MYANMAR'S TRAFFIC ACCIDENT COSTING MODEL

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A Thesis Submitted in Partial Fulfillment of the Requirements for the

Degree of Doctor of Philosophy in Transportation Engineering

Suranaree University of Technology

Academic Year 2017

แบบจำลองมูลค่าความเสียหายจากอุบัติเหตุจราจรสำหรับประเทศเมียนมาร์

นางสาวอิอิ มอน

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิศวกรรมศาสตรดุษฎีบัณฑิต
สาขาวิชาวิศวกรรมขนส่ง
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อิอิ มอน : แบบจำลองมูลค่าความเสียหายจากอุบัติเหตุจราจรสำหรับประเทศเมียนมาร์ (MYANMAR'S TRAFFIC ACCIDENT COSTING MODEL) อาจารย์ที่ปรึกษา : รองศาสตราจารย์ ดร.วัฒนวงศ์ รัตนวราห, 153 หน้า.

สาธารณรัฐแห่งสหภาพเมียนมาร์กำลังประสบปัญหาการใช้รถใช้ถนนจากสภาพถนนที่ไม่มีความปลอดภัย และการจัดการความปลอดภัยทางถนนที่ไม่ดีพอทำให้มีจำนวนอุบัติเหตุทางถนนเพิ่มขึ้น ส่งผลให้เกิดความสูญเสียทั้งทางด้านเศรษฐกิจและสังคมทั้งในระดับครัวเรือนและระดับชาติ การศึกษาครั้งนี้มีวัตถุประสงค์เพื่อทำการประมาณมูลค่าความเสียหายที่เกิดขึ้นจากอุบัติเหตุจราจร สำหรับผู้เสียชีวิตและผู้ที่บาดเจ็บสาหัสในปี พ.ศ.2558 และทำการวิเคราะห์ความสัมพันธ์ระหว่างคุณลักษณะของผู้ใช้รถใช้ถนนที่มีอิทธิพลต่อความเต็มใจที่จะจ่ายเงิน (Willingness to pay : WTP) เพื่อใช้กำหนดนโยบายสำหรับการลดความเสี่ยงที่จะเกิดอุบัติเหตุ

วิธีการประเมินค่าโดยการสัมภาษณ์ประชาชนโดยตรง ด้วยการให้ระบุความเต็มใจที่จะจ่ายบนการ์ด (payment card) ถูกนำมาใช้สำหรับการศึกษานี้ โดยแบ่งกลุ่มผู้ใช้รถใช้ถนนเป็น 3 กลุ่ม คือผู้ใช้รถยนต์ส่วนบุคคล ผู้ใช้รถจักรยานยนต์ และผู้โดยสารรถประจำทาง ความเต็มใจที่จะจ่ายในการศึกษานี้พิจารณาจากการลดความเสี่ยงต่อการเกิดอุบัติเหตุลงได้ร้อยละ 50 วิธีการวิเคราะห์ข้อมูลเพื่อค้นหาปัจจัยที่ส่งผลต่อความเต็มใจที่จะจ่ายเงินประกอบไปด้วย การวิเคราะห์สมการถดถอยพหุคูณ (Multiple regression analysis) โมเดลสมการโครงสร้าง (Structural equation modeling) และสมการถดถอยโลจิสติกส์หลายตัวแปร (Multi-nominal logistic regression)

มูลค่าความเสียหายที่เกิดจากการเสียชีวิตที่ประมาณค่าได้อยู่ระหว่าง 594.681 พันล้านจ๊าต (495.567 ล้านเหรียญสหรัฐ) ถึง ระหว่าง 820.296 พันล้านจ๊าต (683.580 ล้านเหรียญสหรัฐ) และมูลค่าความเสียหายที่เกิดขึ้นจากการบาดเจ็บสาหัสประมาณค่าได้อยู่ระหว่าง 542.113 พันล้านจ๊าต (451.761 ล้านเหรียญสหรัฐ) ถึง ระหว่าง 624.264 พันล้านจ๊าต (520.220 ล้านเหรียญสหรัฐ) ในปี พ.ศ.2558 ดังนั้น มูลค่ารวมที่เกิดขึ้นทั้งผู้เสียชีวิตและผู้บาดเจ็บสาหัสจากอุบัติเหตุจราจรมีค่าประมาณร้อยละ 1.5 ถึง 2.0 ของมูลค่าผลิตภัณฑ์มวลรวมประชาชาติ (GDP)

นอกจากนั้นยังพบว่าปัจจัยที่มีอิทธิพลต่อความเต็มใจที่จะจ่ายเงินอย่างมีนัยสำคัญทางสถิติประกอบด้วย อายุ สถานะทางครอบครัว ระดับการศึกษา อาชีพ รายได้ จำนวนสมาชิกในครัวเรือน การครอบครองยานพาหนะ ยานพาหนะหลักที่ใช้ประจำ สภาพการจราจร พฤติกรรมการดื่มแอลกอฮอล์แล้วขับขี่ ประสบการณ์การเกิดอุบัติเหตุ และการรับรู้ความเสี่ยงของอุบัติเหตุจราจร ผลจากการศึกษานี้สามารถนำไปใช้ในการประเมินความเหมาะสมในการลงทุนของโครงการ และการจัดลำดับความสำคัญของโครงการที่เกี่ยวข้องกับการจัดการความปลอดภัยทางถนน เพื่อให้เกิด

ประโยชน์สูงสุดในการเลือกโครงการที่มีประสิทธิภาพมากที่สุด ทั้งยังจะช่วยในการตัดสินใจเกี่ยวกับการจัดสรรงบประมาณด้านความปลอดภัยและด้านนโยบายได้

สาขาวิชาวิศวกรรมขนส่ง ลายมือชื่อนักศึกษา__________

ปีการศึกษา 2560 ลายมือชื่ออาจารย์ที่ปรึกษา__________

EI EI MON : MYANMAR'S TRAFFIC ACCIDENT COSTING MODEL. THESIS ADVISOR : ASSOC. PROF. VATANAVONGS RATANAVARAHA, Ph.D., 153 PP.

ACCIDENT COSTS/ROAD SAFETY/WILLINGNESS TO PAY

Myanmar is experiencing a rapid motorization with poor road condition and lack of road safety furniture resulting an alarming increase in road traffic accident, negative impact on social-economic and health problem for victim family as well as a nation. This study aims to estimate the subjective value of road traffic accident costs for fatality and serious injury for the year 2015 and to examine the inter-relationships of road users' characteristics and their effects on willingness to pay (WTP) for traffic accident risk reduction. Contingent valuation with payment card format was used to elicit road users' (car drivers, motorcyclists and bus passengers) WTP for 50 percent traffic accident risk reduction. Multiple regression analyses, Structural equation modeling and Multi-nominal logistic regression were used to observe the factors influencing WTP.

The cost of death was estimated to range from MMK 594.681 billion (US$ 495.567 million) to MMK 820.296 billion (US$ 683.580 million) and that of serious injury was estimated to range from MMK 542.113 billion (US$ 451.761 million) to MMK 624.264 billion (US$ 520.220 million) in 2015. Therefore, the total cost of death and serious injury due to road accident was approximately 1.5 to 2 percent of GDP in 2015. In addition, the WTP was found to be significantly associated with age, family status, education, occupation, income, household member, the vehicle ownership, main vehicle used, exposure to traffic, drunk driving, accident

experiences, and the perceived risk of traffic accidents. This study will be helpful in prioritization of road safety related projects to get greatest benefit by choosing most cost effective projects. This study will assist the decision-making for road safety budget allocations and policy development.

School of Transportation Engineering Student's Signature ______________

Academic Year 2017 Advisor's Signature ______________

ACKNOWLEDGEMENT

Firstly I would like to give great thanks to the Suranaree University of Technology for giving me an ASEAN-Ph.D scholarship. I want to express my sincere gratitude to Associate Professor Dr.Vatanavongs Ratanavaraha for his assistance, advice and guidance during the research and writing thesis.

My deep and sincere appreciation to Dr. Buratin Khampirat, Assistant Professor of General Education, Institute of Social Technology, Suranaree University of Technology and Dr. Sajjakaj Jomnonkwao for their patience, guidance and technical support which were invaluable at every step of this work. I would also like to thank Associate Professor Wichuda Satiennam and Associate Professor Thaned Satiennam for serving on my committee and giving me the comments and advice to improve my thesis.

Moreover, I would like to express my gratitude to every Professor giving me a knowledge in my coursework to finish my research successfully. Special thanks to Ms. Wanpen Suebsai, Secretary of Transportation Engineering who help me administrative works for providing me relevant information for this study and her collaboration in contacting persons for necessary information.

Lastly I would like to express my appreciation to my friends and family for their support in data collection and providing information for this study.

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SYMBOLS AND ABBREVIATIONS

β	=	Structural coefficient
df	=	Degree of freedom
p	=	Probability value
$\Delta\rho$	=	Risk change
χ^2	=	Chi-square
CFA	=	Confirmatory factor analysis
CFI	=	Comparative fit index
CM	=	Choice modeling
CV	=	Contingent valuation
GDP	=	Gross domestic product
GNI	=	Gross national income
HC	=	Human capital
ML	=	Maximum Likelihood
MMK	=	Myanmar kyat
MNL	=	Multi-nominal logistic regression

SYMBOLS AND ABBREVIATIONS (Continued)

RP	=	Reveal preference
RMSEA	=	Root mean square of approximation
SC	=	Stated choice
SEM	=	Structural equation modeling
SP	=	Stated preference
SRMR	=	Standardized root mean residual
TLI	=	Tucker Lewis Index
VSI	=	Value of statistical injury
VSL	=	Value of statistical life
WTP	=	Willingness to pay

CHAPER I

INTRODUCTION

1.1 Rationale of the research

Road traffic accidents are untended, preventable and the most causes of injury-related deaths around the world. According to the World Health Organization (2015) report, more than 3,500 people are killed daily on the road. Although the number of registered vehicles in low- and middle-income countries is only 54% of the world's registered vehicles, over 90% of the world's road traffic deaths occur in these countries. Road traffic deaths in high-income countries are therefore half to that of low-income countries, which has been attributed to the successful implementation of road safety improvement programs (World Health Organization, 2015).

