UNIVERSITI PUTRA MALAYSIA

MOTORCYCLE CRASH PATTERNS ALONG EXCLUSIVE MOTORCYCLE LANES IN MALAYSIA

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By

TUNG SOW HOONG

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirement for the Degree of Master of Science

June 2007

This work is specially dedicated to

My beloved family, friends and teachers…

Abstract of thesis presented to the Senate of Universiti Putra of Malaysia in fulfilment of the requirement for the degree of Master Science

MOTORCYCLE CRASH PATTERNS ALONG EXCLUSIVE MOTORCYCLE LANES IN MALAYSIA

By

TUNG SOW HOONG

June 2007

Chairman: **Associate Professor Wong Shaw Voon, PhD**

Faculty: **Engineering**

Motorcycle crashes are being notified as the main contributor to road fatality in our country. Motorcyclists, as the vulnerable road user, are not protected while traveling along the traffic. The exclusive motorcycle lanes have been introduced to tackle the problem by segregating the motorcycle from the main traffic. However, motorcycle accident are still occurring on the exclusive motorcycle lanes. In this study, motorcycle crashes occurred along the exclusive motorcycle lanes in Malaysia was investigated. This study has been focusing on crashes which are roadside object related. The motorcyclists are exposed to roadside hazards while travelling along the pathways. The study has been focused to determine possible risk factors causing fatalities in motorcycle crashes along exclusive motorcycle lanes, to identify the harmful roadside objects to motorcyclist along exclusive motorcycle lanes and to determine the multivariate relationships between the injury severity and other factors of motorcycle crashes along the exclusive motorcycle lanes. The study unveiled that the fatality risk factors for overall motorcycle crashes along exclusive motorcycle lanes in Malaysia are the road geometry of the crash location, the brightness

condition during the crash and finally, the roadside object involvement in the crashes. Fatality risk is found to be higher while colliding with roadside objects, at straight section on the lanes, and crashing during night-time. Furthermore, roadside object is approximately 2.0 times more likely to cause fatality in motorcycle crashes along the exclusive motorcycle lanes. Guardrail has recorded as the most being struck object which represented 20.6% of all roadside object related crashes and 23.5% of all fatal cases were guardrail related. However, narrow surface objects, (e.g. tree trunks, traffic sign posts, streetlighting poles) were determined 2.3 times more likely to cause severe injury compared to non-narrow surface objects (e.g. guardrails, tunnel walls). Therefore, guardrail should be provided to protect the motorcyclist from colliding narrow surface object as initial impact. The study further established that guardrail as one of the factors to cause fatality. Thus, a new guardrail design should be introduced to the exclusive motorcycle lane. Lateral offsets of the collided objects were found to be correlated to injury severity ($p < 0.10$). From the overall roadside object related motorcycle crashes, 85% involved object planted at an offset distance 155 cm or less from the roadside. Furthermore, multivariate analysis has verified that a higher injury severity if motorcycle crashes involved narrow surface object occurred at location where the lane width is more than 300 cm and the narrow object is planted at the offset distance 151.3 cm or less from roadside. Another multivariate analysis performed on wide surface object crashes has shown that higher injury severity to motorcyclist if crashes involved guardrail, crashes during night-time, involved wide surface object that planted at offset distance 75 cm or less from roadside and it is a single motorcycle crash.

Therefore, the existing design criteria of roadside object needed to be reviewed and improved in order to achieve a safer exclusive motorcycle lane in Malaysia.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

BENTUK PELANGGARAN KEMALANGAN MOTOSIKAL YANG BERLAKU DI SEPANJANG LORONG MOTOSIKAL DI MALAYSIA

Oleh

TUNG SOW HOONG

Jun 2007

Pengerusi: **Profesor Madya Wong Shaw Voon, PhD**

Fakulti: **Kejuruteraan**

Di dalam negara kita, kemalangan motosikal memang terkenal sebagai penyumbang utama dalam kadar kematian di atas jalanraya. Penunggang motosikal memang mudah dilukai kerana seolah-olah tidak dilindungi apa-apa pun semasa berada di atas jalanraya. Kaedah penggunaan lorong motosikal telah diperkenalkan untuk menangani masalah ini dengan mengasingkan para penunggang motosikal daripada laluan trafik utama. Walaupun begitu, kemalangan motosikal masih berlaku di atas lorong motosikal. Di dalam kajian ini, kemalangan motosikal yang berlaku di atas lorong motosikal di Malaysia telah disiasat. Kajian ini memberi perhatian ke atas kemalangan-kemalangan motosikal yang melibatkan objek di tepi jalan. Penunggang-penunggang motosikal adalah terdedah kepada bahaya atau risiko pelanggaran dengan objek di tepi jalan semasa bergerak di sepanjang lorong motosikal. Kajian ini dijalankan untuk mengenalpasti faktor-faktor kematian kemalangan motosikal yang berlaku di atas lorong motosikal, mengenalpasti objek-objek tepi jalan yang memudaratkan para penunggang di atas lorong motosikal dan menentukan hubungan multi-variasi di antara tahap kecederaan dengan faktor-faktor

