (2018) compared two groups of riders, one that had undergone a training (safeboda riders) on traffic rules and regulations and the other (regular riders) that had not. The empirical results showed that safeboda riders were more likely to engage in safer activities like wearing a helmet and avoiding use of a phone while riding. It was concluded that such training is effective in improving the safety of boda boda riders.

All these studies elaborate the importance of road safety education and skill training. Providing riders with training or education help them be more aware of the traffic environment and act appropriately as need arises. Therefore, Education can increase the impact of engineering and its activities on the safety of riders.

Effect of the Road Environment (Engineering)

The environmental characteristics (e.g., poor lighting, bad weather conditions, and complicated road geometry) increase the risk of traffic crashes for vulnerable road users, especially motorcyclists (Papadimitriou et al., 2019; Nguyen-Phuoc et al., 2020; Robbins and Fotios, 2020). An investigation of contextual factors suggested that risk after dark is significantly higher for motorcycles compared to four-wheelers, on roads with low-speed limits (≤30 mph), at T-junctions, and junctions controlled by a give-way sign or auto traffic signals (Robbins and Fotios, 2020).

Driver's perception of safety is an important influence on their driving behavior. Nguyen-Phuoc et al. (2020) concluded that environmental factors such as poor lighting, bad weather and multiple lanes, had a positive and direct effect on the frequency that the drivers and motorcyclists used their turn signal. This shows that road users are aware of the increased risk of getting involved in a road crash and try to adapt to the environment.

This is consistent with previous research conducted by Huth et al. (2014). Other studies found that sudden appearance of animals, barriers not meant for riders or road surfacing that makes braking difficult, would heighten the riders' awareness. In order to protect themselves, the riders opted for strategies like riding away from shoulders, constantly monitoring pavements and other infrastructure.

Therefore, the road environment may affect how riders use the road. The improvement of different road features and furniture may lead to reduced risks for motorcycle on sections of the road. It is therefore important that the road environment is made suitable for the riders to follow the new spatial rules and regulations such as staying in their exclusive lane or being able to follow markings leading up to the zoned off areas. To ensure that the riders adhere to this, proper enforcement becomes very important.

The Role of Enforcement

The presence of enforcement of road traffic law is an effective deterrent to dangerous behavior. The role of police in safety matters of motorcyclists has been widely studied, especially in ASEAN countries. To understand how the moto-taxi riders were able to follow traffic rules and regulations, Tuan and Mateo-Babiano (2013) carried out a study in Vietnam and Thailand. The heavy penalties, the banning or cancellation of a riding license were suggested as punishment for riders who violated rules or provided an inappropriate service. However, it is argued that the effects of the police enforcement were temporary. Regarding helmet usage in Thailand, Jiwattanakulpaisarn et al. (2013) found that in areas where there was presence of checkpoints many riders wore helmets; the reverse was true. In some cases, if riders knew the schedule for police checks, they found ways to dodge them altogether.

Similarly, Stanojević et al. (2013) conducted a study on driver's attitudes and behaviors in areas with different police enforcement visibility. The Serbian drivers tendered to follow traffic rules and regulations more frequently as compared to their North Kosovo counterparts because in the former group, police enforcement was stronger.

Road safety campaigns have also been known to be effective in improving the safety of road users. One such campaign is a police campaign "Fika Salama (arrive safe)" initiated by Uganda police in collaboration with Uganda National Roads Authority (UNRA) and Ministry of Works and Transport (MoWT) and several health facilities in response to the increased road accidents that were happening on Kampala-Masaka Highway. After its launch in August 2016, this operation has contributed to a decline in the poor driver behavior and a significant reduction in fatalities, their associated costs among other savings (UNECE, 2018; SPEED, 2019).

Police enforcement plays an important role in ensuring that riders follow traffic rules and regulations. However, police conduct is also something that affects the attitude of riders. If the police are corrupt, many riders might use this opportunity not to follow any rules because they know they will get away with it. To make the enforcement effects last, Adnan and Gazder (2019) suggested that the traffic police would have to aim for a higher

sense of professionalism, serve severe punishment and dismiss corrupt officers.

In some cases, especially in developing nations, first educating the public about dangers of risky behavior (through public consultations or workshops) may boost the effectiveness of enforcement activities. In a study to understand the trends in motorcycle helmet use in Vietnam, Bao et al. (2017) argued that although helmet use significantly increased, this could not be fully attributed to enforcement because enforcement levels and initiatives had not changed during the study period. In order to increase helmet use, they suggested increasing riders' awareness of dangers of substandard helmets and how to identify good quality ones then follow this with consistent enforcement activities.

In another study to identify strategies to increase helmet usage among riders in Delhi, the researchers leaned toward interventions that disseminate information on the dangers of unsafe behaviors. This was suggested as a more feasible approach as compared to enforcing helmet law and speed limits (Grimm and Treibich, 2016).

Limitations on the coverage and efficiency of enforcement have been the motivation behind Ratanavaraha and Jomnonkwao's study (Ratanavaraha and Jomnonkwao, 2013). They argued that although Thailand's enforcement activities are widely spread, the participation of the community in information dissemination activities is a key ingredient in improving safety of riders. In their study, they reported an increase of 13.23% in helmet usage because of community participation activities such as public consultations, meetings and participative decision-making.

Therefore, it is important to first disseminate information to the community as a way to increase the effectiveness of enforcement in road safety.

On Exclusive Lanes and Zoning

Many articles related to motorcycles in Uganda have come out to suggest various engineering-and-enforcement-related measures to improve the safety of riders. Siya et al. (2019) concluded that the construction of separate lanes for boda boda riders would not only be a factor in reducing boda boda related accidents but it would enhance public transport.

Manan et al. (2017) pointed out that motorcyclists were three times more likely to over-speeding on roads without shoulders. They further noted that because riders cannot find refuge on shoulders, they are forced to weave in and out of the main lanes hence increasing the risk of being involved in a crash. As a result, paved shoulders or exclusive lanes were suggested to enable riders to reduce their speeds as a means to promote riders' safety. On the other hand, the exclusive lanes for two-wheelers were found to be most effective on roads with higher speed limits, bigger volumes of traffic, and areas with bus routes (Morrison et al., 2019). Lowering speed limits and installing dedicated off-road cycling infrastructure will attract more bicycle traffic because vehicles and high speed are seen as hazards. Such separated motorcycle lanes have been constructed in some parts of Malaysia.

Sukor et al. (2017) set out to examine the correlation between motorcyclists' psychological factors (attitude, desire, perceived danger, moral obligation, etc.) and their risky riding behaviors (speeding and neglecting to wear a helmet) depending on the type of motorcycle facility they used. It was found that there was a statistically significant relationship between exclusive lanes on speeding behavior. Moreover, psychological factors affected speeding and helmet wearing differently.

Regarding the motorcyclists' compliance toward zoning, Hanan (2019) indicated that the visibility of the zoning regulations would encourage riders to adhere to the restrictions. Another observation was that the motorcyclists wanted the public to approve of their compliance behavior (this can be boosted through Education). It was therefore concluded that public promotion of safety would have to focus on reinforcing positive beliefs toward compliance.

Effect of Passengers

The influence of the 3Es has been expounded upon; however, passengers also influence the driver in both negative and positive ways (Orsi et al., 2013). In the case of moto- taxi riders, the influence from their customer/passengers is bound to be stronger. Positive aspects include being a navigator, keeping the driver alert, alarming the driver of hazards ahead or risky behaviors. In contrast, the negative influences include urging the riders to break the rules so that they pay a reduced transport fare or get to their destination faster (Lyatuu, 2014). Raynor (1923) made similar reports in his study on boda riders in Kampala. This behavior has been supported by a study carried out by Monash University Accident Research Center (Regan and Mitsopoulos, 2001).

Negative influences were most notable among the 16–24 age group if the driver was also in the same age group (Regan and Mitsopoulos, 2001). These included encouraging riskier behavior such as speeding and insulting other drivers. In some cases, some passengers were not aware of their negative influence such as distraction caused by passengers who chatted with their driver. Kubose et al. (2006) noted that conversation is a distraction to driving performance owing to driving on especially a difficult track requires more allocation of the driver's attention. These effects are stronger among younger drivers as compared to older drivers. This is derived from the social identity theory where individuals derive identity from membership in a particular group (Tajfel et al., 1979). It is believed that drivers who want their passengers to like them may drive recklessly and be over-dependent on their passengers with the thought that the passengers play specific roles in their driving (Nakagawa and Park, 2014).

Horvath et al. (2012) concluded that in some scenarios, active pressure (passengers directly influencing driver's intention to speed) may merely reinforce passive pressure (a driver's intention to speed is from the driver's perception that the passengers want them to) as opposed to solely making the driver more intent on speeding.

These studies show that the presence of passengers (customers) may have significant positive or negative effects on the rider's behavior. Therefore, passengers are an important stakeholder to consider in this study.

FIGURE 1 | Relationship between safety hexagon and questionnaire items.
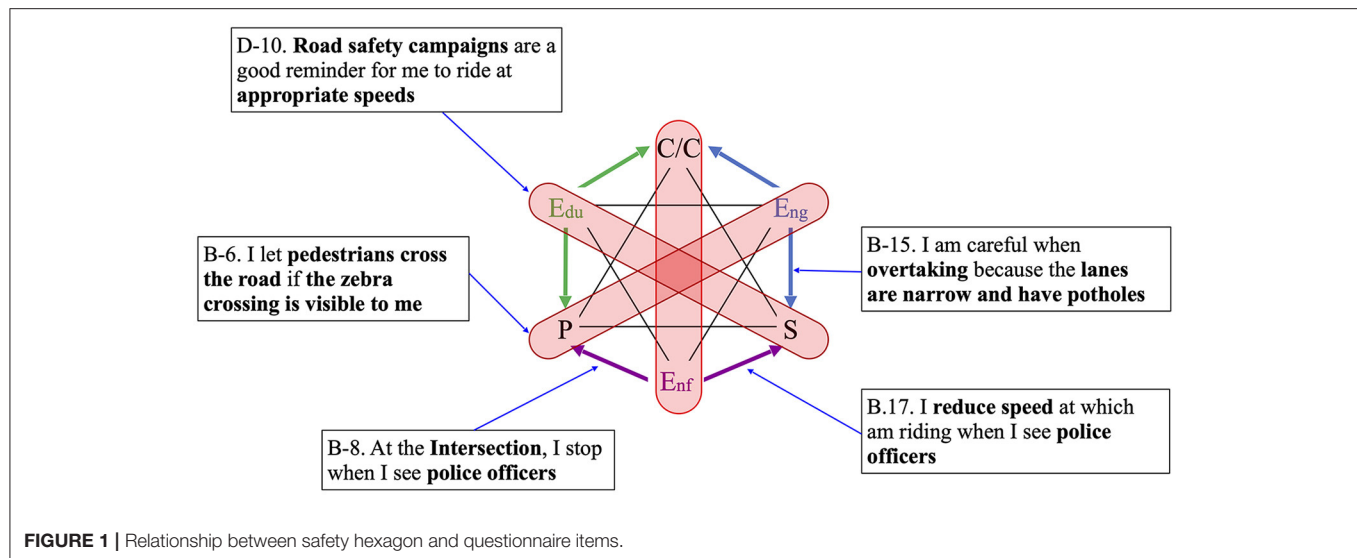
METHODOLOGY

The following methodologies were utilized in this study; literature review, questionnaire survey and meeting with road safety stakeholders, questionnaire survey for riders and SEM analysis.