As most traffic accident victims are mainly in the productive age, reducing road traffic crashes affects medium and long term economic growth prospect. Therefore, investments in road safety are also an investment in human capital as there is a linkage between traffic injuries and economic growth. Moreover, curbing road traffic injuries is not only a victory for the transport sector but also a benefit for public health, wellbeing, and economic growth (World Bank, 2018).

In Myanmar, similar to other low-income, developing countries, road accident is one of the major causes of death. The number of vehicles on the roads increased dramatically after the relaxation of regulations regarding automobile imports in 2011. With this increase, there has been a commensurate rise in road accidents over the past five years. The 2015 statistics from the Road Transport Administration Department

(RTAD) under the ministry of transport and communications in Myanmar state that the number of registered vehicles reached 5,541,361, i.e., more than double the registrations in 2011 (Central Statistical Organization, 2016). Consequently, traffic accidents resulting in deaths and injuries have significantly increased, as shown in Figure 4.1. In 2003, there were 5,369 traffic accidents, which increased to 15,677 by 2015, thrice as that in 2003. In addition, the number of fatalities and injuries was over three times higher, rising from 1,172 and 8,082 in 2003 to 5,037 and 25,612 in 2015 (Central Statistical Organization, 2016).

Road accidents have serious consequences which include deaths, injuries, disabilities, material damages, pain, grief and suffering (Komba, 2006; Partheeban Arunbabu, & Hemamalini, 2008; Haddak, Lefèvre, & Havet, 2016). Therefore, traffic accidents have considerable negative economic and social impacts on the accident victims, their family, friends, as well as on the nation as a whole (Gopalakrishnan, 2012; Niroomand and Jenkins, 2016). However, the importance of road safety is not well recognized in many developing countries including Myanmar. In 2003, one third of injured patients who were admitted to hospitals were victims of road crashes (Asian Development Bank, 2016). Public Health Statistic (2017) also reported that road injuries were the third leading cause of premature death in 2016. Furthermore, road crashes were the first leading cause of death among 15–29-year-olds, and the road traffic mortality rate per 100,000 people increased more than doubled from 2010 to 2016 (Public Health Statistic, 2017). Therefore, road safety has become a major concern in Myanmar, with experts from the Asian Development Bank estimating that fatalities could more than double over the next 5 to 10 years unless immediate action is taken.

This indicates an urgent need to act upon road safety improvement (Asian Development Bank, 2016).

Road transport is the main mode of transport for goods and passengers in Myanmar; carrying 90 % of goods and 86% of passengers. However, Only 20 percent of Myanmar roads are paved and the roads are narrower than those in Thailand. After decades of underinvestment, Myanmar's transport infrastructure lags behind that of other countries in the region. Because of insufficient maintenance, Myanmar roads are below international standard. Sixty percent of trunk highways is in poor condition and need urgent maintenance or rehabilitation while 20 million people are lack of road access (Asian Development Bank, 2016). Budget restrictions face by national government, limited expenditure is allowed in road infrastructure and lack of safety features in Myanmar roads.

As Myanmar is in the initial stage of road safety awareness, and many deficiencies exist that should be addressed for improvement, such as the poor crash data system, shortcomings in relevant legislation, and the need for more safety management funding (Asian Development Bank, 2016). Successful implementation for road safety measure need systematic procedure for taking account for road safety measures as well as highway investment by estimating the effects of different projects and design features on accident rates (eg. estimates of changes in fatal and injury accident rates that are likely to result from road widening, installation of traffic signals, pedestrian crossings, road lightning etc.). Road safety actions are difficult to justify without knowing the monetary benefits of road safety improvements (Bhattacharya, Alberini, & Cropper, 2007). To ensure an economically efficient use of scare resources need to evaluate safety-effects or to compare such effects as between different projects, explicit monetary costs of accidents and values of accident preventions are required (Hills and Jones-Lee, 1983). Therefore, as it is widely recognized that accident costs need to be estimated to perceive the scale of the existing problem, it is imperative to evaluate traffic accident costs for developing appropriate road safety policies (Jacobs, 1995; de Blaeij, Florax, Rietveld, & Verhoef, 2003; Silcock, 2003).

Compared with other developing countries, in Myanmar, there has been little road safety research focusing on the true costs of road accidents. This has been mainly because of the lack of reliable data to assist decision makers in taking relevant actions. Therefore, determining the true costs of traffic accidents in Myanmar is essential: (1) to determine the overall economic losses associated with road accidents; (2) to perceive the scale of the problem and the benefits derived from prevention of accidents; and, (3) to examine the determinants for the willingness to pay (WTP) in order to support key stakeholders develop better road safety policies.

1.2 Purpose of the research

This research has the following objectives;

1.2.1 To observe the variation of the WTP value among different road user groups.

1.2.2 To determine the value of statistical life (VSL), value of statistical injury (VSI) and traffic accident costs in Myanmar for the year 2015.

1.2.3 To examine the relationship among the socioeconomic characteristics, travel and driving behaviors, and accident experience and risk perception.

1.2.4 To study the factors influencing WTP.

1.3 Scope of the research

This research has the following scopes;

1.3.1 Questionnaire survey was conducted for three types of road users including car drivers, motorcyclists and bus passengers (vehicle occupants) from 7 main regions.

1.3.2 Contingent Valuation (CV), payment card questionnaire approach was used to elicit the willingness to pay (WTP) for road accident risk reduction.

1.3.3 50% risk reduction for fatal injury and serious injury was employed to estimate VSL and VSI.

1.3.4 Structural Equation modelling (SEM), multi-nominal logistic regression (MNL) and multiple regression analyses were used to analyze the factors influencing willingness to pay (WTP) for traffic accident risk reduction.

1.4 Research questions

1.4.1 Which individual characteristic explained most on the factors?

1.4.2 How do their characteristics relate each other such as socioeconomic index, travel and driving behaviors and, accident experience and risk perception?

1.4.3 Which factor significantly influence most on WTP?

1.4.4 Is there scope insensitivity result of WTP?

1.4.5 How do Myanmar road users’ VSL differ from other developed and developing countries’ VSL?

1.5 Contribution of the research

The expected benefits and the contributions of this research are as follows;

1.5.1 Provide the value of statistical life (VSL), the value of statistical injury (VSI) and the figure of road accidents cost, which (1) could help to increase levels of road safety investment, (2) can be used for the purpose of economic appraisal and cost benefit analysis of road safety related projects for Myanmar road authorities (3) to compare the costs of road traffic accident with the costs in other policy areas.

1.5.2 Provide factors influencing WTP which will be helpful for the decision-makers in priority setting to target road user groups in traffic safety policy making.

1.6 Organization of the research

This research is divided into 6 chapters as follows;

Chapter I: Introduction section includes the rationale and the importance of the research, purpose of the research, scope of the research, research questions and expected contribution of the research.

Chapter II: Myanmar motorbike riders' willingness to pay for fatality risk reduction.

Chapter III: Estimating the willingness to pay and the value of fatality risk reduction for car drivers in Myanmar.

Chapter IV: Willingness to pay for mortality risk reduction for traffic accidents in Myanmar.

Chapter V: Willingness to pay for traffic accident risk reduction for non-fatal injuries in Myanmar.

Chapter VI: Conclusion and recommendations. This section concludes the results from chapter II–chapter V and gives the recommendations for future research.

1.7 References

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CHAPTER II

MYANMAR MOTORBIKE RIDERS’ WILLINGNESS TO PAY FOR FATALITY RISK REDUCTION

2.1 Abstract

The rapid rise in the number of motorbikes in Myanmar over the last few years has resulted in a commensurate increase in road accidents, with nearly half of all road traffic deaths being motorbike riders. Therefore, there is an urgent need to improve road safety in general, with a specific focus on motorbike accidents. This study estimates the value of statistical life (VSL) for Myanmar motorcyclists and examines the influence of the individual rider characteristics on the willingness to pay (WTP) for fatality risk reduction. A contingent valuation payment card approach was used to determine the motorcyclist WTP for fatality risk reduction, after which structural equation modeling (SEM) was used to explore the factors affecting WTP. The resultant median and mean VSL were found to be MMK 145.833 million (US$ 121,528) and MMK 162.687 million (US$ 135,573), with gender (male) being found to negatively influence and government staff being found to positively influence good driving behaviors. Gender (male) was also found to have a positive direct effect on the WTP; however, the resultant total effect on the WTP was negative. Socioeconomic characteristics, good driving behavior, and risk perception factors were found to positively influence the WTP, with the good driving behavior factor being found to have the strongest effect. This study can be used to assist road transport authorities to

make decisions on budget allocations for road safety related projects and to develop road safety policies.

2.2 Introduction

Traffic accidents have been identified as the major cause of fatalities and disabilities in developing countries (World Health Organization, 2015). As the number of vehicle owners has risen over the last few years in Myanmar, there has been a significant increase in traffic accidents, which has become a major health issue and has had serious economic and social effects. As more people have moved from the bicycle to the motorbike, there has been a rapid increase in the number of motorbikes over the last fifteen years. A road traffic administration department (RTAD) statistics report stated that from 2001 to 2015, motorbike ownership increased from around 0.17 million to over 4.5 million, with motorbike ownership increasing from 38% to 84 % of all motor vehicles from 2001 to 2015 (Central Statistical Office, 2016). The RTAD reported that in 2015, the motorbike accounted for 84% of all vehicles, followed by passenger cars (8%) and light trucks (3%). Commensurately, therefore, 53% of all accidents involved motorbikes, followed by passenger cars (18%) and trucks (11%), and of these, nearly half of all road fatalities involved motorbikes (47%), followed by passenger cars (16%) and trucks (14%) (Central Statistical Office, 2016). Therefore, as motorbike accidents are now the major cause of traffic deaths in Myanmar, taking action to increase motorbike safety should be a high priority (Asian Development Bank, 2016).

