



# Motorcycles entering from access points and merging with traffic on primary roads in Malaysia: Behavioral and road environment influence on the occurrence of traffic conflicts



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## ABSTRACT

This paper uses data from an observational study, conducted at access points in straight sections of primary roads in Malaysia in 2012, to investigate the effects of motorcyclists' behavior and road environment attributes on the occurrence of serious traffic conflicts involving motorcyclists entering primary roads via access points. In order to handle the unobserved heterogeneity in the small sample data size, this study applies mixed effects logistic regression with multilevel bootstrapping. Two statistically significant models (Model 2 and Model 3) are produced, with 2 levels of random effect parameters, i.e. motorcyclists' attributes and behavior at Level 1, and road environment attributes at Level 2. Among all the road environment attributes tested, the traffic volume and the speed limit are found to be statistically significant, only contributing to 26–29% of the variations affecting the traffic conflict outcome. The implication is that 71–74% of the unmeasured or undescribed attributes and behavior of motorcyclists still have an importance in predicting the outcome: a serious traffic conflict. As for the fixed effect parameters, both models show that the risk of motorcyclists being involved in a serious traffic conflict is 2–4 times more likely if they accept a shorter gap to a single approaching vehicle (time lag <4 s) and in between two vehicles (time gap <4 s) when entering the primary road from the access point. A road environment factor, such as a narrow lane (seen in Model 2), and a behavioral factor, such as stopping at the stop line (seen in Model 3), also influence the occurrence of a serious traffic conflict compared to those entering into a wider lane road and without stopping at the stop line, respectively. A discussion of the possible reasons for this seemingly strange result, including a recommendation for further research, concludes the paper.

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## 1. Introduction

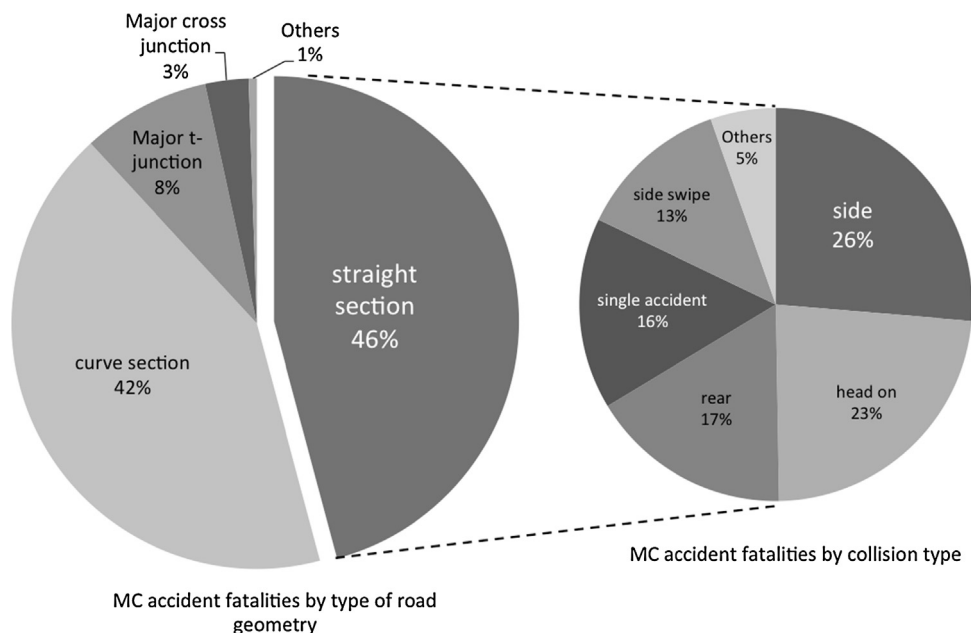
Malaysia has the highest road fatality per 100,000 population among the South East Asian countries, with the majority of road accident fatalities involving motorcyclists (Abdul Manan et al., 2013) and constituting more than 50% of the total number of fatalities in Malaysia, of which more than 60% have occurred on primary roads (Radin Umar, 1994; Abdul Manan and Várhelyi, 2012). Motorcycle accident fatalities on Malaysian primary roads are also overrepresented due to the fact that motorcycles only constitute 20–25% of the total traffic composition on these roads (Abdul Manan et al., 2013). Moreover, motorcycle accident fatalities per kilometer on Malaysian primary roads are statistically significantly

affected by the number of access points per kilometer and the average daily motorcycle traffic (Abdul Manan et al., 2013). An access point in this study is defined as a three-legged priority control junction that serves to connect an access road to a main road, e.g. a primary road.