Questionnaire Survey for Boda Boda Riders

Survey Design and Measures

Based on the literature review above, online discussions were held with road safety stakeholders to further understand the road safety situation of the riders on the ground. Thereafter, a questionnaire survey targeting boda boda riders was prepared and a test run was done in September 2020. A draft of the questionnaire was distributed to 40 randomly chosen boda boda riders and passed a series of pre-test trials to ensure all materials were accurate and appropriate.

The original questionnaire survey consisted of four sections A–E. Section A, B, D and E originally consisted of 14, 18, 20, 20 questions respectively. A Confirmatory Factor Analysis (CFA) was conducted to test the convergent reliability and discriminant validity of the measurement model. Some items in section B and E did not meet the criteria; therefore, they were removed from the final questionnaire.
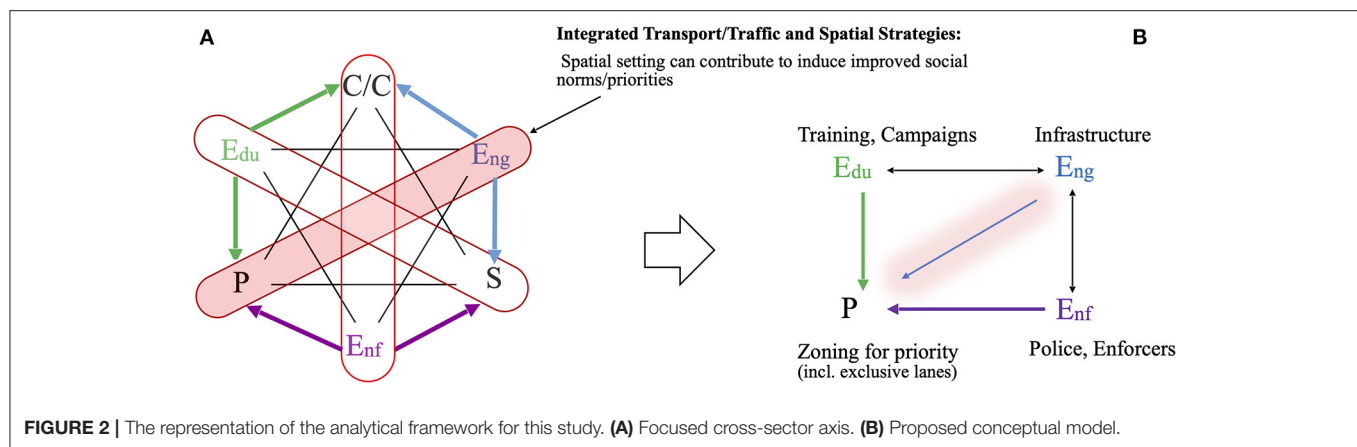
The final questionnaire was in both English and Luganda (a local language commonly spoken in Kampala city). Section A consists of 14 questions that were designed to collect general information about the riders such as age and years riding a motorcycle. Section B consists of 15 questions, whose target was to understand how police presence, road conditions and driver behavior affects the behavior of riders. Section D consists of 20 questions, whose aim was to understand how knowledge of the law (traffic rules and regulations), customer, friends and self-belief influence the behavior of riders. While section E consists of 12 questions whose aim was to understand how zoning and exclusive lanes will influence their behavior.

Each question in sections B, D and E was designed to reflect a riding behavior and its motivation. The items were measured using a five-point Likert scale (5 = strongly agree, 1 = strongly disagree). The motivation is a form of 3Es (Education, Engineering and Enforcement) while the behavior is a form of PSC principle (Priority, Speed and Comprehension). The behaviors targeted in this study were; speeding, overtaking, yielding to pedestrians, stopping at traffic lights or unsignalized intersections and wearing a helmet. Sunagawa et al. (2015) proposed a holistic framework on safer use of road crossing facilities by including PSC elements as a way to create a balance in the usability, safety and accessibility of the road space. Yoh et al. (2017) utilized the PSC principle to identify and classify the traffic violations and accidents that foreign drivers in Japan are prone to commit depending on their region of origin. Mwebesa et al. (2018) defined the relationship between 3Es and PSC principle as a safety hexagon that represents a type of cross-sector cooperation approach, whereby PSC represent the risks or causes of road accidents while 3Es represents the solutions to these problems. For example, education interventions can inform other road users on whom to prioritize on the road (P) or how to regulate speed (S) on the road. **Figure 1** illustrates the relationship between the questionnaire items and the safety hexagon.

Sample Size Determination

Previous studies targeting boda boda riders in Kampala have used varying sample sizes depending on the purpose of the study. In a cross-sectional study, the sample size used was 200 boda boda riders (Siya et al., 2019). In two studies comparing the behavior of safeboda riders and regular riders, sample sizes of 400 and 342 riders were deemed necessary (Muni et al., 2018, 2019).

Although this study did not seek to compare behavior between safeboda riders and regular riders, a methodology similar that in Muni et al. (2019) was used to determine the sample size. Helmet use is a behavior whose statistics are easily accessible as compared to other behaviors; therefore, it was used as a basis

FIGURE 2 | The representation of the analytical framework for this study. **(A)** Focused cross-sector axis. **(B)** Proposed conceptual model.

to calculate sample size. Roehler et al. (2013) and Kamulegeya et al. (2015) state that the percentage helmet use among riders is at 18.6 and 30.8% respectively. Based on these studies and others mentioned above, the percentage of riders willing to wear helmets was estimated at 30%. Considering a type error rate of 0.01 using a X^2 test, and the power to detect a difference between the two groups of riders to be 80%, a total of 300 samples was decided upon according to table A4 in Fleiss et al. (2003). This sample size falls in the range of sample sizes used in previous studies, therefore it is deemed appropriate for this study.

Data Collection Method
Based on the new boda boda stages allocated by KCCA, 70 locations were chosen from three divisions (Nakawa, Central and Kawempe) to interview the riders. These three divisions were chosen because they are the Industrial, Administrative and Education divisions of the city respectively. The locations chosen were those near public places like markets, schools, government offices and locations on main roads leading to the Northern by-pass (a major road directing traffic from the city to roads leading upcountry). A group of five experienced research assistants were remotely trained to carry out the survey. An independent supervisor was also trained to oversee the whole process.

The final questionnaire survey was held between 14th and 24th October 2020. Three hundred and seventy six willing boda boda riders were interviewed, although during data cleaning only 319 samples were used for analysis.

Structural Equation Modeling (SEM) Analysis
SEM approach is used in data analysis to examine complex and multi-faceted relationships between measured variables and latent constructs, in various disciplines such as travel behavior, psychology and sociology (Golob, 2003). SEM consists of two models a structural model and measurement model, which gives it an advantageous edge in data analysis. The structural model measures the latent variables while the structural model tests the hypothetical dependencies between latent variables and measured variables based on path analysis (Mattson, 2012).

The variable measurements primarily based on the analytical framework (**Figure 2**) were developed through a detailed review

of the relevant literature. Studies show that various education and training programs are effective in enabling riders to recognize obstacles or hazards, pay attention to other road users, adapt to road furniture and adjust speed to adapt to different road conditions (Chapman et al., 2002; Underwood, 2007; Rosenbloom et al., 2008; Crundall et al., 2014; Boele-Vos and de Craen, 2015). This may imply that imparting knowledge on riders boosts the effectiveness of engineering interventions such as providing road furniture and upgrading road environment.

Enforcement plays a big role in improving safety of riders. However, some studies suggest that interventions that increase awareness of riders, information dissemination and participative decision making not only boost the effectiveness of enforcement but in some cases they may be more feasible than enforcement (Ratanavaraha and Jomnonkwao, 2013; Grimm and Treibich, 2016; Bao et al., 2017).

Therefore, different forms of education and training may increase the effectiveness of engineering and enforcement interventions that may in turn influence the riders' behavior toward adhering to zoning and exclusive lane regulations. The SEM analysis was adopted in order to identify dimensions of 3Es that would enable the riders to adhere to the spatial strategies of zoning and exclusive lanes in the city. By identifying the latent structure, a combination of solutions was proposed as a way to promote sustainable mobility.

Table 1 describes the constructs that were examined in the study. The names are derived from the literature reviewed in section literature review. Before proceeding with the analysis of model specification and causality, the goodness-of-fit indices of the hypothesized structural model were estimated to confirm the model fitness. The SEM analysis was conducted using the package "lavaan" in R program.

RESULTS AND DISCUSSIONS
General Characteristics of Boda Boda Riders
Table 2 lists the sample characteristics of the respondents. Majority of the respondents are between the age of 18 and 40 years, and have had a riding experience of 1–10 years. These results are similar to those found by Raynor (1923). Therefore,

TABLE 1 | Definition of latent constructs examined in this study.

SN	Construct	Explanation	References
1	Social environment	A form of education where riders gain knowledge about the traffic rules and regulations. For majority of riders, this information is formally or informally through the people who teach them how to rider or their colleagues at the boda boda stages or at the road safety trainings they attend.	Chapman et al. (2002), Underwood (2007), Rosenbloom et al. (2008), Crundall et al. (2010, 2014), Di Stasi et al. (2011), Boele-Vos and de Craen (2015), Muni et al. (2018)
2	Human Influence	Customers or passengers' influence on riders	Raynor (1923), Tajfel et al. (1979), Regan and Mitsopoulos (2001), Kubose et al. (2006), Horvath et al. (2012), Orsi et al. (2013), Lyatuu (2014), Nakagawa and Park (2014)
3	Sense of safety	Riders' need for speed and the necessity to wear helmets	Tunnicliff et al. (2012), Cordellieri et al. (2019), Nguyen-Phuoc et al. (2020)
4	Traffic conditions	The influence of drivers or road features on the riders' behavior	Clarke et al. (2007), Maestracci et al. (2012), Robbins et al. (2018a,b), Papadimitriou et al. (2019)
5	Road furniture	Absence or presence of road furniture and its influence on riders' behavior on the road	Huth et al. (2014), Nguyen-Phuoc et al. (2020), Robbins and Fotios (2020)
6	Enforcement	Presence of police officers or other forms of law enforcers	Jiwattanakulpaisarn et al. (2013), Stanojević et al. (2013), Tuan and Mateo-Babiano (2013), UNECE (2018), Adnan and Gazder (2019), SPEED (2019)

TABLE 2 | General characteristics of the respondents.