Experts from the Asian Development Bank have advised that “strong, well-managed and well-funded road safety efforts” are required to reduce road crash frequency and fatalities (Asian Development Bank, 2016). Therefore, scarce resources need to be systematically and consistently allocated for greater effectiveness (Jones-Lee, Hammerton, & Philips, 1985). Policy-makers have used cost-benefit analysis to evaluate proposed regulations and public investments (Jacobs, 1995; Elvik, 2003; Svensson, 2009) in many developed countries to compare the value of traffic accident fatality risk reduction and the cost of implementing road safety measures (Bhattacharya, Alberini, & Cropper, 2007), for which the value of statistical life (VSL) as measured by a WTP approach has been used to estimate the risk reduction value (Persson, Norinder, Hjalte, & Gralen, 2001). Until recently, no such risk reduction valuation research had been conducted in Myanmar; therefore, this study is a pioneer for the VSL estimates for Myanmar motorcyclists.

There are two ways to elicit the WTP; stated preference (SP) and revealed preference (RP). The RP approach derives value from actual real-life decision purchases and choices (Bateman, Carson, Day, Hanemann, Hanleys, Hett, Jones-Lee, Loomes, Mourato, & Ozdemiroglu, 2002; Andersson, 2005; Wijnen, Wesemann, & De Blaeij, 2009); however, as this approach is unable to be used to estimate non-use value (Bateman et al., 2002), it is difficult to implement in developing countries (Bhattacharya et al., 2007).

The SP approach, however, uses different payment mechanisms and questionnaire designs so that individuals can state their preferences for a marginal rate of substitution between wealth and a specific type of mortality risk reduction (Milligan, Kopp, Dahdah, & Montufar, 2014), and therefore it can be used to value both market goods and nonmarket goods (Heywood, 2010), and can match survey questions to policy risk contexts to achieve broad representation; therefore, SP has been widely used to value safety (Wijnen et al., 2009; Milligan et al., 2014). The SP approach can be sub divided into contingent valuation (CV) and choice modeling (CM) (Bateman et al., 2002). When using the CV method, participants state the maximum amount they are willing to pay for the goods or services (Beattie, Covey, Dolan, Hopkins, Jones-Lee, Loomes, Pidgeon, Robinson, & Spencer, 1998, Bateman et al., 2002). When using the CM method, participants choose from different levels of attributes or characteristics (Bateman et al., 2002); however, it was decided that the CM approach was not suitable for Myanmar participants as they would tend to select without proper deliberation.

In recent years, the CV approach has been widely used to estimate the economic value of nonmarket goods and services in the environmental (Whittington, 1998) and health care sectors (Lim, Shafie, Chua, & Ahmad Hassali., 2017). As road safety is a nonmarket good, the CV approach was seen as an appropriate tool for measuring the WTP for traffic accident risk reduction. CV surveys can have various formats; open-ended, iterative bidding, dichotomous choice, and payment card; with each format having its own strengths and weaknesses. Of these, the payment card format has been found to avoid starting point bias, reduce outliers (Bateman et al., 2002), provide more information, have a reduced cognitive burden for participants, and be superior to open-ended questions and bidding games (Svensson and Vredin Johansson, 2010).

Based on a literature review, an SP-CV approach with a payment card format was selected as the most appropriate approach for Myanmar participants. This study aimed: (1) to investigate the extent to which Myanmar motorcyclists are aware of road safety, (2) to examine the relationships between the factors and the influence of these factors on the WTP for road accident fatality risk reduction; and (3) to estimate the VSL for Myanmar motorcyclists. This study used the SP-CV payment card format to elicit the WTP of motorcyclists for traffic accident fatality risk reduction. Then, the VSL of the motorcyclists was calculated based on the reported number of road accident deaths in Myanmar in 2015. A structural equation modeling (SEM) approach was employed to assess the relationships between the factors and their influence on the WTP.

2.3 Materials and Methods

In this study, a WTP-CV questionnaire with a modified payment card format was used to elicit the motorcyclists' willingness to pay for traffic accident fatality risk reduction. Face-to-face interviews were conducted to ensure a full understanding of the questionnaire and to select a suitable WTP value. Background information; research objectives, road accident consequences, and the road accident death rate in Myanmar; was given to participants before the interview. Participants were asked about individual characteristics, travel and driving behavior, accident experience, and risk perception, after which they were asked to nominate a WTP value.

2.3.1 Questionnaire Design

The questionnaire was designed based on the previous related research and was divided into four sections: socioeconomic characteristics; gender, age, income, education, occupation and vehicle ownership (De Dios Ortúzar, Cifuentes, & Williams, 2000; Yang, Liu, & Xu, 2016); travel and driving behavior such as trip purpose, main vehicle, helmet wearing, driving against traffic flow, phone usage while driving, drunk driving, and speeding (Haddak, Lefèvre, & Havet, 2016; Yang et al., 2016); and personal traffic accident experience, family or friend's traffic accident, and risk perception (Andersson and Lundborg, 2007). The fourth section was the heart of the questionnaire, in which the participants were asked to nominate the maximum amount of money they were willing to pay for a road accident fatality risk reduction of 50%. Prior to asking this WTP question, the interviewer explained that the goods to be valued were hypothetical and were used only as a sample to allow for an easy risk reduction valuation. Then, the participants were told they had to choose a new motorbike helmet, and were given two choices (A and B). Each helmet had a one year safety warranty but as the head-injury safety quality of each helmet was different; helmet A had the possibility of 8 deaths from head injury per 100,000 population and helmet B had the possibility of 4 deaths per 100,000 population; the cost for each was different (Chaturabong, Kanitpong, & Jiwattanakulpaisarn, 2011). The participants were asked how much more they would be to pay for helmet B compared to helmet A to reduce the likelihood of motorbike head injury deaths by 50%. The participants were required to choose the amount from a modified payment card which had a range of possibilities; however, if their choices were not on the list, they were able to nominate their own amount.

2.3.2 Data Collection

The questionnaire was translated into Myanmar and a pilot test was conducted to examine comprehension, after which it was revised. A total of 429 motorcyclists from the Sagaing, Mandalay, Nay Pyi Taw, Magway, Bago, Yangon, and Ayeyarwady regions of Myanmar were interviewed from October 2016 to January 2017. The participants over 18 years with at least eight grade education were randomly selected, after which face to face interviews were conducted in several different locations such as government offices, government staff dormitories, universities, student dormitories and company offices. The sample size was chosen based on the advice garnered from previous research; for example, both Kline (1998) and Loehlin (1998) suggested that to reduce bias to an acceptable level, the minimum sample size for any type of SEM estimation was 200. Stevens (1996) also recommended that the sample size for maximum likelihood (ML) estimation should be at least 15 times the number of observed variables, and Bentler and Chou (1987) and Bentler (1995) advised that the sample size for ML estimation should be at least 5 times the number of free parameters including error terms in the model. Therefore, based on Stevens (1996), 330 ($22 \times 15 = 330$) participants were seen as the minimum possible for the ML estimation as there were twenty-two observed variables. After removing nine zero participants, the sample size used in this research was 420 ($420 - 9$), which was deemed sufficient for the SEM analysis.

2.3.3 Estimating the Motorcyclists' VSL

The VSL is an aggregate value of the WTP to prevent the expected occurrence of one statistical death (Persson et al., 2001; Svensson, 2009) and is usually calculated as the mean or median value of the WTP divided by the change in risk ($\Delta\ \rho$) (Jones-Lee, 1974; Persson et al., 2001; Milligan et al, 2014) as shown in Equation (2.1). As the number of deaths by road user categories was not available in Myanmar, the fatality risk value in this study was determined from the total number of road accident deaths as reported by the RTAD divided by the country's population in 2015. The change in risk ($\Delta\ \rho$) value of 50% was based on the target action plan for road safety improvement.

$$\mathrm{VSL} = \frac{\text{mean or median WTP}}{\text{change in risk } (\Delta\, \rho)} \tag{2.1}$$

2.3.4 Analyzing the WTP Determinants

This study used a SEM analysis which allowed for; (1) an assessment of the complex relationships between the variables using discrete or continuous data, (2) an examination of the direct and indirect effects, and (3) an analysis of the model using multiple dependent observed or latent variables (Golob, 2003; Kline, 2011). SEM was applied to examine the relationship between the WTP responses of the Myanmar motorcyclists and their socioeconomic characteristics, travel and driving behavior, accident experience, and risk perception. Various fit indices; the ratio of $\chi 2$ to the degree of freedom (χ^2/df), the p-value (p), the standardized root mean square residual (SRMR), the root mean square error of approximation (RMSEA), the comparative fit index (CFI), and the Tucker-Lewis index (TLI); were used to assess overall model fit. The required measures used were $\chi 2/df < 3$, $p > 0.05$ (Kline, 2011), SRMR ≤ 0.08, RMSEA ≤ 0.08, CFI > 0.90 (Hu and Bentler, 1999), and TLI > 0.80 (Hooper, Coughlan, & Mullen, 2008) as these could indicate the good fit of the model to the data.

2.4 Results and Discussion

2.4.1 Sample Participant Characteristics

There were 46.2% male and 53.8% female participants, with 58.0% being single, 42.0% being married, 54.5% ≤ 30 years, and 66.9% holding a diploma or bachelor’s degree. Most participants were government staff (64.6%), 49.2% had a monthly individual income between US$ 84 and US$166, 48.7% had a monthly household income ≤ US$ 250, and 41.7% had a household of 4–5 members. Over half (52.7%) had two or more than two motorbikes, 46.6% had only one motorbike and 84.1% did not have a car in their household.