The most typical automobile-motorcycle fatal crash in developed countries, e.g. Western countries, is one in which an automobile violates the motorcycle's right of way (ROW) (Pai, 2011). Developing Asian countries, such as Malaysia, may also have a similar problem. Previous local research has found that the majority of motorcycle fatal accidents occurred when motorcyclists had the right-of-way, particularly while they were traveling straight ahead on primary roads (Radin Umar, 1999). Abdul Manan et al. (2013), have found that the majority of Malaysian motorcycle fatalities have occurred along straight road sections, which are mostly two-lane undivided roads with several small junctions or access points connecting to villages, plantations and industrial areas. Of

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**Fig. 1.** Percentage of motorcycle accident fatalities on two lane undivided primary roads from 2008 to 2010 based on road geometry and collision type (ADSA, 2011; Abdul Manan and Várhelyi, 2012).

the total motorcycle accident fatalities from 2008 to 2010, 46% occurred along straight sections of this type of road (see Fig. 1). Out of the 46%, 26% were involved in a fatal side collision, which was the highest among all types of collision (see Fig. 1). The police records do not specify the details of these types of fatal crashes. The most probable explanation for these fatal side collisions on straight road sections is that the motorcyclists' right of way was infringed by motorists (or vice versa) entering the primary road from an access point. Abdul Manan et al. (2013) have estimated that motorcycle fatalities per kilometer on primary roads are statistically significantly correlated with the number of access points per kilometer.

Notwithstanding our knowledge about the most likely motorcycle accident fatality locations, and our ability to predict motorcycle accident fatalities by applying known risk factor variables (Abdul Manan et al., 2013), we still lack an understanding of the contributing factors to accidents at access points on primary roads in Malaysia. Gathering data on the actual traffic situation is a prerequisite for understanding the motorcycle accidents at access points. It is also of interest to study motorcyclists' behavior at access points, e.g. stopping behavior, manner of entering the flow of the primary road and interaction with vehicles on the primary road. Earlier research has pointed out that one of the main contributing factors to accidents resulting from infringement of motorcyclists' right-of-way is the failure of motorists to stop or yield when entering the primary road from the access point (Preusser et al., 1995; Pai et al., 2009).

Abdul Manan and Várhelyi (2014) carried out an observational study at access points on straight sections of primary roads in Malaysia in 2012, in order to gain more insight into the actual road traffic situation and the course of events at these sites. The study recorded all motorists' involvement (at the access points) in serious traffic conflicts, as well as their behavior, such as 'use of turning indicator' and 'headlight usage', 'stopping behavior', 'manner of entering' etc. (Abdul Manan and Várhelyi, 2014). The findings revealed that out of the 800 observed motorists entering the primary road from the access point, 537 interactions were recorded between motorists from the access point and motorist passing on the primary road, which resulted in 56 serious traffic

conflicts (Abdul Manan and Várhelyi, 2014). Out of the total serious conflict, 64.3% of them were between a motorcycle from the access point and a motorist on the primary road (Abdul Manan and Várhelyi, 2014). Thus, the present study intends to further analyze the collected variables from that study in order to investigate the behavioral (motorcyclists entering from the access point) and road environment influence on the occurrence of traffic conflicts involving motorcycles entering from access points and merging with traffic on primary roads in Malaysia.

## 2. Method

This section describes the data and methods used in this study. The first two sub-sections summarize the data from the study by Abdul Manan and Várhelyi (2014). The final sub-section presents the analysis method, i.e. mixed logistic regression.

### 2.1. Site selection

Abdul Manan and Várhelyi (2014) selected 8 sites (i.e. a straight road section with access points) based on several stringent criteria. The sites were located in the Arau, Kodiang, Kuala Selangor, Banting, Morib and Meru districts (see Table 1). The selected study sites were as follows:

1. The selected access point was situated along a straight section of a primary road that had a 20–30% motorcycle volume of the ADT, i.e. the average share of motorcycles in the modal split of Malaysian traffic. The selected primary road had a two-lane single carriageway configuration, with lane width between 2.5 m and 3.50 m, i.e., the standard lane width for Malaysian primary roads.
2. The selected access point was "typical", i.e. a simple design of the access point with no provision of auxiliary lanes and channelizing islands. It also had at least a stop line indicating that the road user must stop before entering from the access point – which is the typical regulation of an access point.

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