Characteristic	Category	Sample size	Percentage
Age	18–30 years	119	37.3%
	31–40 years	140	43.8%
	41–50 years	55	17.2%
	Over 50 years	5	1.6%
Years of riding a motorcycle	Less than 1 year	14	4.4%
	1–5 years	154	48.3%
	5–10 years	103	32.3
	11–15 years	32	10%
	Over 15 years	16	5%
Road safety training	Yes	236	74%
	No	83	26%
How rider learned how to ride a motorcycle	Others	12	3.8%
	Family	35	11%
	Friends	137	42.9%
	Myself	135	42.3%
Own a riding permit	Yes	189	59.2%
	No	130	40.8%

the samples in this study can be thought to be representative of boda boda rider in Kampala city.

About 84% of the riders interviewed taught themselves how to ride or were taught by a friend. This has been cited by many researchers as a one of the root causes of accidents among boda boda riders. However, the situation is that there are no known motorcycle riding schools and with no regulations on joining the trade, this behavior is bound to continue. To somewhat salvage the situation, private companies like Vivo energy (Oneal,

2014) and Safeboda Initiative (EABW DIGITAL, 2018) started providing road safety training to improve the safety of riders.

In some of these workshops, riders are not only taught traffic rules and regulation but are given riding basics and shown videos of how their bad behavior can be detrimental to their safety and livelihood. These initiatives account for the 74% of riders who reported to have attended a road safety training before.

Descriptive Statistics

Table 3 shows the mean and standard deviation of the measurement items of each construct of the conceptual model.

Results From the Structural Equation Modeling (SEM) Analysis

The results from the SEM analysis will be discussed in two parts. Of the six models, four are related to zoning while the others are related to exclusive lanes. In the first part, results related to zoning will be discussed while the second part will be focused on the results related to exclusive lanes.

Results Related to Zoning

The estimated model 1 showed a good fit ($CFI = 0.971$, $TLI = 0.959$, $RMSEA = 0.043$, $GFI = 0.966$, $AGFI = 0.941$), in addition all paths are significant. Model 1(**Figure 3**) shows that the social environment (knowledge of the traffic rules and regulations imparted formally or informally) would enable the riders to "read" the traffic conditions and this would in turn enable them to adhere to the traffic rules and regulations related to zoning.

Overall, any form of trainings has a bigger impact on the riders adhering to the zoning conditions. Many of the road safety campaigns in Uganda are led by private sector in conjunction with the Uganda Police Force. These campaigns not only run education material on media but also hold training sessions (Vivo Energy, 2017a). Previous studies have shown that, after training, riders are able to perceive hazards, adjust their speeds and identify risks (Rosenbloom et al., 2008; Crundall et al., 2010; Boele-Vos

TABLE 3 | Descriptive statistics of measurement items.

Constructs and items	Mean	SD
Road furniture		
B6. I let pedestrians cross the road if the zebra crossing is visible to me	4.188	0.660
B7. I let pedestrians cross the road if the traffic lights are functional	4.069	0.758
B9. At intersections, I stop when the traffic lights are functional, if not I just join the road	2.721	1.298
Traffic conditions		
B14. Drivers are intolerant and impatient so I try to signal before I overtake	4.182	0.587
B15. I am careful when overtaking because the lanes are narrow and have potholes	4.288	0.518
B18. Car drivers are reckless so I have to rider within the speed limit of that area	4.207	0.664
Social environment		
D7. I always give way to pedestrians because it is the law	4.364	0.566
D10. Road safety campaigns are a good reminder for me to ride at appropriate speeds	4.229	0.719
D1. I always stop at the traffic lights because it is the law	4.382	0.602
D9. I ride at designated speed limits because the law says so	4.288	0.622
Enforcement		
B8. At intersections, I stop when I see the police	2.379	1.186
B5. At zebra crossings, I let pedestrians cross if I see the police	2.690	1.351
B17. I reduce the speed at which a riding when I see police officers	2.715	1.312
Human influence		
D11. I usually ride at high speeds because many customers ask me to do so	4.179	0.976
D2. I run the red lights because customers want to reach their destination quickly	4.414	0.690
D14. Sometimes my customers ask me to crisscross through cars so I do so	4.254	0.859
Zoning		
E3. As I approach the zoned off areas, I will rider within appropriate speeds	4.172	0.603
E7. As I approach the zoned off areas, I will be keen on stopping at traffic lights	4.066	0.735
E14. I will be more careful when overtaking as I approach the zoned off areas	4.110	0.637
Exclusive lanes		
E1. I am willing to ride at the speed limit if we are given exclusive lanes	3.937	0.969
E6. I am willing to stop at the traffic lights if we are given exclusive lanes	3.552	1.238
E12. If we are given exclusive lanes, am willing to overtake more carefully	3.838	1.002

and de Craen, 2015). About 74% of the riders who participated in this survey had undergone a road safety training; this would partly explain why "social environment" factor has an overall impact on zoning. Training emphasizing the importance of speed limits and stopping at traffic lights would have a greater impact on riders' behavior because of the higher factor loadings of these two observable variables.

As compared to drivers, Robbins et al. (2018a) indicated that riders have stronger awareness of danger because of the unique dangers they face on the road. In many African cities, including Kampala, such instincts may have been sharpened because cars are valued more than other forms of movement. Secondly, the road conditions favor drivers; this is illustrated by "the drivers' intolerance" having a higher exploratory power toward traffic conditions.

Such conditions may explain why the ability to read the traffic conditions may enable riders to follow the zoning regulations. Furthermore, improvement in road conditions and introducing "emphatic driving" for drivers would improve the riders' adherence to zoning regulations.

Model 1 is referred to as the "speed model" because the highest factor loading for "social environment" and "traffic condition"

are all speed related. Therefore, a combination of proper training for riders and drivers and improved traffic conditions would not only increase riders' adherence to zoning regulations but may also result in reduced over-speeding.

The fit indices of model 2 were within acceptable limits (*CFI* = 0.959, *TLI* = 0.943, *RMSEA* = 0.043, *GFI* = 0.965, *AGFI* = 0.940), indicating that the model is a good fit. Model 2 (**Figure 4**) is similar to model 1, the only difference is that knowledge of the traffic rules and regulations would enable the riders to be more aware of road furniture, which in turn would enable them adhere to zoning conditions.

Several studies have shown that misleading or absence of road furniture may affect the riders' behavior on the road (Nguyen-Phuoc et al., 2020; Robbins and Fotios, 2020). Based on the results above, the absence or non-functional road furniture affects the riders' reaction to pedestrians. Therefore, proper placement of road furniture would not only play a role in the riders' ability to follow zoning regulations but would also enable them to prioritize pedestrians in the road space. This is why model 2 is referred to as "Priority Model." Overall, the knowledge of the traffic rules and regulations has a bigger impact on the adherence to zoning regulations.

FIGURE 3 | Model 1—Speed model.