For travel behavior, 83.9% generally used their motorbikes to commute to school or work, with only 16.1% using their motorbikes for non-compelling trips such as shopping, recreation, or others. A majority (91.8%) of participants used a motorbike when going outside their homes and only 8.2% used other vehicles such as private cars, buses, or taxis. For driving behavior, 81.6% drove often, 62.0% always wore a helmet, 62.9% never drove against the traffic, 61.3% never used their phone while driving, 78.6% never drove after drinking alcohol, and 88.3% drove at less than 50 kph.

In terms of accident experience and risk perceptions, only 8.7% had experienced the death of family members, relatives or close friends in a traffic accident, and only 14.7% had had personal traffic accident experience in the last two years. Interestingly, 74.6%, 21.7%, and 3.7% respectively perceived that their accident risk was lower than average, average, and higher than average; that is, very few believed that their traffic accident risk was higher than average. A similar result was found in Sweden (Andersson, 2007), which reported that most people believed that their risk of experiencing a traffic accident fatality was low because their driving behavior was safer than that of others.

2.4.2 WTP Value and VSL of Motorcyclists

Table 2.1 shows the mean and median WTP values for a 50% fatality risk reduction and the motorcyclists' VSL. As can be seen, only 2.1% of participants nominated a zero WTP, with the mean and median WTP values being MMK 7,809

(US$ 6.51) and MMK 7,000 (US$ 5.83) for a 50% risk reduction in road accident deaths (US$1= MMK1200). The traffic accident fatality risk value was calculated based on a RTAD report from 2015, which reported 5037 deaths from the 52.449 million population; that is, 9.6 deaths per 100,000 people (Central Statistical Office, 2016). Consequently, the value for (Δ ρ) for a 50% risk reduction in road accident deaths was 4.8 deaths per 100,000 people. Based on the WTP median and mean values, the VSL was calculated using Equation 2.1, from which it was found that the Myanmar motorcyclists' VSL ranged from MMK 145.833 million (US$ 0.121528 million) to MMK 162.687 million (US$ 0.135573 million), which was commensurate with other developing countries such as Thailand (US$ 0.17–0.21 million) (Chaturabong et al., 2011) and India (US$ 0.15 million) (Bhattacharya et al., 2007), but noticeably lower than the VSL in other developed countries.

Table 2.1 WTP value for 50 percent risk reduction in fatality and VSL of motorcyclists

	WTP MMK[a] (US$)	Risk Change (Δρ) (x 100,000 pop)	VSL MMK[a] x 10^6 (US$ x 10^3)
Mean	7809 (6.51)	4.8	162.687 (135.573)
Median	7000 (5.83)	4.8	145.833 (121.528)
SD	4964 (4.14)		
Skewness	0.76		
SE of Skewness	0.118		
Sample size	429		
% zeroWTP	2.1		

[a] Myanmar Kyat , US$1= MMK1200

2.4.3 WTP Determinants

As the WTP values were slightly dispersed in this study as shown in Table 2.1, the WTP values were converted to a natural logarithm prior to the analysis. As only nine participants (2.1%) chose zero WTP values and the logarithm of zero was infinity, these data were excluded from the analysis (Chaturabong et al., 2011). All nominal and categorical variables were then converted to dummy variables (Lee, Chung, & Son, 2008), and the skewness and kurtosis were checked to ensure normality; based on Kline (2011), skewness should be < 3 and kurtosis should be < 10.

The ML estimation was used to construct and test the measurement model, and preliminary analyses were conducted on various observed variables for each measurement model. At first, when all indicators were included in the measurement models, the model fit indices were poor; therefore, after examining the preliminary analyses results, some observed variables were removed to improve model fit. Finally, there were respectively three, five, and three observed variables left for the socioeconomic characteristics, travel and driving behavior, and risk perception factors. Structural pathways were then developed to connect the exogenous observed variables, latent variables, and endogenous observed variables (WTP) in the SEM model. After checking the statistical output from the preliminary analysis, pathways were added and removed until the structural model exhibited adequate fit.

Table 2.2 gives the explanation for all observed variables, and Table 2.3 illustrates the sample characteristics of the candidate variables. It can be seen that the skewness was less than 3 for all variables and the kurtosis was less than 10, implying that all variables were normal (Kline, 2011).

Figure 2.1 shows the parameter estimates for the measurement model and path model. The resulting values for the goodness of fit statistics were: (1) chi-square ($\chi2$) = 95.239, (2) degree of freedom (df) = 58, (3) $\chi2$/df = 1.642 (4) p-value = 0.0015, (5) RMSEA = 0.039, (6) CFI = 0.922, (7) TLI = 0.879, and (8) SRMR = 0.043. All statistical values were compatible with the recommended model fit index, other than the p-value < 0.05. As the $\chi2$ value was hypersensitive to large sample sizes (n > 200), it led to a rejection of the null hypothesis (Hooper et al., 2008; Kline, 2011). Due the large sample size (n = 420) in this study, it was concluded that the model fit well and was able to explain 26.9% of the WTP variance.

Table 2.2 Definition of observed variables.

Code	Definition	Category
G	Gender	1 Male, 0 Female
A1	Age level 1	1 if ≤ 30, 0 otherwise
A2	Age level 2	1 if 30 – 40, 0 otherwise
A3	Age level 3	1 if > 40, 0 otherwise
FS	Family status	1 if married, 0 single
E1	Education level 1	1 if ≤ High School, 0 otherwise
E2	Education level 2	1 if Diploma or Bachelor, 0 otherwise
E3	Education level 3	1 if Master and above, 0 otherwise
O1	Occupation 1	1 if Student, 0 otherwise
O2	Occupation 2	1 if Government staff, 0 otherwise
O3	Occupation 3	1 if Private employee, 0 otherwise
I1	Monthly Individual income level 1	1 if ≤ 83, 0 otherwise
I2	Monthly Individual income level 2	1 if 84–166, 0 otherwise
I3	Monthly Individual income level 3	1 if >166, 0 otherwise
HI1	Monthly Household income level 1	1 if ≤ 250, 0 otherwise
HI2	Monthly Household income level 2	1 if 251–416, 0 otherwise
HI3	Monthly Household income level 3	1 if > 416, 0 otherwise
HM	Household member	Continuous
MC	No of motorcycle	Continuous
C	No of car	Continuous
CM	Compelling (school or work)	1 if School or work, 0 otherwise
VEH	Mainly used vehicle	1 if motorcycle, 0 otherwise
ETF	Exposure to the traffic (driving frequency)	1 if often, 0 otherwise
HEL	Helmet wearing	1 if often, 0 otherwise
AG	Against the traffic flow	1 if never, 0 otherwise
PH	Speak phone while driving	1 if never, 0 otherwise
DD	Drunk driving	1 if never, 0 otherwise
SP	Usual operating speed	1 if ≤ 50 kph, 0 otherwise
PEA	Personal experience on accident	1 if had accident, 0 otherwise
FEA	Family or friends had accident	1 if had accident, 0 otherwise
PRI	Perceived risk of accident	1 if average or higher than average risk, 0 lower than average risk
WTP	Willingness to pay	Continuous

Table 2.3 Sample characteristics of candidate variables.

Code	Variable	Mean	SD	Skewness		Kurtosis	
				Stat.	Std. Err	Stat.	Std. Err
G	Gender	0.47	0.499	0.134	0.119	−1.9925	0.238
MC	Motorcycle ownership	1.75	0.876	0.900	0.119	0.133	0.238
O2	Government staff	0.65	0.479	−0.609	0.119	−1.637	0.238
E1	Up to high school	0.20	0.402	1.487	0.119	0.212	0.238
HI3	Monthly Household income level 3	0.18	0.3845	1.663	0.119	0.771	0.238
HEL	Helmet wearing	0.84	0.364	−1.891	0.119	1.583	0.238
OP	Against traffic flow	0.63	0.484	−0.524	0.119	−1.734	0.238
PH	Speaking phone	0.63	0.484	−0.524	0.119	−1.734	0.238
DD	Drunk driving	0.78	0.412	−1.380	0.119	−0.095	0.238
SP	Speed	0.88	0.321	−2.397	0.119	3.762	0.238
PAE	Personal accident experience	0.15	0.357	1.967	0.119	1.880	0.238
FAE	Family or friend accident experience	0.29	0.455	0.926	0.119	−1.147	0.238
PRI	Perceived risk	0.25	0.436	1.144	0.119	−0.694	0.238
WTP	Willingness to pay	8.764	0.719	−0.623	0.119	−0.106	0.238

As all estimated values for the factor loadings and path coefficients were standardized solutions, it was considered feasible to compare the effects of the variables on the observed dependent WTP variable. For the direct effects, the gender (male) indicator (β = 0.613), socioeconomic characteristics (β = 0.541), good driving behavior (GDBH) (β = 0.793) and risk perception (RPC) (β = 0.648) factors were found to be statistically significant and had a positive influence on the WTP.

The government staff (O2) (β = 0.312) indicator was found to be significant and had a positive influence on the GDBH factor; however, the male indicator (β = −0.542) was significant and had a negative influence on the GDBH factor. For the indirect effects, government staff (O2) was found to have a positive influence on the WTP mediated through the GDBH factor, while the male indicator was found to have a negative influence. Overall, the GDBH factor (β = 0.793) was found to have the highest influence on the WTP, followed by the RPC factor (β = 0.648).