yang terlibat dalam kemalangan motosikal yang berlaku di atas lorong motosikal. Secara keseluruhan, kajian ini telah membuktikan bahawa risko kematian penunggang motosikal adalah bergantung kepada faktor-faktor seperti bentuk geometri jalan di mana kemalangan berlaku, keadaan cahaya semasa kemalangan dan penglibatan objek tepi jalan. Kecenderungan berlakunya kematian adalah bagi kemalangan motosikal melibatkan objek tepi jalan, di kawasan lurus sepanjang lorong motosikal dan dalam keadaan gelap. Kemalangan yang melibatkan objek di tepi jalan adalah 2.0 kali lebih cenderung menyebabkan kematian jika dibandingkan dengan kemalangan motosikal yang tidak melibatkan objek di tepi jalan. Oleh itu, satu panduan rekabentuk perkakas tepi jalan yang lebih selamat adalah diperlukan bagi menjamin keselamatan penggunaan lorong motosikal di Malaysia. Kajian ini mendapati bahawa, penghadang jalan merupakan objek yang mencatatkan jumlah kemalangan tertinggi (20.6%). Sementara itu, 23.5% daripada jumlah kemalangan maut merupakan kemalangan yang menglibatkan penghadang jalan. Walaupun begitu, objek-objek berpermukaan sempit (cth. pohon pokok, tiang besi isyarat jalan, tiang lampu jalan) didapati 2.3 kali lebih cenderung menyebabkan kecederaan parah (termasuk kematian) jika dibandingkan dengan jenis objek-objek berpermukaan luas (cth. penghadang jalan, dinding terowong). Oleh itu, penghadang jalan adalah sesuai disediakan untuk melindungi penunggang motosikal daripada melanggar objek-objek berpermukaan sempit yang berada di sepanjang tepi lorong motosikal. Walaupun begitu, penghadang jalan masih merupakan salah satu faktor utama menyebabkan kematian penunggang motosikal. Oleh itu, rekabentuk baru khas penghadang jalan adalah penting diperkenalkan ke dalam rekabentuk lorong motosikal di Malaysia. Ofset sisi bagi objek-objek yang dilanggar didapati

berkorelasi dengan tahap kecederaan ($p < 0.10$). Secara keseluruhan daripada kemalangan-kemalangan motosikal yang melibatkan objek tepi jalan, 85% daripada jumlah kes didapati melibatkan objek-objek yang diletakkan pada ofset 155 cm atau kurang dari tepi jalan. Analisa multivariasi menunjukkan bahawa kemalangan-kemalangan motosikal yang melibatkan objek-objek berpermukaan sempit adalah cenderung melibatkan kecederaan parah apabila berlaku di lokasi jalan yang berkelebaran 300 cm atau lebih dan objek-objek tersebut diletakkan pada ofset sejauh 152 cm daripada tepi lorong. Satu lagi analisa multivariasi telah menunjukkan tahap kecederaan adalah lebih tinggi bagi kemalangan-kemalangan motosikal yang melibatkan objek-objek berpermukaan luas dan melibatkan penghadang jalan, dalam keadaan kurang bercahaya, kemalangan motosikal tunggal dan objek-objek yang dilanggar diletakkan pada jarak ofset 75 cm atau kurang dari tepi lorong. Oleh itu, reka bentuk perkakas tepi jalan bagi lorong motosikal sekarang perlulah diimbas kembali dan diperbaharui bagi menjamin keselamatan lorong motosikal di Malaysia.

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I certify that an Examination Committee met on **14th June 2007** to conduct the final examination of Tung Sow Hoong on his Master of Science thesis entitled "Motorcycle Crash Patterns Along Exclusive Motorcycle Lanes in Malaysia" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree.