FIGURE 4 | Model 2—Priority model.
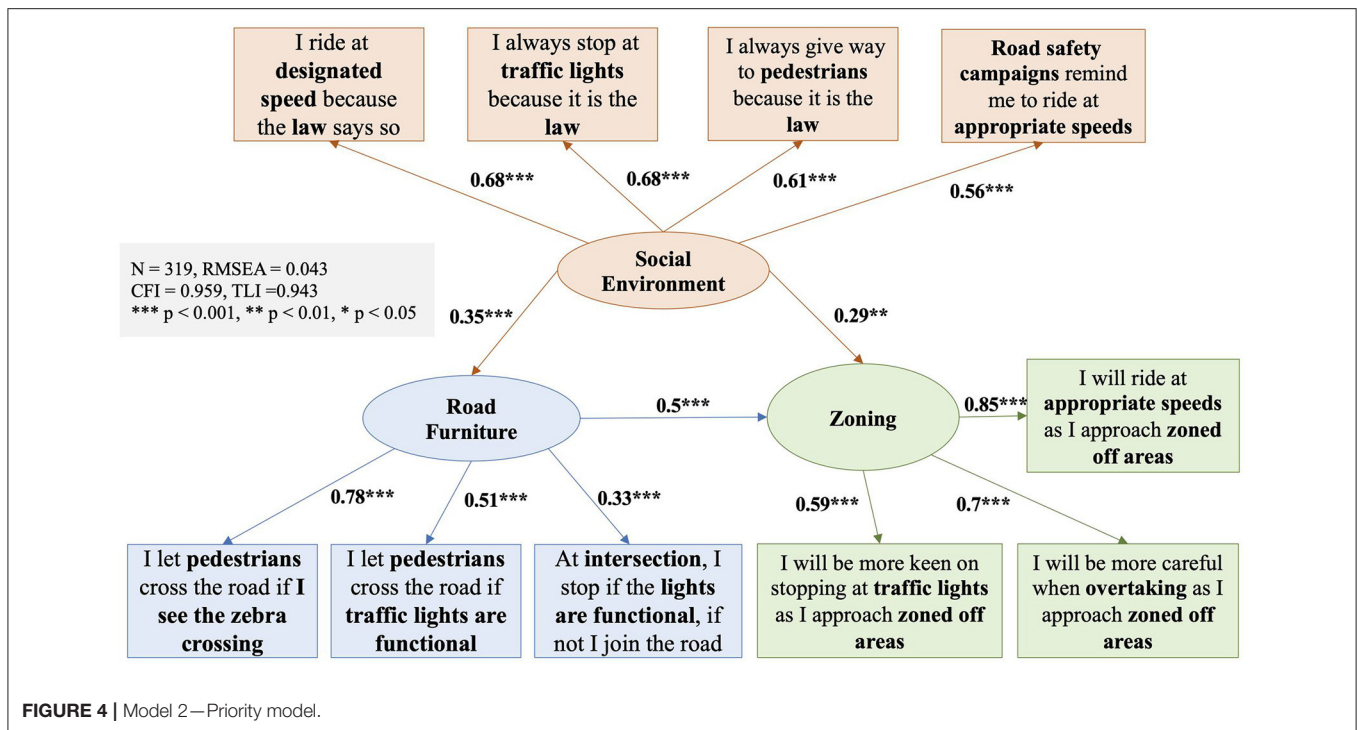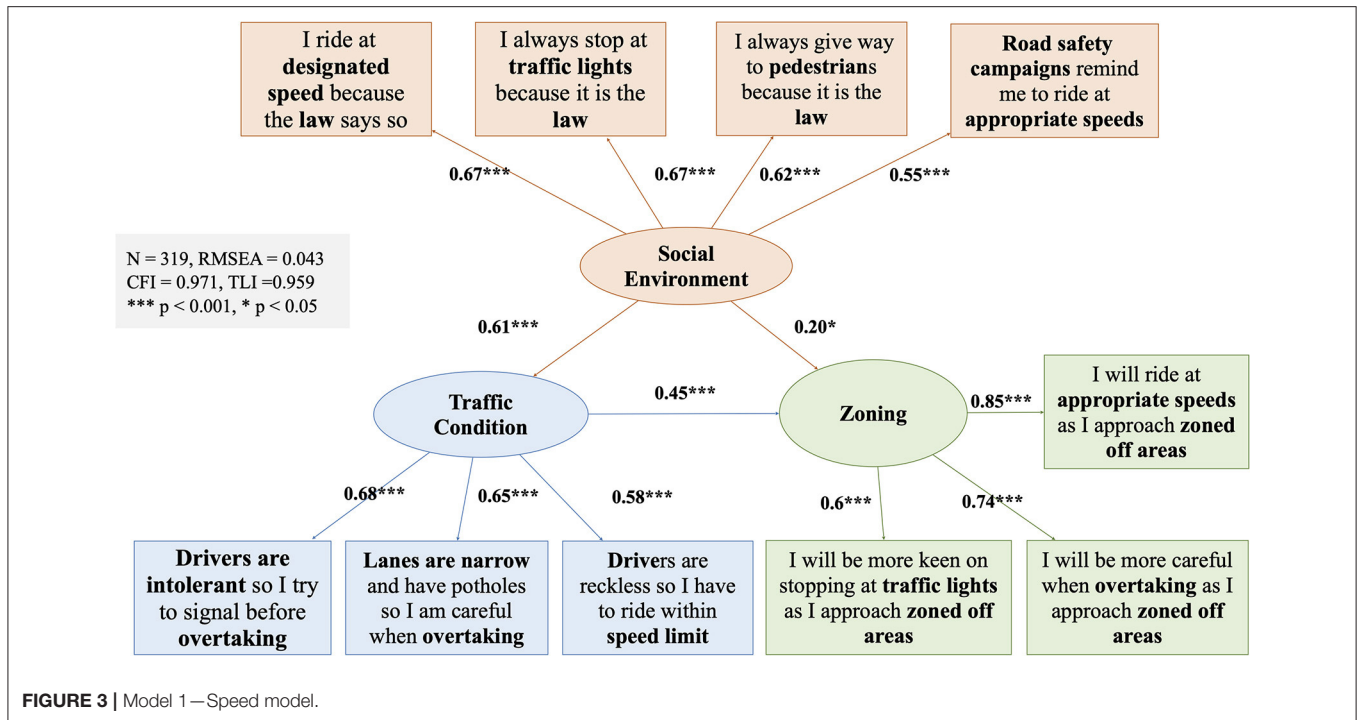
The causal relationships shown in model 3 are significant and the model has a good fit ($CFI = 0.925$, $TLI = 0.904$, $RMSEA = 0.062$, $GFI = 0.940$, $AGFI = 0.911$). Model 3 (**Figure 5**) is a combination of model 1 and 2; this further cements the importance of imparting knowledge of the traffic rules and regulations onto the riders. This model also shows

that engineering in the form of proper road furniture placement and better roads are important if zoning is to be successfully implemented. As a combination of model 1 and 2, it earns the name "Speed and Priority Model."

The fit indices of model 4 are within acceptable tolerances, showing a good fit ($CFI = 0.944$, $TLI = 0.928$, $RMSEA = 0.055$,
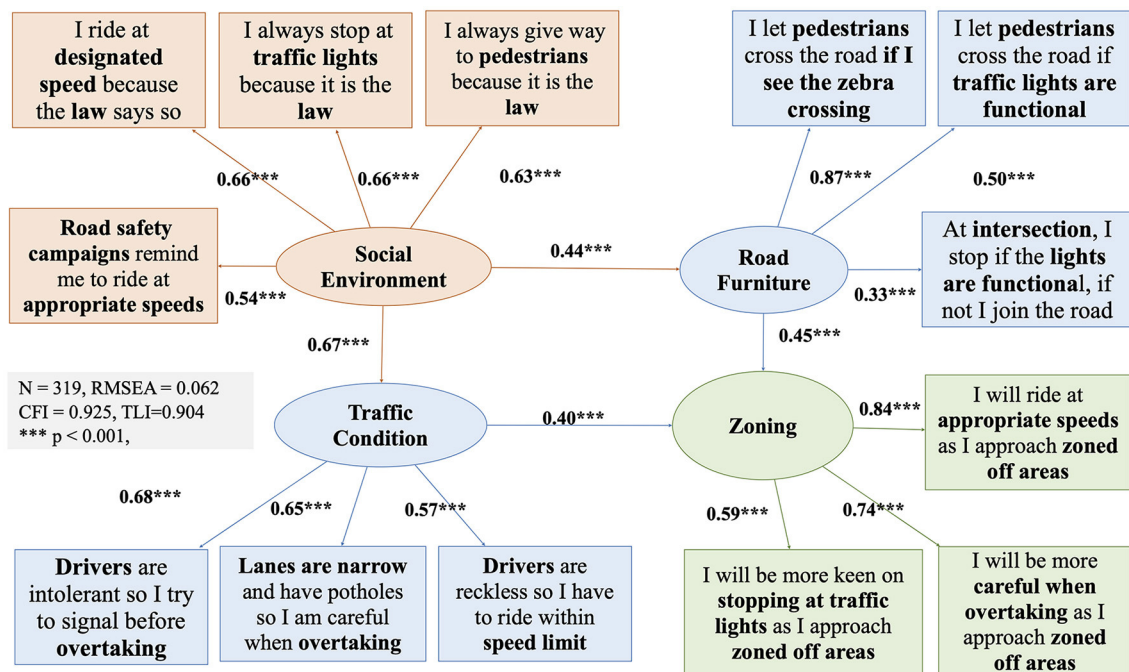
FIGURE 5 | Model 3—Speed and priority model.
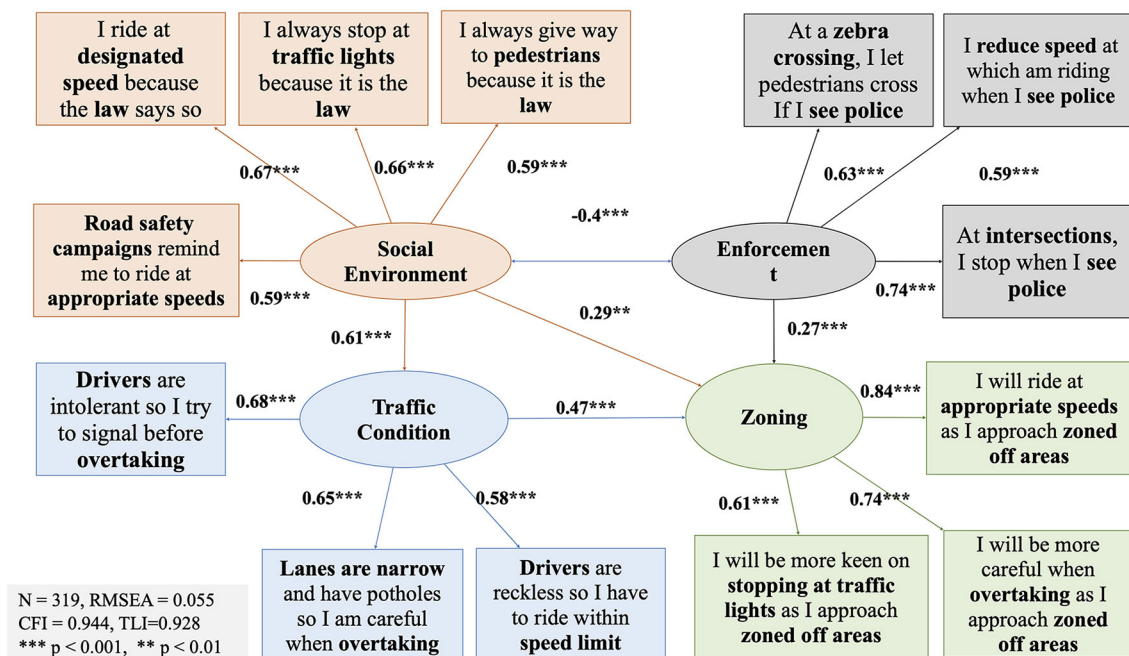
FIGURE 6 | Model 4—The effect of enforcement on zoning.