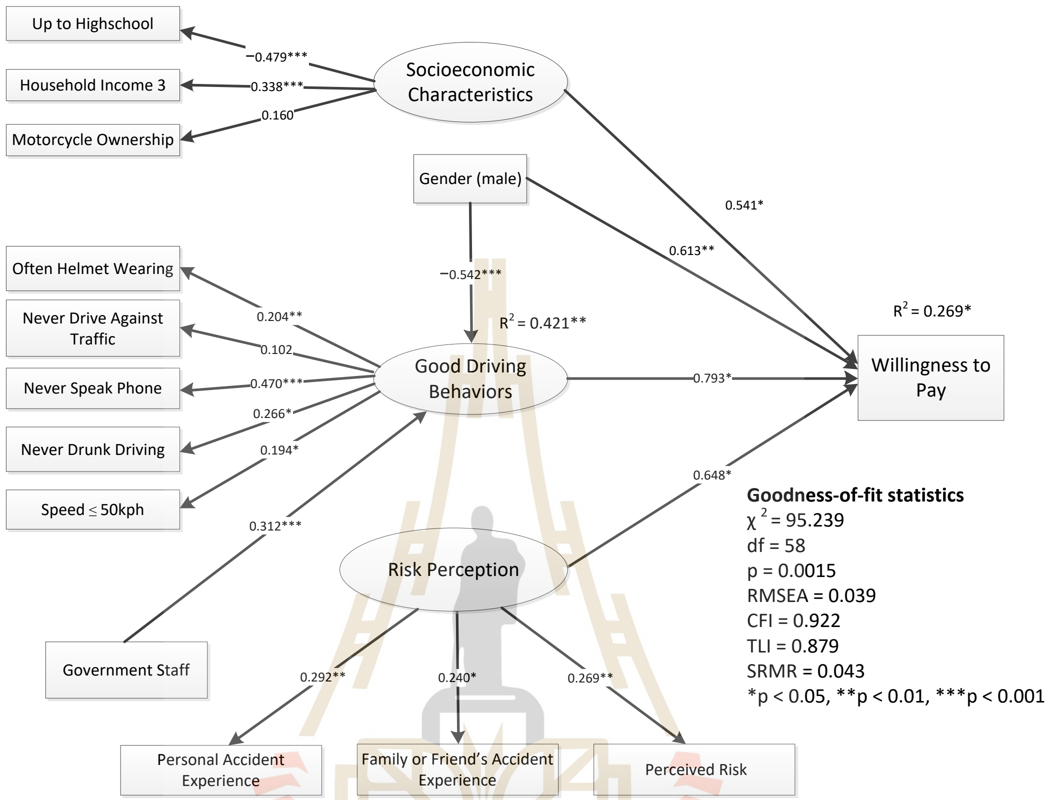

Figure 2.1 SEM of motorcyclist' WTP for fatality risk reduction

The SEM analysis results shown in Figure 2.1 were as follows. The socioeconomic characteristics factor was measured using three indicators: motorcycle ownership (MC), up to high school education (E1), and monthly household income level 3 (HI3). E1 and HI3 variables were found to be statistically significant; E1 had negative associations with the socioeconomic characteristics factor, and HI3 had a positive association, and E1 was found to have the higher influence (β = −0.479), followed by HI3 (β = 0.338). Further, the socioeconomic characteristics factor was found to significantly and positively affect (β = 0.541) the WTP. From these results, it was reasonable to surmise that lower educated people were less likely to pay for traffic accident risk reduction compared to more highly educated people. An alternative result reported by Yang et al. (2016) was that the more highly educated participants focused more on traffic accidents, had a better appreciation of the potential benefits of traffic safety improvements, and therefore were more likely to pay than lower educated people. Participants from higher income family were found to be more willing to pay for traffic accident risk reduction compared to participants from lower income families, which was in line with economic theory and previous studies (Mofadal, Kanitpong, & Jiwattanakulpaisarn, 2015; Yang et al., 2016) in Sudan and China that indicated that wealthy people tended to value their life more.

The GDBH factor was measured using five observed variables; helmet wearing (HEL), driving against the traffic flow (AG), using the phone while driving (PH), drunk driving (DD), and speeding (SP). All variables, except AG, were found to be positively significant, with the PH indicator having the highest association (β = 0.470) with WTP. In addition, the GDBH factor was found to have a significantly positive influence (β = 0.793) on the WTP, indicating that participants who followed traffic rules and regulations were more likely to pay for fatality risk reduction compared to participants who tended to violate traffic rules. However, an alternative result was found in prior research (Moen, 2007) that studied the determinants of safety priorities and the WTP to increase safety, in which it was reported that car drivers with a negative attitude to traffic rules were less willing to pay for traffic accident risk reduction.

The male (G) variable was found to have a significant negative influence (β = −0.542) on the GDBH factor. G was also found to have a significant and positive direct effect (β = 0.613) as well as a negative indirect effect on the WTP mediated through the GDBH factor. The resulting total effect of G on WTP was positive, which suggested that male participants were more likely to violate the traffic rules compared to females, as found in prior studies (Holubowycz, Kloeden, & Mclean, 1994; Zhang, Lindsay, Clarke, Robbins, & Mao, 2000; Yau, Lo, & Fung, 2006; Kim, Brunner, & Yamashita, 2008; Zhang, Yau, & Chen, 2013) in which it was found that male drivers had a higher probability of traffic violations. However, the total effect on the WTP indicated that male participants were more willing to pay for traffic accident risk reduction than females.

The government staff (O2) variable was found to have a significant positive influence (β = 0.312) on the GDBH factor; therefore, O2 positively influenced the WTP mediated through the GDBH factor. This result could be explained by the fact that government staffs were more likely to obey the traffic rules and were more willing to pay for accident risk reduction than other road users as they were following the instructions of their department heads to obey traffic rules and regulations (especially helmet usage). This finding supported the results in Chaturabong et al. (2011), which concluded that government officers were more likely to pay to reduce fatality risk than students.

The risk perception (RPC) factor was measured using three indicators: personal accident experience (PAE), family or friend's accident experience (FAE) and perceived risk (PRI). All variables were found to be significantly and positively associated, with the RPC factor significantly and positively influencing (β = 0.648) the WTP, which suggested that participants who had been involved (personal or close community) in a traffic accident were more likely to pay for accident risk reduction than participants who had had no traffic accident experiences; a finding that was consistent with previous studies in Sweden and France (Andersson and Lindberg, 2009; Haddak et al., 2016). In prior research (Andersson and Lindberg, 2009), it was found that the PRI indicated that participants who perceived their road accident risk to be average or higher than average were more likely to pay for accident risk reduction than participants who believed their risk was lower than average.

2.5 Conclusions

As the number of motorbikes has increased dramatically over the last few years in Myanmar, motorcyclist deaths, which accounted for half of all total road traffic accident deaths in Myanmar, have become a major road safety concern. This study examined the VSL in Myanmar motorcyclists and the influence of individual characteristics on the willingness to pay (WTP) for fatality risk reduction. A total of 429 motorcyclists from seven major regions in Myanmar were interviewed using a WTP-CV approach, after which the VSL for Myanmar motorcyclists was then estimated and a SEM analysis employed to assess the direct and indirect effects of the Myanmar motorcyclists' characteristics, behaviors, and attitude toward the WTP.

The estimated VSL was found to have a mean value of MMK 162.687 million (US$ 135,573) and a median value of MMK 145.833 million (US$ 121,528), which was significantly less than in developed countries, but commensurate with other developing countries. Socioeconomic characteristics, good driving behavior, and risk perception factors were found to positively influence the WTP, gender (male) had a negative effect on good driving behavior, and being government staff had a positive effect. Gender (male) was also found to have a positive direct effect on the WTP.

Overall, good driving behavior factor was found to have the highest influence on the WTP.

Based on the result from this study, road authorities need to do road safety campaign and to educate more on specific target groups such as male, student. VSL can also be used as an input for benefit of preserving the life of motorcyclists in benefit cost analysis to compare the cost of road safety measure such as constructing a separate lane for motorcycle. This study could be helpful to road transport authorities when formulating road safety policies for motorcyclists, who are one of the most vulnerable road user group. It could also be useful in decision making processes for budget allocations and when prioritizing road safety related project investments to improve national road safety.

2.6 Acknowledgement

The project was funded by the Suranaree University of Technology Research and Development Fund.

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CHAPTER III

ESTIMATING THE WILLINGNESS TO PAY AND THE VALUE OF FATALITY RISK REDUCTION FOR CAR DRIVERS IN MYANMAR

3.1 Abstract

To curb the rising road traffic accident trend in Myanmar, there is an urgent need to improve road safety. This study aims to evaluate current government road safety interventions. The contingent valuation-payment card method was used to elicit car drivers' willingness to pay (WTP) for fatality risk reduction. The value of statistical life (VSL) was then estimated and the factors influencing the WTP were examined using structural equation modeling. The estimated range for VSL was found to be MMK 104.167 million (US$ 86,805) to MMK 195.771 million (US$ 163, 142). Gender (male), mediating good driving behavior, and age indicators were found to negatively influence the WTP, whereas socioeconomic characteristics, good driving behavior, and risk perception factors were found to positively influence the WTP. The proposed model explained 33.7% of the variance and traffic accident risk perception was found to have the strongest influence on the WTP. This study can serve as a decision making tool for road safety improvement policies.

3.2 Introduction

With the rapid increase in vehicle ownership, traffic accidents in Myanmar have been commensurately increasing. In the past 10 years, there has been a five-fold increase in the number of vehicles on the road (0.978 million in 2005 and 5.385 million in 2015), which has resulted in a dramatic increase in traffic accidents (5755 in 2005 to 15677 in 2015). Official statistics report that in 2015, there were 5037 traffic fatalities, with a further 25612 injuries (Central Statistical Office, 2016). Therefore, road safety has become a major issue in Myanmar as in other developing countries because of the severe burden on the economy and the negative impact on victims, their families, and the nation (Parsekar, Singh, Venkatesh, & Nair, 2015).

