Tile of thesis: Estimating the Real World Effectiveness of Antilock Braking Systems in Improving Safety for Motorised Two Wheelers

Presenter: Mr. ABHAYA JHA , PhD scholar, UQ–IITD Joint PhD Program

ABSTRACT

Road traffic injuries have been one of the top ten causes of death globally. Among the victims of these road traffic crashes are pedestrians, cyclists, and motorised two-wheeler (MTW) users, which make up the most vulnerable road users (VRU). Unlike a car or other motorised transport modes, the VRU, obviously, by design, lacks a metal shield in the form of the vehicle body and is exposed directly to other vehicles and environmental safety hazards. Over the past few decades, much work has been done in the form of road and vehicle design, along with legislative and policy interventions to reduce pedestrian and cyclist deaths in road crashes. Among motorised modes, there have also been advances in safety technologies such as seatbelts, airbags, and even advanced driver assist systems that have greatly reduced the number of road-user deaths.

MTWs, on the other hand, have not seen major improvements in vehicle safety systems, and many of them are still in the laboratory testing phases. The main reason for that gap is the complexity of the vehicle dynamics of an MTW compared to other motorised modes. Another reason is probably that many developed nations where such technology development occurs have a very small number of MTWs. In developing countries, MTWs are the main mode of transport, and surprisingly, these countries account for 84% of the fatalities from MTWs around the world.

The antilock braking system (ABS) is one of the few vehicle safety devices that have been successfully implemented for MTW applications. By changing the braking function from a step to a high-frequency pulse function, ABS reduces the braking distance and improves vehicle lateral stability, reducing fatal crashes by up to 40% in laboratory conditions and in simulation studies. Very few studies have studied how ABS impacts the safety of MTW riders in real-world scenarios. This thesis aims to bridge this gap by studying the effectiveness of ABS in reducing MTW fatalities.

In this thesis, the effectiveness of ABS in the real world has been tested through policylevel interventions (in both developed and developing countries) to reduce crash rates and injuries to riders at the vehicle level.

The first part of the thesis examined the effectiveness of the mass adoption of ABS in MTW applications in urban Australia and Delhi (India). Both countries passed legislation that allows the adoption of ABS, which is very close to each other. This provided a unique opportunity to examine the impact of this intervention and compare its impact in

two different contexts of socioeconomic conditions and the composition of the traffic fleet. An interrupted time series model was used to estimate the effectiveness of these interventions, and the results showed diametrically opposite results at the two study locations. In the Indian context, a reduction of 11% was observed in Delhi, while during the same period of time, Australia saw an increase of 19% in fatal MTW crashes. Due to unforeseen circumstances caused by the COVID-19 pandemic that significantly affected mobility patterns during the study period, an innovative approach was taken to estimate the exposure variable and the crash rate variable to compensate for it.

The second part of the thesis looked at the effectiveness of ABS in reducing injuries during a crash scenario for an MTW. A Simulink model was created to model the ABS system for the Hero Splendour Plus motorcycle that showed an improvement of around 12% in reducing vehicle speed during the pre-crash braking event. A front-end crash simulation was performed according to the parameters illustrated in ISO 13232 for the vehicle postbraking event in Madymo crash simulation software. The crash simulation results showed a very small reduction in the number of crash injuries from the rider using the ABS.

These studies pointed to the fact that ABS has shown a significant reduction in preventing fatal crashes in environments where MTWs are the dominant transport mode. However, in the context of countries such as Australia, where MTWs have a small modal share in their fleet, the introduction of ABS increases crashes in the short term. However, introducing ABS in a more four-wheeler-dominated transport context may have a long-term benefit, which requires further studies. ABS is a crash prevention device that reduces the probability of a serious crash. It has very little impact on when a serious crash occurs. Additionally, since the device requires active rider intervention, this limits the types of crash configurations to front-end and side-swipe where there are going to be any possible benefits of the system.