$GFI = 0.946$, $AGFI = 0.919$). Model 4 (**Figure 6**) is similar to model 1 but here, the effect of enforcement is explored. Presence of police or any other enforcement unit will ensure that riders adhere to zoning regulations. One of the reasons as to why riders

that belong to the safeboda ride hailing company, adhere to traffic regulations is because there is an enforcement arm of the company whose responsibility is to ensure riders adhere to traffic rules (EABW DIGITAL, 2018). Those that do not are penalized
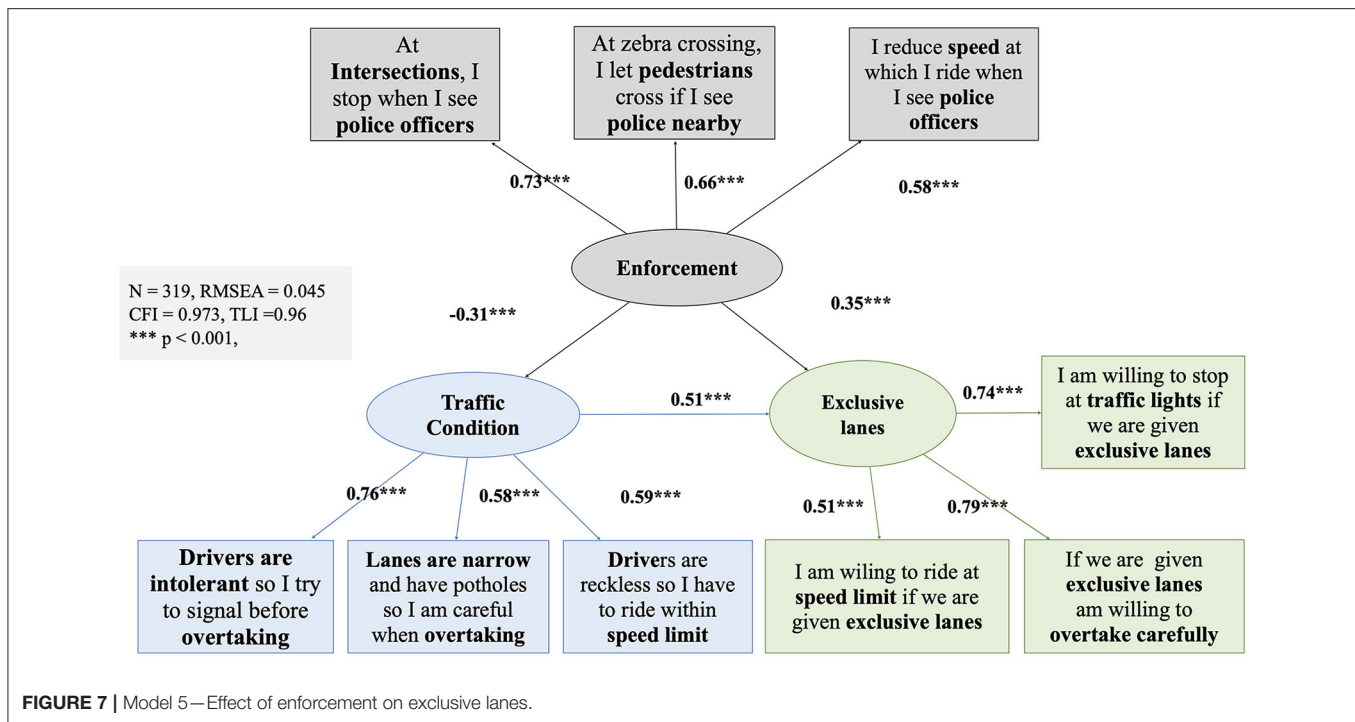
FIGURE 7 | Model 5—Effect of enforcement on exclusive lanes.

and this has seen a great improvement in how these riders behave on the road as compared to their other counterparts.

Many studies suggest that enforcement should be implemented after education as this is the logic way to ensure road users adhere to traffic rules and regulations. The relationship between "social environment" and "enforcement" should therefore show a positive covariance however in model 4 it is a highly significant negative value. This is a true reflection of the road user-traffic police relationship in many developing countries. Some reports show that the police is involved in bribery, extortion and harassment of the riders. This has therefore created mistrust between the two parties and may explain why the riders are reluctant to follow police directives (Raynor, 1923; BBC Online News, 2020; Kalokwera, 2021; Uganda Radio Network, 2021a,b). The lack of trust between the public and authorities came up as one of the reasons why the effects of an enforcement campaign targeting helmet use, in Karachi, did not last long (Adnan and Gazder, 2019).

Zoning of this magnitude is new to many stakeholders including the police force. Therefore, awareness campaigns targeting the public and the traffic police may salvage this situation. This would most probably improve the public image of the traffic police as is suggested by some studies (Adnan and Gazder, 2019).

Results Related to Exclusive Lanes

Model 5 also shows a good fit ($CFI = 0.973$, $TLI = 0.960$, $RMSEA = 0.045$, $GFI = 0.973$ $AGFI = 0.950$). In Model 5 (**Figure 7**), police presence would enable the riders to stay in their lanes. However, police presence would have a negative effect on traffic conditions. As earlier discussed under model 4, there is mistrust between the public and the police. This may explain

the negative regression coefficient between "enforcement" and "traffic conditions."

As elaborated in model 1, riders are able to read the traffic environment and hence stay in their lanes. Overall, police presence, improved driver behavior (through emphatic driving) and improving the road conditions would enable the riders to follow the regulations related to exclusive lanes. Such a combination of solutions, albeit "non-traditional" is a good way to explore solutions that may boost sustainability in mobility and safety.

The structural model 6 shows an acceptable fit based on the $CFI = 0.910$, $TLI = 0.865$, and $RMSEA = 0.085$, $GFI = 0.949$, $AGFI = 0.904$. Model 6 (**Figure 8**) is similar to model 1 and model 5 but in this model the influence of passengers is examined. The influence of other people on drivers or riders has been to be either positive or negative (Tajfel et al., 1979; Regan and Mitsopoulos, 2001; Kubose et al., 2006; Orsi et al., 2013; Nakagawa and Park, 2014). In Kampala, riders have reported that customers or passengers pressurize them to take risks because they want to arrive fast or to cut costs (Raynor, 1923; Lyatuu, 2014). This is further illustrated by the high exploratory power of "I ride at high speeds because customers ask me to." This would explain why "human influence" has a negative effect on riders' perception of traffic conditions.

However, the effect of "human influence" has a relatively low significance on exclusive lanes. This maybe because exclusive lanes are a new concept, some passengers may be for it or against it depending on whether they prioritize their safety or getting to their destination. Overall, improvement of drivers' attitude to riders and road conditions would have a higher impact on riders' adherence to exclusive lanes regulations.
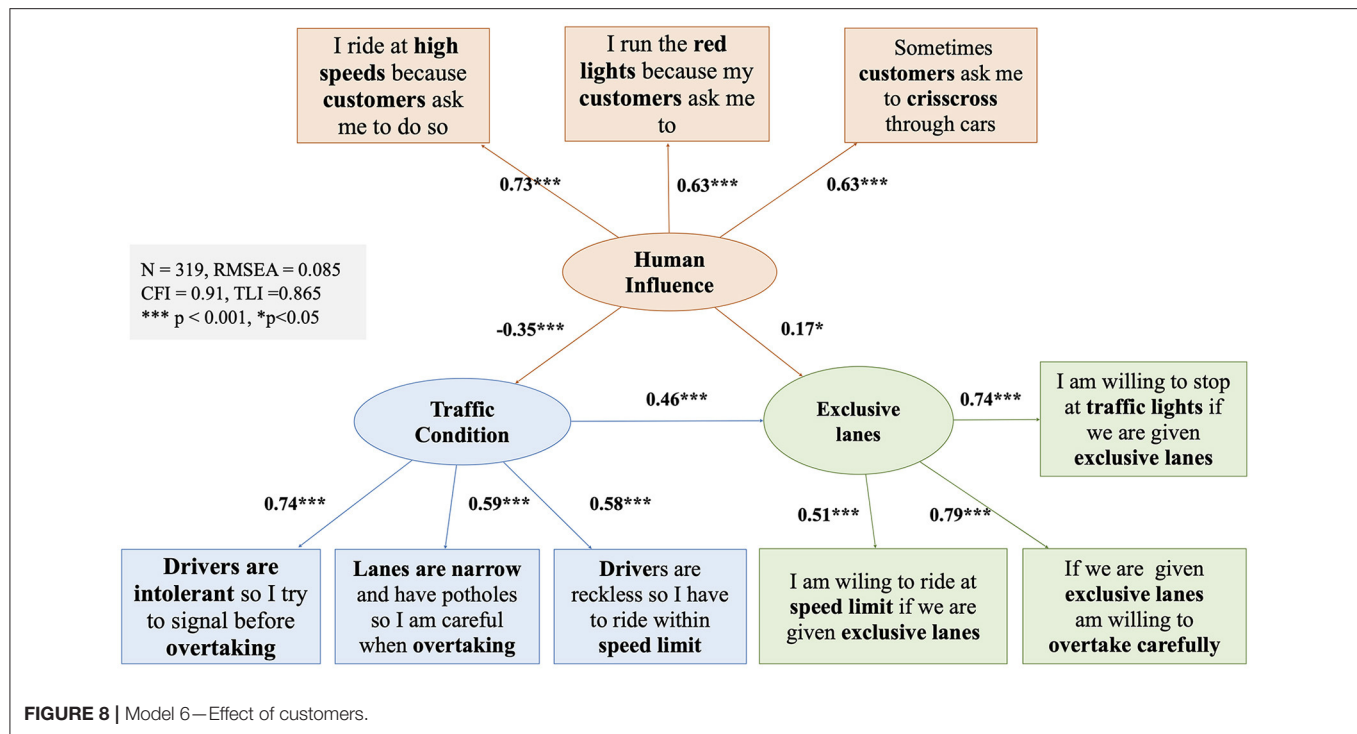
FIGURE 8 | Model 6—Effect of customers.

This model brings in the socio-economic aspect that is rarely explored when it comes to moto-taxi riders. Matters concerning the income of the rider have not been widely voiced by other stakeholders, most probably because they do not completely comprehend the dynamics. It also introduces another important stakeholder, the passenger or customer, whose role in the behavior and safety of riders has not been extensively discussed yet they play a crucial role. It is believed that, campaigns targeting the passengers or customers' attitude toward speed would improve the riders' adherence to exclusive lanes.

CONCLUSIONS

This study has suggested the cross-sector solutions that different stakeholders can plug into to ensure that there is a bridge between spatial planning and traffic management in the form of zoning and exclusive lanes. The proposed solutions create another perspective that developing countries, especially African cities with high numbers of moto-taxi riders, can utilize to boost sustainable mobility and safety.

Imparting knowledge of traffic rules and regulations has a cumulatively higher effect on promoting zoning. To achieve this, targeted trainings and campaigns should be tailored to improve the riding skills of riders but also introduce empathic driving for drivers. Some researchers like Muni et al. (2019) have reported the success of targeted training programs. Their study showed that, as compared to other riders in Kampala, safeboda riders engaged in safer ridding behaviors because of the rigorous road safety training and the "sense of community" that was instilled in them.

In addition, many studies have concluded that drivers "don't see" or "don't acknowledge" riders as rightful users of the road that deserve respect and priority. Huth et al. (2014) emphasized that driver training should include information about riders to familiarize drivers with other road users; and that campaigns should encourage drivers to "use their mirrors more". Clarke et al. (2007) also re-echoes the need to "make drivers aware of the numerous ways that they fail to perceive a motorcycle." Therefore, including these aspect in driving training courses would create a safer environment for riders. For this to happen, the designated road safety agencies together with legislators, civil service and driving school instructors should come together and draft guidelines on the content and mode of delivery to ensure effective training in the driving schools. By bringing together relevant stakeholders, new localized sustainable solutions will be birthed.