Experts from the Asian Development Bank estimated that the number of fatalities was expected to double by 2020 and reach 15,000 per year by 2025 if immediate action were not taken to improve road safety. Therefore, "strong, well-managed and well-funded road safety efforts" are needed to reverse the increasing traffic accident trend (Gururaj, 2014; Asian Development Bank, 2016). Although Myanmar's authorities have been trying to resolve these problems, crash rates have continued to rise. Therefore, it has become necessary to develop a more strategic focus based on data, research evidence, and proven successful practices (Asian Development Bank, 2016).

An estimate of the economic losses due to road accidents is necessary to understand the magnitude of the road safety problems in the country (Chaturabong, Kanitpong, & Jiwattanakulpaisarn, 2011). As fatal accidents results in substantial traffic accident costs, any fatal accident cost evaluations requires a monetary valuation for the loss of life or the value of a statistical life (VSL) (de Blaeij, Florax, Rietveld,

& Verhoef, 2003). Moreover, because of the scarcity of resources, policy makers need to prioritize different social benefit policies (Svensson and Vredin Johansson, 2010). Therefore, policy makers have generally used cost benefit analyses to evaluate the benefits of proposed regulations and public investment in road safety. Therefore, a monetary traffic safety valuation is required to compare the value in reducing the traffic mortality risk with the costs of implementing road safety measures (de Blaeij et al., 2003; Svensson, 2009; Wijnen and Stipdonk, 2016). Many economists have focused on the willingness to pay (WTP) concept and the concept of the value of statistical life (VSL) to monetize mortality risk reduction (Mishan, 1971; Jones-Lee, 1974; Andersson, 2007). VSL refers to the individual integrated marginal WTP value of avoiding one statistical road traffic accident death (Andersson, 2007; Svensson, 2009; Yang, Liu, & Xu, 2016). VSL can be also calculated by dividing the WTP by the risk change value (Milligan, Kopp, Dahdah, & Montufar, 2014). Furthermore, Wijnen, Wesemann, & De Blaeij (2009) and Wegman (2017) found that it was difficult to compare VSL estimates across countries as the valuation depended on many factors that differed significantly (such as local conditions and circumstances), and strongly recommended that the VSL be evaluated separately for each country and be updated regularly.

A person's WTP for traffic death risk reduction is directly related to the valuation of their own life, their personal risk perceptions (Hensher, Rose, Ortúzar, & Rizzi, 2009), and their preferences toward road safety (Andersson and Lindberg, 2009). Therefore, understanding people's road safety preferences as well as their individual characteristics is important to road safety policy measures (Andersson and Lindberg, 2009) such as traffic regulations and legislation that targets different driver groups (Zhang, Yau, & Chen, 2013). Consequently, as shown in Table 3.1, there has been a great deal of research into the impact of people's characteristics, behaviors, and risk perceptions on the WTP for road accident death risk reduction.

Table 3.1 Factors associated with WTP on previous research.

Item	**Author**	**Indicators**	**Association with WTP**	
			Positive	Negative
1		**Socioeconomic Characteristic**		
	Persson *et al.* (2001), Bhattacharya *et al.* (2007), Andersson and Lindberg (2009), Chaturabong *et al.* (2011), Haddak *et al.* (2016)	Income, Education, Government staff	✓	
	Persson *et al.* (2001), Bhattacharya *et al.* (2007), Andersson and Lindberg (2009), Chaturabong *et al.* (2011), Haddak *et al.* (2016)	Age, Gender (male), Number of adult in a household, Number of dependent in a household,		✓
2		**Travel/Driving Behavior**		
	Bhattacharya *et al.* (2007), Chaturabong *et al.* (2011)	Often helmet usage, Exposure to traffic	✓	
	Chaturabong *et al.* (2011)	Alcohol impaired driving		✓
3		**Accident experience & Risk perception**		
	Persson *et al.* (2001), Andersson and Lindberg (2009), Haddak *et al.* (2016)	Accident experience, Risk perception or subjective risk, Close community accident experience	✓	
	Andersson and Lindberg (2009)	Lower risk perception		✓

The WTP can be divided into two categories: revealed preference (RP) and stated preference (SP) (Wijnen et al., 2009). As RP refers to actual behavior and the choice of market goods (Cnaan and Kang, 2011), it has been commonly used to studyconsumer behavior; therefore the applicability of RP to road safety has been limited (Wijnen et al., 2009). An alternative approach to RP is SP, which is based on hypothetical surveys that use different payment mechanisms and designs to value both market goods and non-market goods (Svensson, 2009; Wijnen et al., 2009), and has the ability to match survey questions to policy risk contexts to achieve broad representation (Milligan et al., 2014); therefore, SP has been commonly used to value travel time, safety (such as fire, road, work), pollution (such as air, water, noise), and natural resources (Wijnen et al., 2009). The SP method can be further divided into contingent valuation (CV) and choice modeling (CM) or stated choice (SC). In the CV approach, respondents are directly asked to state the maximum amount they are willing to pay for particular goods or risk reduction (Beattie, Covey, Dolan, Hopkins, Jones-Lee, Loomes, Pidgeon, Robinson, & Spencer, 1998; Carthy, Chilton, Covey, Hopkins, Jones-Lee, Loomes, Pidgeon, & Spencer, 1998; Wijnen et al., 2009; Haddak, Lefèvre, & Havet, 2016). In the CM approach, respondents are asked to make a choice between different goods or alternatives, such as different levels of travel time, costs, and accident risk (Wijnen et al., 2009).The CM approach, however, is not suitable for Myanmar respondents as they might select randomly without due consideration. There are many approaches to CV elicitation, such as open-ended, iterative bidding or bidding game, payment cards, and dichotomous choice (Bateman, Carson, Day, Hanemann, Hanleys, Hett, Jones-Lee, Loomes, Mourato, & Ozdemiroglu, 2002). In open-ended elicitation, without being given a clue as to the value, respondents are directly asked the amount that are willing to pay for the goods or services. Therefore, people not familiar with the risk reduction valuations and who had never thought about such valuations before may have difficulties and may give protest answers or no answer, which could result in a large non-response rate and outliers (Bateman, Carson, Day, Hanemann, Hanley, Hett, Jones-Lee, Loomes, Mourato, Ozdemiroglu, Pearce, Sugden, & Swanson, 2003; Vloerbergh, Fife-Schaw, Kelay, Chenoweth, Morrison and Lundehn, 2007). In the bidding game approach, people are asked whether or not (yes/no) they are willing to pay a certain amount over several rounds of discrete choice questioning until their maximum WTP is reached. However, this method has been found to have anchorage bias and a large number of outliers because of false responses (Bateman et al., 2003; Vloerbergh et al., 2007). In the payment card format, people can choose what they are willing to pay from a list of amounts and there is also a space to write an alternative amount if the choices are not suitable, which makes the valuation task easier. The payment card format has been found to have a higher response rate, avoids a starting point bias, reduces outliers, and has a lower cognitive burden on respondents (Bateman et al., 2002; Vloerbergh et al., 2007; Mofadal, Kanitpong, & Jiwattanakulpaisarn, 2015). Of these, the payment card format has been found to be superior to open-ended and bidding game approach (Bateman et al., 2002). Therefore, this study used the payment card approach to elicit the WTP for fatality risk reduction.

From the literature review, a WTP-CV payment card questionnaire was found to be the most suitable method as Myanmar residents are unfamiliar with risk reduction valuations. Because of the difficulty in getting reliable data, no previous research has been conducted regarding the estimation of car driver's VSL for traffic accident risk reduction in Myanmar.

This study aimed: (1) to inform traffic safety policy by examining the influence various factors on each other and the degree to which they influence the WTP for traffic accident fatality risk reduction; and (2) to gather information for national authority road safety resource allocation decision making by estimating the statistical value of life of Myanmar car drivers. A contingent valuation-payment card questionnaire approach was used to elicit the WTP for fatality risk reduction by Myanmar car drivers. Then, the VSL of car drivers was estimated based on the accident rate in Myanmar during 2015. A structural equation modeling (SEM) approach was used to assess the factors that influenced the WTP.

3.3 Materials and Methods

In this study, a WTP-CV questionnaire using a modified payment card format was employed to elicit car drivers' willingness to pay for road traffic fatality risk reduction. As Myanmar respondents were unfamiliar with the WTP and risk reduction value concepts, face-to-face interviews were conducted to ensure a complete understanding of the questionnaire so that respondents would choose an appropriate WTP value.

Before the interview, background information was explained, such as the research purpose (Yang et al., 2016), the importance of road safety, the impact of traffic accidents, and the road accident fatality rate in Myanmar. Respondents were then asked about socioeconomic characteristics, travel behavior, driving behavior, accident experience, risk perception, and asked to give a WTP value.

The road accident fatality risk was calculated from official statistics reported by the Myanmar Police Force for 2015 (Central Statistical Organization, 2016). As the number of traffic deaths by road user type was not available, the fatality risk was calculated from the number of deaths in the country divided by the country's population. Therefore, the risk value for car drivers was the same as for all road users. A 50% traffic accident fatality risk reduction was set based for Myanmar's national road safety improvement goal. The VSL was estimated based on the Persson, Norinder, Hjalte, & Gralen (2001) approach in which the mean and median WTP were divided by the risk change (de Blaeij et al., 2003; Chaturabong et al., 2011; Yusof, Nor, & Mohamad, 2013). Persson et al. (2001) stated that the VSL in a road traffic context could be evaluated by analyzing the relationship between an individual's WTP for a marginal reduction in the risk of being killed in a road accident and that risk reduction. The VSL can then be calculated as the average of the sum of all individual marginal WTPs to avoid the expectation of one statistical death. Finally, structural equation modeling was used to analyze the factors influencing the WTP.