Members of the Examination Committee are as follows:

Shahnor Basri, PhD
Professor
Faculty of Engineering
Universiti Putra Malaysia
(Chairman)

Hussain Hamid, PhD
Lecturer
Faculty of Engineering
Universiti Putra Malaysia
(Internal Examiner)

Mohd. Sapuan Salit, PhD
Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Internal Examiner)

Ahmad Kamal Ariffin Mohd. Ihsan, PhD
Associate Professor
Faculty of Engineering
Universiti Kebangsaan Malaysia
(External Examiner)

HASANAH MOHD. GHAZALI, PhD
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date : 27 September 2007

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

Wong Shaw Voon, PhD
Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Chairman)

Radin Umar Radin Sohadi, PhD
Professor
Faculty of Engineering
Universiti Putra Malaysia
(Member)

Law Teik Hua, M.Sc
Lecturer
Faculty of Engineering
Universiti Putra Malaysia
(Member)

Abdul Ali Raja Mohamad
Lecturer
Trauma and Emergency
University Malaya Medical Centre
Universiti Malaya
(Member)

AINI IDERIS, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date : 15 November 2007

DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

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TUNG SOW HOONG

Date : 20 August 2007

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Motorcycles have been the most registered type of vehicle in Malaysia for the past 10 years. There are 5,842,617 registered motorcycles, which represents 48.5% of all registered vehicles in Malaysia in year 2002. This shows that the motorcycle is a very popular mode of transportation in Malaysia. Its popularity may be due to the affordable prices of the motorcycle. The popularity also resulted in the highest fatality rate among all modes of transport. From 1997 to 2002, motorcyclists had the highest fatality rate (per 10,000 vehicle) as shown in Figure 1.1 (PDRM, 2003). The high rate of motorcyclist fatalities seems to be a major concern in our country.

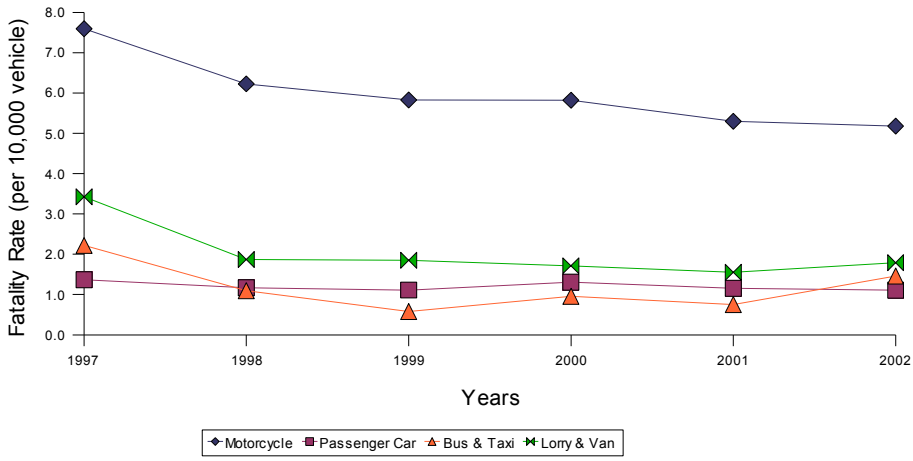

Figure 1.1: The fatality rate per 10,000 registered vehicle in Malaysia from 1997 to 2002 (Source: Royal Malaysia Police (PDRM), 2003)

Many measures have been carried out to reduce the number of fatalities every year. One of the most effective measures is the introduction of the exclusive motorcycle lane for motorcyclists. The exclusive motorcycle lane segregates the motorcycle traffic from the main traffic stream. The segregation reduces the high number of motorcycle crashes with other vehicles. A short-term reduction of 39% of motorcycle crashes was found after the introduction of the exclusive motorcycle lane along Federal Highway F0002 in Malaysia (Radin et. al, 1995). However, there are still motorcycle crashes occurring along exclusive motorcycle lanes. Fatality is due to multiple motorcycle crashes, single motorcycle crashes and even due to motorcycles colliding into objects at the roadside. Clear zones are a feature of modern highways that have great impact on roadside safety (M. H. Ray, 1998). Thus, allocating proper clear zones along the exclusive motorcycle lanes can reduce the collisions of the motorcycles with roadside objects planted along the exclusive motorcycle lane.

The existing exclusive motorcycle lanes in the country were designed according to a design guide, Arahan Teknik (Jalan) 10/86: A Guide to the Design of Cycle Track. However, some of the design parameters in the existing design guide are combinations of highway and cycle track design. These might not be suitable because of high volume of motorcycle traffic in our country. Unfortunately, the guide does not include any design for clear zones. Therefore, a better design guide is needed to produce safer exclusive motorcycle lanes for present and future usage of the motorcyclist.