Like in many countries, road safety campaigns target drivers but not riders. There has been reported success of campaigns such as "*Fika Salama*" (SPEED, 2019) and "*Twedekko*" (Vivo Energy, 2017a), however these were tailor made for drivers and the public but not the riders. Over the years, the European Union (Delhaye and Marot, 2015) has conducted studies to design and disseminate effective road safety campaigns targeting riders. They have hence suggested the following considerations; the riders' profile (riders' motivation, attitudes and patterns) and type of communication (stand-alone, campaigns combined with other supportive activities and integrated campaigns). In addition, Akbari et al. (in press) noted that campaigns were more effective if they were held for more than a year and if they joint enforcement and education in nature. Therefore, similar campaigns should be tailored for the public

and riders to educate them about zoning and exclusive lane regulation and the benefits of having such interventions in cities with high vehicle reliance and underdeveloped public transport systems.

In addition, holding workshops or having accessible inquiry desks to answer to the public's concerns would create "buy-in" from the public and riders because they would support a cause they fully understand. This "buy-in" strategy has been a success in some cities that were looking to create new street design guidelines (Mwebesa et al., 2021). Akinlade and Brieger (2003) also suggested that extending safety education and campaigns to the community through community leaders (religious and otherwise) would be beneficial in improving the road safety in South Western Nigeria. Zoning and exclusive are new strategies that may benefit from this method.

Passengers or customers are part of the public, so the proposed solutions would most likely change their mindsets toward positively influencing the riders rather than encouraging them to break the law. Such human-centered interactions have worked well in the creation of sustainable street design guidelines in some cities in India (Mwebesa et al., 2021). Broadcasting messages such as "having more than one passenger increases the risk of sustaining serious injuries," is one of the suggestions Oluwadiya et al. (2014) made as a way of discouraging passenger overload. Therefore, they can also work well in situations where sustainable mobility and safety is the goal.

Presence of police or enforcement in developing countries has a negative covariance effect on "social environment" and a negative correlation to "traffic conditions" in relation to zoning and exclusive lanes respectively. This can be remedied by re-training the traffic police on regulations related to zoning and exclusive lanes. However, this leaves the aspect of low public confidence in the police.

Two avenues can be utilized to build public confidence in the police. Use of surveillance cameras to display good acts of policing. This strategy has been utilized in creating road safety campaigns by displaying how reckless behavior leads to avoidable road crashes (Vivo Energy, 2017b). Another avenue is the use of social media which is faster and far reaching. Both the police organization and many high-ranking officials have official social media handles that the public can readily access. This platform could be used to address queries from the riders (or public) or it could be used to highlight good policing acts to improve the image of the city. It could also be used to report police officers that act out of line. The Global Road Safety Partnership (GRSP) pointed out that social media is a platform it recommends for disseminating information about road safety and engaging with its partners all over the world (Global Road Safety Partnership, 2012). It is the 4th Industrial revolution therefore; technology is a big part of our lives today and should therefore be utilized in whatever form available to improve safety of riders and hence foster sustainability in transportation.

Improvement of the road conditions and furniture placement has a positive correlation on zoning especially when it comes to prioritizing pedestrians. Visible and functional road furniture is an aspect of engineering that has not received a lot of

attention in developing nations including Uganda. Yet, it is a fundamental tool for improving road safety especially of vulnerable road users. In Cameron, moto-taxi riders identified poor road conditions as the main cause of accidents (Wankie et al., 2021). While in Australia, riders called for improvement of road surfacing, markings and placement of road furniture, as one of the interventions to enable them ride safely on the road (Huth et al., 2014). Many studies have shown that riders are able to scan their environment as they move; absence of road furniture might cause them to act in an appropriate way that would put them and other road users in danger.

The initial step of providing and properly placing the road furniture is important even though some stakeholders have pointed out theft and vandalism as the main reason for the absence of road furniture in many developing countries, especially in Africa. This is a rather difficult issue to tackle because it is a symptom of a deeper societal problem. However, campaigns pointing out the importance of road furniture and serious police crackdowns on places where stolen road furniture is sold, maybe some of the temporary solutions to this problem.

The road to sustainable mobility requires various stakeholders coming together to support a hybrid of solutions as opposed to supporting one intervention at a time. Apart from the traditional stakeholders, politicians, police, engineers, driving/riding instructors, other stakeholders should be considered in these hybrid solutions. These include the public (who include customers or passengers and pedestrians), IT professionals (to deal with technological aspects), drivers and the motorcycle riders themselves. Road safety training or campaigns should be tailor made for riders and other road users. In addition, for all new mobility or safety measures, training or awareness campaigns for all parties involved should precede enforcement.

Sustainable mobility can be achieved by using the A-S-I strategy that stands for Avoid, Shift and Improve (Sustainable Urban Transport Project, 2019). Spatial planning strategies like zoning are a good "avoid strategy" which look to moderate speeds through urban design reforms. Therein curbing the excessive freedom of moto-taxi riders while paving way for walking and cycling. However, this should not be done with the sole aim of "throwing the riders out" of the cities.

In the "shift strategy," moving toward public transport is the overall goal. As earlier explained, moto-taxi still play a major role as public transport modes while the countries are in planning phases of implementing public transport modes that cover a wider area and carry more passengers. Once, these are implemented, moto-taxi riders will continue to play an auxiliary role of "first and last mile" to and from public transport hubs. With this in mind, it is important to continue ensuring that the riders' safety needs are met both in short and long term.

Exclusive lanes are a kind of spatial segregation in the road space that can be considered as an "improve strategy" and "avoid strategy." As city authorities look to improve existing infrastructure and create new master plans, exclusive lanes should be considered. This will in a way monitor the riders' behavior.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author/s.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Makerere University School of Public Health, Higher Degrees and Research Ethics Committee (MakSPH, HDREC), and Uganda National Council for Science and Technology (UNCST). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

MEM designed the study, collected and analyzed the data, and compiled the manuscript. C-CC proofread the document and contributed toward compilation of the final manuscript. KY and KD proofread the document and were in charge of overall supervision of the study. All authors read and approved the final manuscript.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/frsc.2021.775011/full#supplementary-material

REFERENCES

Abbas, S., and Haghighi, F. (2020). Driver distraction by digital billboards. Structural equation modelling based on naturalistic driving study data: a case study in Iran. *J. Saf. Res.* 72, 1–8. doi: 10.1016/j.jsr.2019.11.002

Adnan, M., and Gazder, U. (2019). Investigation of helmet use behavior of motorcyclists and effectiveness of enforcement campaign using CART approach. *IATSS Res.* 43, 195–203. doi: 10.1016/j.iatssr.2019.02.001

Akbari, M., Lankarani, K. B., Tabrizi, R., Vali, M., Heydari, S. T., Motevalian, S. A., et al. (in press). The effect of motorcycle safety campaign on helmet use: A systematic review and meta-analysis. *IATSS Res.* doi: 10.1016/j.iatssr.2021.06.001

Akinlade, O. C., and Brieger, W. R. (2003). Motorcycle taxis and road safety in southwestern Nigeria. *Int. Q. Commun. Health Enquity Res. Policy* 22, 17–31. doi: 10.2190/KQPM-RJ52-4UY6-9L1Y

Alonso, F., Useche, S. A., Faus, M., and Esteban, C. (2020). Does urban security modulate transportation choices and travel behavior of citizens? A national study in the Dominican Republic. *Front. Sustain. Cities* 2:42. doi: 10.3389/frsc.2020.00042

Anca, G. (2021). Devex News. Available online at: https://www.devex.com/news/africa-s-air-quality-problem-old-cars-and-no-data-99744 Devex HP (accessed September 27, 2021)

Bao, J., Bachani, A. M., Viet, C. P., Quang La, N., Nguyen, N., and Hyder, A. A. (2017). Trends in motorcycle helmet use in Vietnam: results from a four-year study. *Public Health* 144, S39–S44. doi: 10.1016/j.puhe.2017.01.010

BBC Online News (2020). Available online at: https://www.bbc.com/news/world-africa-53278900 (accessed on September 27, 2021).

Boele-Vos, M. J., and de Craen, S. (2015). A randomized controlled evaluation study of the effects of a one-day advanced rider training course. *Accid. Anal. Prevent.* 79, 152–159. doi: 10.1016/j.aap.2015.03.021

Chapman, P., Underwood, G., and Roberts, K. (2002). Visual search patterns in trained and untrained novice drivers. *Transport. Res. F. Traffic Psychol. Behav.* 5, 157–167. doi: 10.1016/S1369-8478(02)00014-1

Clarke, D. D., Ward, P., Bartle, C., and Truman, W. (2007). The role of motorcyclist and other driver behaviour in two types of serious accident in the UK. *Accid. Anal. Prevent.* 39, 974–981. doi: 10.1016/j.aap.2007.01.002

Cordellieri, P., Sdoia, S., Ferlazzo, F., Sgalla, R., and Giannini, A. M. (2019). Driving attitudes, behaviours, risk perception and risk concern among young student car-drivers, motorcyclists and pedestrians in various EU countries. *Transport. Res. F. Traffic Psychol. Behav.* 65, 56–67. doi: 10.1016/j.trf.2019.07.012

Crundall, D., Andrews, B., Van Loon, E., and Chapman, P. (2010). Commentary training improves responsiveness to hazards in a driving simulator. *Accid. Anal. Prevent.* 42, 2117–2124. doi: 10.1016/j.aap.2010.07.001

Crundall, D., Stedmon, A. W., Crundall, E., and Saikayasit, R. (2014). The role of experience and advanced training on performance in a motorcycle simulator. *Accid. Anal. Prevent.* 73, 81–90. doi: 10.1016/j.aap.2014.08.009

Delhaye, A., and Marot, L. (2015). *PTW Safety and EU Research Work - Review of PTW-Related Research Work from ERSO Portal, Annex 21 of the EC/MOVE/C4 Project RIDERSCAN*. Available online at: http://www.fema-online.eu/riderscan/IMG/pdf/annex_21.pdf

Di Stasi, L. L., Contreras, D., Cándido, A., Cañas, J. J., and Catena, A. (2011). Behavioral and eye-movement measures to track improvements in driving skills of vulnerable road users: First-time motorcycle riders. *Transport. Res. F. Traffic Psychol. Behav.* 14, 26–35. doi: 10.1016/j.trf.2010.09.003

Diaz Olvera, L., Plat, D., Pochet, P., and Sahabana, M. (2012). Motorbike taxis in the "transport crisis" of West and Central African cities. *EchoGéo* doi: 10.4000/echogeo.13080

EABW DIGITAL (2018). Safeboda unveils the Safeboda academy. *East African Business Week*. Available online at: https://www.busiweek.com/safeboda-unveils-the-safeboda-academy/ (accessed January 20, 2020).