3.3.1 Questionnaire design

The questionnaire had four sections. The first section gathered information about socioeconomic characteristics: gender, age, income, education, occupation, household income, and vehicle ownership. (de Dios Ortúzar, Cifuentes, & Williams, 2000; Yang et al., 2016). The second section assessed the respondent's travel and driving behavior: trip purpose, primary vehicle, seatbelt usage, driving against traffic flow, speaking on the phone while driving, drunk driving, and speeding (Haddak, 2016; Yang et al., 2016). The third section collected personal experience of traffic accidents, which included family or friends' experiences and the perceived risks (de Dios Ortúzar et al., 2000; Andersson, 2007; Andersson and Lindberg, 2009, Fyhri and Backer-Grøndahl, 2012; Vilela da Silva and Braga, 2017). The last section was the main part of the questionnaire, in which respondents were asked to nominate the maximum annual payment they were willing to pay for accident risk reduction. Before asking the WTP question, the respondents were told that the goods being valued in the WTP question were hypothetical and were only used as samples for an easier risk reduction evaluation. The main purpose of the WTP questionnaire was to elicit the maximum annual payment they were willing to pay for an accident risk reduction of 50%. The respondents were then asked; "How much would you be at most willing to pay each year for renting a safety device (e.g., speed controlled device) that would cut your risk of a traffic accident fatality in half (eight to four deaths per 100,000 people)?"(Persson et al., 2001; Andersson, 2007); the respondents then chose the maximum payment they would be willing to pay from the modified payment card.

3.3.2 Data collection

This study focused on respondents exposed to traffic hazards as it was felt that they would gain the greatest benefit from road safety improvements. To ensure that they could understand the risk reduction valuations and the WTP concept, adult respondents 18 years or over with at least an eighth grade education were randomly selected from the urban areas of seven major regions: Nay Pyi Taw, Yangon, Mandalay, Magway, Sagaing, Bago, and Ayeyarwady; in which 77% and 68% of the Myanmar's accidents and deaths occur. The number of respondents from each region was determined based on the proportion of population and road accident occurrence. The required sample size for SEM was determined based on research suggestions. Golob (2003) suggested that: (1) the minimum sample size for SEM analysis was 200 (Kline, 1998; Loehlin, 1998); (2) the sample size used to estimate maximum likelihood (ML) estimation should be at least 15 times the number of observed variables (Stevens, 1996); (3) the sample size used to estimate ML estimation should be at least 5 times the number of free parameters in the model, including error terms (Bentler and Chou, 1987; Bentler, 1995); and (4) the sample size used to estimate ML estimation should be 10 times the number of free parameters (Hoogland and Boomsma 1998). This study had 22 observed variables and ML estimation was used in the SEM analysis. Stevens (1996) suggested that the required sample size for this type of study was 22 × 15, which is equal to 330. This study had 385 car drivers, which was considered sufficient for the SEM analysis. The WTP-CV survey with face-to-face interviews were conducted from October 2016 to January 2017 at universities, government offices, company offices, government staff dormitories, and student dormitories in the seven major regions.

3.3.3 Method to estimate VSL of car drivers

VSL is defined as the total amount an individual is willing to pay to avoid an expected occurrence of one fatality (Andersson, 2008), and can be estimated from the WTP mean or median divided by risk change (Δρ) (Persson et al., 2001; Andersson, 2007; Svensson and Vredin Johansson, 2010). The formula for calculating VSL is shown in Equation 3.1.

$$\text{VSL} = \frac{\text{mean or median WTP}}{\Delta\rho} \tag{3.1}$$

VSL = Value of statistical life

WTP = Willingness to pay

$\Delta\rho$ = Change in risk for fatality

3.3.4 Analyzing the WTP determinants

SEM has been widely used in travel behavior research (Ratanavaraha et al., 2016) because it has the ability to simultaneously examine complex relationships in a single model, to measure direct and indirect effects, and to test models with multiple dependent variables (Golob, 2003; AmirAlavifar, Mehdi Karimimalayer, & Anuar, 2012; Sukor, Tarigan, & Fujii, 2017). It has also the ability to analyze data that are continuous or discrete, observed or unobserved (Ullman, 2006). The objective of this study was to observe the relationship between socioeconomic characteristics and risk perceptions on good driving behavior as well as the effects on the WTP for traffic accident fatality risk reduction. Therefore, this study sought to examine not only the direct effects of the socioeconomic characteristics and risk perceptions on the WTP but also the indirect effects of those factors or predictor variables on the WTP mediated through good driving behavior. Therefore, to examine the interrelationships between the exogenous observed or latent variables and their effects on the traffic accident fatality risk reduction WTP, SEM was considered appropriate for this study.

SEM is a combination of CFA and path analysis (Lei and Wu, 2007; Kline, 2011). Confirmatory factor analyses (CFA) were conducted to validate the measurement models (assess the relationship between the observed variables and the latent construct) using maximum likelihood (ML) approximation. After validating the three measurement models, structural paths were added and the full structural model tested. Goodness of fit indices were employed to assess model fit of CFA and SEM. A good fit was indicated by the ratio of $\chi2$ to a degree of freedom ($\chi2/df < 3$), the p-value ($p > 0.05$), the standardized root mean square residual (SRMR ≤ 0.08), the root mean square error of approximation (RMSEA ≤ 0.07), the comparative fit index (CFI ≥ 0.90) and the Tucker Lewis index (TLI ≥ 0.80) (Hu and Bentler, 1999; Kline, 2005; Steiger, 2007; Hooper, Coughlan, & Mullen, 2008; Wu, West, & Taylor 2009; Kline, 2011).

3.4 Results and discussion

3.4.1 Descriptive statistics of respondents

Table 3.2 shows the descriptive statistics for the respondents. The age of the respondents ranged from 18 to 68 years, with those between 31 to 40 years having the highest percentage (40.5%). The proportion of male respondents (78.7%) was high, which reflected the fact that three-quarters of all road accident victims were male in Myanmar (Central Statistical Organization, 2016). The education of the respondents was high school (20.3%), diploma or bachelor degree (49.6%), and master's degree and above (30.1%). For employment, 10.1% were students, 24.7% were government staff, 31.7% were company staff, and 33.5% were private employers, housewives, or pensioners. Nearly half (48.6%) the respondents earned between US$ 167 – 416 monthly, with the highest percentage earning US$ 251– 416 month (35.3%), followed by US$ > 583 at 28.9%, and US$ ≤ 250 (20.3%) in the household. Nearly half (49.4%) the respondents had up to 3 household members and only 8.6% had more than 5 household members. Further, 36.4% of respondents did not own a motorcycle, 43.9% had one motorcycle, 19.8% had two or more motorcycles, and 81.8% owned a car in the household; around 50% of respondents had both a motorcycle and a car in their household.

For respondent's travel behavior and driving behavior, 82.1% traveled to school or work, and only 17.9% traveled for shopping or recreation. A significant majority (81.3%) used a private car when traveling outside their home and 18.7% used other vehicles such as motorcycles and buses. Overall, 73.8% of respondents drove often, only one-third (33.2%) always wore a seatbelt, 64.4% never rode against the traffic, 23.1% never used the phone while driving, 58.7% never drove after drinking alcohol, and 62.1% drove at less than 70 kph.

With regards to accident experience and traffic accident risk perceptions, 31.9% of respondents had had family members or close friends who had been involved in a traffic accident, and only 9.4% of respondents had had a traffic accident experience in the previous two years. For the perceived risk of traffic accidents variable, 65.2% of respondents believed that their accident risk was lower than the average risk, 31.2% thought their accident risk was average, and only 3.6% perceived accident risk was higher than average. Similar to these results, Andersson (2007) reported that Swedish respondents under assessed their own mortality risks for both road- and total-mortality risks. One reasonable explanation given in earlier studies (Jones-Lee and Whittaker, 1989; Andersson and Lundborg, 2007) was that the observed underestimation of fatality risks might be due to "optimism bias or availability heuristics," as most people imagined that negative consequences were less likely to occur because their actions were safer than others.

Table 3.2 Descriptive statistics of respondents.

No	Particulars		Frequency	Percentage
	(a) Socioeconomic characteristics			
1	Gender	Male	303	78.7
		Female	82	21.3
2	Age (year)	≤ 20	9	2.3
		21–30	85	22.1
		31–40	156	40.5
		>40	135	35.1
3	Marital status	Single	107	27.8
		Married	287	72.2
4	Education	≤ High-school	78	20.3
		Diploma or Bachelor	191	49.6
		≥ Master	116	30.1
5	Occupation	Student	21	10.1
		Government staff	212	24.7
		Private employee	43	31.7
		Others (private employer, housewives, etc.,)	109	33.5
6	Individual income (US$)	≤ 83	39	10.1
		84–166	95	24.7
		167–416	187	48.6
		>416	64	16.6
7	Household income (US$)	≤ 250	78	20.3
		251–416	136	35.3
		417–583	60	15.6
		>583	101	28.9
8	Household member	≤ 3	190	49.4
		4–5	162	42.0
		> 5	33	8.6
9	No of motorcycle	0	140	36.4
		1	169	43.9
		≥ 2	76	19.8
10	No of car	Do not have Car (0)	70	18.2
		Have car (≥ 1)	315	81.8

Table 3.2 Descriptive statistic of respondents (Continued).