European Union (2017). *How to Get Cities Moving: Public Transport Challenges in Developing Countries*. Available online at: https://europa.eu/capacity4dev/articles/how-get-cities-moving-public-transport-challenges-developing-countries (accessed February 24, 2020).

Fleiss, J. J., Levin, B., and Myunghee, C. P. (2003). *Statistical Methods for Rates and Proportions, 3rd Edn.* John Wiley & Sons. doi: 10.1002/0471445428

Global Road Safety Partnership (2012). Building a culture of road safety with social media. Available online at: https://www.grsproadsafety.org/building-a-culture-of-road-safety-with-social-media/ (accessed September 29, 2021).

Golob, T. F. (2003). Structural equation modeling for travel behavior research. *Transport. Res. B. Methodol.* 37, 1–25. doi: 10.1016/S0191-2615(01)00046-7

Grimm, M., and Treibich, C. (2016). Why do some motorbike riders wear a helmet and other don't? Evidence from Delhi, India. *Transport. Res. A. Policy Pract.* 88, 318–336. doi: 10.1016/j.tra.2016.04.014

Hanan, S. A. (2019). Motorcyclists' beliefs of compliance with the Malaysian school zone speed limit (SZSL). *IATSS Res.* 43, 148–152. doi: 10.1016/j.iatssr.2018.12.003

Heuler, H. (2013). New Ugada campaign aims to prevent motorbike accidents. *VOA News*. Available online at: https://www.voanews.com/science-health/new-uganda-campaign-aims-prevent-motorbike-accidents (accessed January 15, 2020).

Horvath, C., Lewis, I., and Watson, B. (2012). Peer passenger identity and passenger pressure on young drivers' speeding intentions. *Transport. Res. F. Traffic Psychol. Behav.* 15, 52–64. doi: 10.1016/j.trf.2011.11.008

Huth, V., Füssl, E., and Risser, R. (2014). Motorcycle riders' perceptions, attitudes and strategies: findings from a focus group study. *Transport. Res. F. Traffic Psychol. Behav.* 25, 74–85. doi: 10.1016/j.trf.2014.05.004

Jiwattanakulpaisarn, P., Kanitpong, K., Ponboon, S., Boontob, N., Aniwattakulchai, P., and Samranjit, S. (2013). Does law enforcement awareness affect motorcycle helmet use? Evidence from urban cities in Thailand. *Glob. Health Promot.* 20, 14–24. doi: 10.1177/1757975913499030

Kalokwera, P. (2021). *Daily Monitor Newspaper*. Available online at: https://www.monitor.co.ug/uganda/news/national/police-boda-association-under-spotlight-over-extortion$-$3433994 (accessed September 27, 2021).

Kampala Capital City Authority (2017). Control of Noise Pollution in Kampala City. Available online at: https://www.kcca.go.ug/news/198/CONTROL-OF-NOISE-POLLUTION-IN-KAMPALA-CITY#.YVAEIn2RXIU (accessed September 27, 2021).

Kampala Capital City Authority (2018a). *Multi Modal Urban Transportation Master Plan for GKMA – Cities that work Workshop on Urban Transport*. Available online at: https://www.theigc.org/wp-content/uploads/2018/04/KCCA-Presentation-Cities-that-Work-Multi-Modal-Urban-Transport-Master-Plan-Apr2018.pdf (accessed September 1, 2021).

Kampala Capital City Authority (2018b). *Public Transport a Challenge: Does KCCA Care?* Available online at: https://www.kcca.go.ug/news/308/#.YU_5FX2RXIU (accessed September 27, 2021).

Kampala Capital City Authority (2020a). *Kampala Capital City Strategic Plan Launch – Executive Remarks*. Available online at: https://www.kcca.go.ug/news/425/KAMPALA-CAPITAL-CITY-STRATEGIC-PLAN-LAUNCH-EXECUTIVE-REMARKS#.YTRQg9-RXIU (accessed August 9, 2021).

Kampala Capital City Authority (2020b). *Press Statement on the Public Transport Reforms to Streamline and Regulate the Boda Boda Industry as Approved by Cabinet*. Kampala: Kampala Capital City Authority Press Statement. Available online at: https://www.kcca.go.ug/news/413/press-statement-on-the-public-transport-reforms-to-streamline-and-regulate-the-boba-boda-industry-as-approved-by-cabinet#.X9gK_9j7S1s (accessed August 20, 2020).

Kampala Capital City Authority (2021). *Implementing the Non-Motorized Transport Pilot corridor in Kampala city Uganda*. Available online at: https://www.kcca.go.ug/media/docs/IMPLEMENTING%20THE%20NMT%20-%20KAMPALA.pdf (accessed September 1, 2021).

Kamulegeya, L. H., Kizito, M., Nassali, R., Bagayana, S., and Elobu, A. E. (2015). The scourge of head injury among commercial motorcycle riders in Kampala; a preventable clinical and public health menace. *Afr. Health Sci.* 15, 1016–1022. doi: 10.4314/ahs.v15i3.41

Kubose, T. T., Bock, K., Dell, G. S., Garnsey, S. M., Kramer, A. F., and Mayhugh, J. (2006). The effects of speech production and speech comprehension on simulated driving performance. *Appl. Cognit. Psychol.* 20, 43–63. doi: 10.1002/acp.1164

Kumar, A. (2011). Understanding the emerging role of motorcycles in African cities. A political economy perspective. *SSATP Discussion Paper No.13, Urban Transport Series*. Available online at: https://www.ssatp.org/sites/ssatp/files/publications/SSATP-DiscussionPapers/DP13-Role-Motorcycles.pdf

Lyatuu, J. (2014). *The Observer Newspaper*. Available online at: https://www.observer.ug/component/content/article?id=34953:-boda-boda-riders-defy-traffic-overloading-rule (accessed January 21, 2020).

Maestracci, M., Prochasson, F., Geffroy, A., and Peccoud, F. (2012). Powered two-wheelers road accidents and their risk perception in dense urban areas: case of Paris. *Accid. Anal. Prevent.* 49, 114–123. doi: 10.1016/j.aap.2011.05.006

Manan, M. M. A., Ho, J. S., Arif, S. T. M. S. T., Ghani, M. R. A., and Várhelyi, A. (2017). Factors associated with motorcyclists' speed behaviour on Malaysian roads. *Transport. Res. F. Traffic Psychol. Behav.* 50, 109–127. doi: 10.1016/j.trf.2017.08.006

Mattson, M. (2012). Investigating the factorial invariance of the 28-item DBQ across genders and age groups: an exploratory structural equation modeling study. *Accid. Anal. Prevent.* 48, 379–396. doi: 10.1016/j.aap.2012.02.009

Morrison, C. N., Thompson, J., Kondo, M. C., and Beck, B. (2019). On-road bicycle lane types, roadway characteristics, and risks for bicycle crashes. *Accid. Anal. Prevent.* 123, 123–131. doi: 10.1016/j.aap.2018.11.017

Mugisha, A. (2017). *New Vision Newspaper*. Available online at: https://www.newvision.co.ug/new_vision/news/1455739/traffic-jam-eats-sh28-trillion (accessed September 27, 2021)

Mugo, G. (2021). *The Star Newspaper*. Available online at: https://www.the-star.co.ke/counties/central/2021-05-27-limuru-boda-boda-riders-protest-insecurity/ (accessed September 27, 2021).

Muni, K., Kobusingye, O., Mock, C., Hughes, J. P., Hurvitz, P. M., and Guthrie, B. (2018). Motorcycle taxi program increases safe riding behaviors among its drivers in Kampala, Uganda. *Inj. Prevent.* 26, 5–10. doi: 10.1136/injuryprev-2018-043008

Muni, K., Kobusingye, O., Mock, C., Hughes, J. P., Hurvitz, P. M., and Guthrie, B. (2019). Motorcycle taxi program is associated with reduced risk of road traffic crash among motorcycle taxi drivers in Kampala, Uganda. *Int. J. Inj. Control Saf. Promot.* 26, 294–301. doi: 10.1080/17457300.2019.1594952

Musselwhite, C. B., Avineri, E., Susilo, Y. O., and Bhattachary, D. (2012). Public attitudes towards motorcyclists' safety: a qualitative study from the United Kingdom. *Accid. Anal. Prevent.* 49, 105–113. doi: 10.1016/j.aap.2011.06.005

Mutabazi, H. (2020). KCCA releases new map for boda free zone. *The New Vision*. Available online at: https://www.newvision.co.ug/news/1523416/kcca-releases-map-boda-free-zone (accessed August 20, 2020).

Mwebesa, M. E., Kento, Y. O. H., Hiroto, I. N. O. I., and Kenji, D. O. I. (2018). A new approach to cross-sector cooperation in road safety through a comparison of policies in selected countries. *IATSS Res.* 42, 197–206. doi: 10.1016/j.iatssr.2018.08.001

Mwebesa, M. E., Yoh, K., and Doi, K. (2021). Developing the logical cross-sectoral framework of local SDGs project targeting safety and sustainability. *IATSS Res.* 45, 49–59. doi: 10.1016/j.iatssr.2021.03.005

Nakagawa, Y., and Park, K. (2014). Psychological effect of passenger presence on drivers and its dimensions: scale development and validation. *Transport. Res. F. Traffic Psychol. Behav.* 25, 86–97. doi: 10.1016/j.trf.2014.04.018

Nguyen-Phuoc, D. Q., De Gruyter, C., Oviedo-Trespalacios, O., Ngoc, S. D., and Tran, A. T. P. (2020). Turn signal use among motorcyclists and car drivers: the role of environmental characteristics, perceived risk, beliefs and lifestyle behaviours. *Accid. Anal. Prevent.* 144:105611. doi: 10.1016/j.aap.2020.105611

NuweAbine, D. M. (2021). *Daily Monitor Newspaper*. Available online at: https://www.monitor.co.ug/uganda/oped/commentary/floods-will-soon-be-no-more-in-kampala-3366224 (accessed September 27, 2021).

Oluwadiya, K. S., Ojo, O. D., Olayinka, A. O., and Ogunsuyi, P. S. (2014). Vulnerability of riders and passengers to injuries in multi-occupant motorcycle crashes. *Inj. Prevent.* 18 (Suppl. 1), A195.2–A195. doi: 10.1136/injuryprev-2012-040590s.19

Oneal, N. (2014). Vivo energy trains motorcyclists on road safety. *The New Vision*. Available online at: https://www.newvision.co.ug/new_vision/news/1309915/vivo-energy-trains-motorcyclists-road-safety (accessed January 20, 2020).

Orsi, C., Marchetti, P., Montomoli, C., and Morandi, A. (2013). Car crashes: the effect of passenger presence and other factors on driver outcome. *Saf. Sci.* 57, 35–43. doi: 10.1016/j.ssci.2013.01.017

Oswald, O. (2018). *Noise Risk Assessment in Selected Worship and Entertainment Centers in the City of Kampala, Uganda*. Available online at: https://www.researchgate.net/publication/339457687_Noise_Risk_Assessment_in_Selected_Worship_and_Entertainment_Centers_in_the_City_of_Kampala_Uganda

Papadimitriou, E., Filtness, A., Theofilatos, A., Ziakopoulos, A., Quigley, C., and Yannis, G. (2019). Review and ranking of crash risk factors related to the road infrastructure. *Accid. Anal. Prevent.* 125, 85–97. doi: 10.1016/j.aap.2019.01.002

Ratanavaraha, V., and Jomnonkwao, S. (2013). Community participation and behavioral changes of helmet use in Thailand. Transport Policy 25, 111–118. doi: 10.1016/j.tranpol.2012.11.002

Raynor, B. (1923). *Informal Transportation in Uganda: A Case Study of the Boda Boda. Independent Study Project (ISP) Collection.* Available online at: https://digitalcollections.sit.edu/isp_collection/1923

Regan, M. A., and Mitsopoulos, E. (2001). *Understanding Passenger Influences on Driver Behavior: Implications for Road Safety and Recommendations for Countermeasure Development.* Monash University Accident Research Centre, Clayton, VIC, Australia. Available online at: https://www.monash.edu/muarc/archive/our-publications/reports/muarc180 (accessed March 8, 2020).

Robbins, C. J., Allen, H. A., and Chapman, P. (2018a). Comparing car drivers' and motorcyclists' opinions about junction crashes. *Accid. Anal. Prevent.* 117, 304–317. doi: 10.1016/j.aap.2018.05.001

Robbins, C. J., Allen, H. A., and Chapman, P. (2018b). Comparing drivers' gap acceptance for cars and motorcycles at junctions using an adaptive staircase methodology. *Transport. Res. F. Traffic Psychol. Behav.* 58, 944–954. doi: 10.1016/j.trf.2018.07.023

Robbins, C. J., and Fotios, S. (2020). Motorcycle safety after-dark: the factors associated with greater risk of road-traffic collisions. *Accid. Anal. Prevent.* 146:105731. doi: 10.1016/j.aap.2020.105731

Roehler, D. R., Naumann, R. B., Mutatina, B., Nakitto, M., Mwanje, B., Brondum, L., et al. (2013). Using baseline and formative evaluation data to inform the Uganda helmet vaccine initiative. *Glob Health Promot.* 20, 37–44. doi: 10.1177/1757975913509657

Rosenbloom, T., Shahar, A., Elharar, A., and Danino, O. (2008). Risk perception of driving as a function of advanced training aimed at recognizing and handling risks in demanding driving situations. *Accid. Anal. Prevent.* 40, 697–703. doi: 10.1016/j.aap.2007.09.007

Rowden, P., Watson, B., Howorth, N., Lennon, A., Shaw, L., and Blackman, R. (2016). Motorcycle riders' self-reported aggression when riding compared with car driving. *Transport. Res. F. Traffic Psychol. Behav.* 36, 92–103. doi: 10.1016/j.trf.2015.11.006

Sebaggala, R., Matovu, F., Ayebale, D., Kisenyi, V., and Katusiime, M. (2015). *The Cost of Motorcycle accidents in Uganda.* Available online at: https://www.researchgate.net/publication/275025887_The_cost_of_motorcycle_Accidents_in_Uganda

Siya, A., Ssentongo, B., Abila, D. B., Kato, A. M., Onyuth, H., Mutekanga, D., et al. (2019). Perceived factors associated with boda-boda (motorcycle) accidents in Kampala, Uganda. *Traffic Inj. Prevent.* 20, S133–S136. doi: 10.1080/15389588.2019.1658084

SPEED (2019). *Sharing Preliminary Results for the Fika Salama Study.* Available inline at: http://speed.musph.ac.ug/fika-salama-results/ (accessed February 5, 2020).

Stanojević, P., Jovanovi,ć, D., and Lajunen, T. (2013). Influence of traffic enforcement on the attitudes and behavior of drivers. *Accid. Anal. Prevent.* 52, 29–38. doi: 10.1016/j.aap.2012.12.019

Sukor, N. S. A., Tarigan, A. K., and Fujii, S. (2017). Analysis of correlations between sychological factors and self-reported behavior of motorcyclists in Malaysia, depending on self-reported usage of different types of motorcycle facility. *Transport. Res. F. Traffic Psychol. Behav.* 46, 509–523. doi: 10.1016/j.trf.2016.09.032

Sunagawa, T., Doi, K., and Suzuki, K. (2015). Evaluation of usability towards safer use of road-crossing facilities. *J. East. Asia Soc. Transport. Stud.* 11, 1259–1271. doi: 10.11175/easts.11.1259

Sustainable Urban Transport Project (2019). *Avoid-Shift-Improve (A-S-I). SUTP Homepage.* Available online at: https://sutp.org/publications/sustainable-urban-transport-avoid-shift-improve-a-s-i-inua-9/ (accessed February 20, 2020).

Tajfel, H., Turner, J. C., Austin, W. G., and Worchel, S. (1979). An integrative theory of intergroup conflict. Organ. *Identity* 56, 9780203505984–97802035059816.

The Independent (2019). Boda boda riders protest increased insecurity. *The Independent.* Available online at: https://www.independent.co.ug/boda-boda-riders-protest-increased-insecurity/ (accessed September 28, 2021).

The Independent (2020a). Gov't to operationalise boda boda free zone in November. *The Independent.* Available online at: https://www.independent.co.ug/govt-to-operationalise-boda-boda-free-zone-in-november/ (accessed August 20, 2020).

The Independent (2020b). Boda boda operators reject new stages, registration guidelines. *The Independent.* Available online at: https://www.independent.co.ug/boda-boda-operators-reject-new-stages-registration-guidlines/ (accessed May 28, 2021).

Tuan, V. A., and Mateo-Babiano, I. B. (2013). Motorcycle taxi service in Vietnam–Its socioeconomic impacts and policy considerations. *J. East. Asia Soc. Transport. Stud.* 10, 13–28. doi: 10.11175/easts.10.13

Tumusiime, B. (2021). *Daily Newspaper.* Available online at: https://www.monitor.co.ug/uganda/news/national/boda-boda-criminals-caught-on-cctv-but-get-away-scot-free-3407550 (accessed September 27, 2021).

Tunnicliff, D. J., Watson, B. C., White, K. M., Hyde, M. K., Schonfeld, C. C., and Wishart, D. E. (2012). Understanding the factors influencing safe and unsafe motorcycle rider intentions. *Accid. Anal. Prevent.* 49, 133–141. doi: 10.1016/j.aap.2011.03.012

Uganda Police Force (2020). Uganda Police Annual Crime Report (s). Available online at: https://www.upf.go.ug/publications/ (accessed January 13, 2020).

Uganda Radio Network (2021a). *The Observer Newspaper.* Available online at: https://observer.ug/news/headlines/70794-riders-accuse-police-of-working-with-boda-boda-criminals (accessed September 27, 2021).

Uganda Radio Network (2021b). *The Independent Newspaper.* Available online at: https://www.independent.co.ug/boda-boda-riders-accuse-wandegeya-police-officers-of-extortion/ (accessed September 27, 2021).

Ukwayi, J. K., Ogaboh, A. M., and Michael, C. E. (2013). Public perception of the involvement of commercial motorcyclists in crime in South-South Nigeria. *Int. J. Hum. Soc. Sci. Invent.* 2, 21–31. Available online at: https://www.researchgate.net/publication/330702776_Public_Perception_of_the_Involvement_of_Commercial_Motorcyclists_in_Crime_in_South-South_Nigeria

Underwood, G. (2007). Visual attention and the transition from novice to advanced driver. *Ergonomics* 50, 1235–1249. doi: 10.1080/00140130701318707

UNECE (2018). *Road Safety Performance Review Uganda.* Available online at: https://www.unece.org/trans/resources/publications/transwp1publications/2018/road-safety-performance-review-uganda.html (accessed January 24, 2020).

Vivo Energy (2017a). *Vivo Energy Takes Tweddeko to Masaka Road.* Available online at: https://www.vivoenergy.com/fr-FR/Actualit%C3%A9s/entryid/7240/VIVO-ENERGY-TAKES-TWEDDEKO-TO-MASAKA-ROAD (accessed January 20, 2020).

Vivo Energy (2017b). *Vivo Energy Uganda and NTV launch Twedekok Road Safety Campaign.* Available online at: https://www.vivoenergy.com/News/tabid/1368/entryid/7111/Vivo-Energy-Uganda-and-Ntv-launch-Twedeko-Road-Safety-Campaign.aspx (accessed September 29, 2021).

Wankie, C., Al-Delaimy, W., Stockman, J., Alcaraz, J., Shaffer, R., and Hill, L. (2021). Prevalence of crashes and associated factors among commercial motorcycle riders in Bamenda, Cameroon. *J. Transport Health* 20:100993. doi: 10.1016/j.jth.2020.100993

World Bank Group (2015). *Promoting Green Urban Development in African Cities –Kampala, Uganda.* Available online at: https://documents1.worldbank.org/curated/en/172411468190763021/pdf/100090-REVISED-P148662-Report-Kampala-UEP-Final-September-2015.pdf (accessed September 26, 2020).

World Health Organization (2018). *Global Status Report on Road Safety 2018.* WHO. Available online at: https://www.who.int/publications/i/item/9789241565684 (accessed June 12, 2019).

Yoh, K., Okamoto, T., Inoi, H., and Doi, K. (2017). Comparative study on foreign drivers' characteristics using traffic violations and accident statistics in Japan. *IATSS Res.* 41, 94–105. doi: 10.1016/j.iatssr.2017.06.004

Yoh, K., Uchiyama, C., and Doi, K. (2019). A video based approach to promote safe driving among foreign visitors to Japan. *IATSS Res.* 43, 139–147. doi: 10.1016/j.iatssr.2018.11.004