No	Particulars			Frequency	Percentage
	(b) Travel / Driving Behavior				
11	Trip purpose	Non-compelling (shopping, recreation etc.,)		69	17.9
		Compelling (school, work)		316	82.1
12	Main vehicle used	Private car		313	81.3
		Others (motorcycle, bus etc.,)		72	18.7
13	Driving frequency	Not often		101	26.6
		Often		284	73.8
14	Seatbelt usage	Never		36	9.4
		Rarely		61	15.8
		Sometimes		83	21.6
		Frequently		77	20.0
		Always		128	33.2
15	Riding against traffic	Sometimes		9	2.3
		Rarely		128	33.2
		Never		248	64.4
16	Speak phone	Frequently		15	3.9
		Sometimes		110	28.6
		Rarely		171	44.1
		Never		89	23.1
17	Drunk driving	Frequently		2	0.5
		Sometimes		29	7.5
		Rarely		128	33.3
		Never		226	58.7
18	Usual operating speed	> 70kph		46	37.9
		≤ 70kph		239	62.1
	(c) Accident experience and risk perception				
19	Accident experience	Personal	No	349	90.6
			Yes	36	9.4
20		Family or friend	No	262	68.1
			Yes	123	31.9
21	Perceived risk of accident	< average risk		251	65.2
		= average risk		120	31.2
		> Average risk		14	3.6
	Total Sample			**385**	

3.4.2 Mean, median WTP values and VSL for 50% fatality risk reduction

Table 3.3 shows the mean and median WTP values for a 50% fatality risk reduction. It can be seen that 7.5% of respondents selected zero WTP. One possible explanation for this was that although the interviewer explained that the safety device (e.g., Speed controlled device) value was an example to allow for an easier accident risk reduction valuation, the cognitive ability of the respondents to understand the WTP questionnaire thoroughly was dubious. Consequently, respondents who drove slowly might have believed that the WTP value depended on the commodity value given as the example, so chose a zero WTP. The mean value for the WTP was estimated at 9,397 MMK (US$ 7.83) and the median WTP value was estimated at 5,000 MMK (US$ 4.17) for a 50% fatality risk reduction (1 US$ = 1200 MMK).

Table 3.3 WTP value for 50 percent risk reduction in fatality of car drivers.

Road User	Mean MMK(US$)	Median MMK(US$)	SD MMK(US$)	Skewness	SE of Skewness	Sample size	% zeroWTP
Car Driver	9397 (7.83)	5000 (4.17)	10548 (8.79)	2.54	0.124	385	7.5

Note: MMK = Myanmar Kyat, N = 385, 1 US$ = 1200 MMK

According to a report from the Myanmar Police Force in Myanmar for 2015, there were 15,677 accidents that resulted in 5,037 deaths and 25,612 injuries (Central Statistical Organization, 2016), a traffic fatality rate of 9.6 deaths per 100,000 population. Therefore, the value of ($\Delta\rho$) for a 50% risk reduction in traffic deaths was 4.8 people per 100,000 people. On the basis of the median and mean WTP values, the

VSL was estimated using the equation given in section 3.3.3, as shown in Table 3.4. It can be seen that the estimated VSL for Myanmar car drivers ranged from 104.167 million MMK (US$ 86,805) to 195.771 million MMK (US$ 163,142), which was considerably lower than the VSL in other developed countries but comparable with other developing countries.

Table 3.4 VSL of car driver in 2015.

	WTP MMK (US$)	$\Delta\rho$ (x 100,000 pop)	VSL MMK x 10^6 (US$ x 10^3)
Mean	9397 (7.83)	4.8	195.771 (163.142)
Median	5000 (4.17)	4.8	104.167 (86.805)

3.4.3 Analysis of factors influencing WTP

3.4.3.1 Assessing the normality and the associations between the major variables

In this study, as the WTP values were slightly skewed, as shown in Table 3.3, these values were transformed into a natural logarithm for normality before the analysis. As only 29 respondents (7.5%) nominated a zero WTP value, these data were restrained in the analysis, and all nominal and categorical variables were transformed into dummy variables (Lee, Chung, & Son, 2008). Correlation analysis was employed to assess the inter-correlations between the major variables (Tao, Zhang, & Qu, 2017), and the skewness and kurtosis of the variables were examined to check the normality. From Kline (2011), skewness should be <3 and kurtosis <10.

Table 3.5 gives the definitions for all the observed variables, and Table 3.6 shows the correlation analyses for the candidate variables. It can be seen that no correlation values were zero, indicating that there was a relationship between the variables, which ranged from 0.003 to 0.398, with both positive and negative signs. Higher household income level 4 (HI4), household members (HM), car ownership (C), never drive against traffic (AG), never drive drunk (DD) and perceived risk (PRI) were all found to be significant and positively related to the WTP. Age (A) was found also to be statistically significant and negatively related to the WTP. In addition, perceived risk was found to have the strongest relationship with the WTP (r = 0.398). The sample characteristics for the candidate variables are shown in Table 3.7. All variables had skewness values less than 3 and kurtosis values less than 10, indicating that the variables were normal (Kline, 2011).

3.4.3.2 Model testing

Measurement models were constructed and tested using ML estimation. A number of preliminary analyses were conducted using various observed variables such as age, gender, income, education, and occupation in socioeconomic characteristics factor, trip purpose, exposure to traffic, seatbelt use, speaking phone, drunk driving in good driving behavior factor. However, the model fit index was found to be weak when all attributes were included. Therefore, after examining the analyses results, some items were excluded to improve the model fit; as a result, only four socioeconomic characteristic variables, five travel and driving behavior variables, and two risk perception variables were included in the measurement models. Structural paths were added to the measurement models and the model fit indices were assessed in the SEM model. The addition or deletion of pathways was executed based on an examination of the parameter estimates and model modification indices, which were found to be meaningful and consistent with theory. Finally, the structural model indices displayed a reasonably good fit.

Table 3.8 and Figure 3.1 show the parameter estimates for the measurement model and the path model. The obtained goodness of fit statistical values were: (1) chi-square ($\chi2$) = 82.194, (2) degree of freedom (df) = 58, (3) p-value = 0.020, (4) root mean square error of approximation (RMSEA) = 0.034, (5) comparative fit index (CFI) = 0.943, (6) Tucker Lewis index (TLI) = 0.911, and (7) standardized root mean square residual (SRMR) = 0.042. All statistical values were consistent with the suggested criteria for model fit except for the p-value <0.05, which was because the $\chi2$ value was sensitive to a large sample size (n > 200), so tended to reject the null hypothesis (Hooper et al., 2008; Kline, 2011). Therefore, because of the large sample size in this study, it was concluded that the model fit well, with the SEM model explaining 33.7% of the variance in the WTP.

3.4.3.3 Results of the structural and measurement models

Table 3.9 shows the direct effects, indirect effects, and the total effects of the factors and predictors for the WTP. As all estimated coefficients were standardized solutions, it was possible to compare the effects of each variable on the latent variables. For the direct effects, age was found to have a significant and negative influence on the WTP, while socioeconomic characteristics (β = 0.175), good driving behavior (β = 0.305), and risk perception factors (β = 0.542) were found to be significant and positively influenced the WTP. For the indirect effects, the gender (male) indicator (β = −0.426) was found to be significant and had a negative influence on the WTP mediated through good driving behavior. The risk perception factor was found to have the strongest effect (β = 0.542) on WTP, and age had the weakest effect (β = −0.010) on the WTP.

The SEM analysis results shown in Table 3.8, Table 3.9, and Figure 3.1, were as follows. The socioeconomic characteristics factor was measured using four observed variables: master's or higher degree education (E3), household income level 4 (HI4), household member (HM), and car ownership (C). All variables were statistically significant at a 0.001 level and had a positive effect on that factor. HI4 had the strongest influence (β = 0.619) and HM had the weakest influence (β = 0.260) on that factor. The socioeconomic characteristics factor was found to positively influence (β = 0.175) the WTP. From these results, it could be surmised that respondents with a Master's or higher education (E3) were more willing to spend on their traffic safety than respondents with high school (E1), diploma, or bachelor degree education (E2), which was consistent with findings in Yang et al. (2016) who reported that as more highly educated people were more inclined to pay greater attention to traffic safety and had a better understanding of the potential effects of traffic safety counter measures, they were more willing to pay than lower educated people were. Respondents from higher income families (HI4) were more willing to pay for traffic accident risk reduction than respondents from lower income families (HI1, HI2 and HI3) which was consistent with economic theory and was also in line with previous research in Sweden and France (Persson et al., 2001; Andersson, 2007; Andersson and Lindberg, 2009; Haddak, 2016), which found that the WTP increased with wealth. Respondents with a higher number of household members were more likely to pay for traffic accident reduction. A similar result was observed in Svensson (2009), which found that respondents who had children below the age of 18 living in the house had some (positive) association with the WTP for safety improvements. However, a contradictory result was found also in previous studies (Bhattacharya, Alberini, & Cropper, 2007; Andersson and Lindberg, 2009). Andersson and Lindberg (2009) investigated the value of road safety in Sweden and found that the WTP decreased with the number of adults in the household. Moreover, Bhattacharya et al. (2007) studied the WTP of commuters in Delhi, India and reported that the respondents who were primary household breadwinners tended to be more reluctant to pay for accident risk reductions as the number of dependents increased. It was also found that the WTP increased as the number of cars in the household increased. A possible reason for this finding is related to household income as only wealthier people would tend to have more than one car and therefore, would be more likely to pay for traffic accident risk reduction.

Gender (male) was found to be significant and negatively associated ($\beta = -0.426$) with good driving behavior, which indicated that the male respondents were more likely to violate traffic rules and regulations. This result was consistent with previous studies in Greece, Australia, and Spain (Fernandes, Hatfield, & Job, 2010; Vardaki and Yannis, 2013; Jiménez-Mejías, Prieto, Martínez-Ruiz, Castillo, Lardelli-Claret, & Jiménez-Moleón, 2014), all of which found that male drivers were more likely to be involved in risky behavior such as speeding, drink driving, cell phone use, and the lower use of seatbelts; therefore, gender (male) had a negative influence on the WTP mediated through good driving behavior. This result suggested that male respondents were less willing to pay for traffic accident fatality risk reduction compared to females.

The good driving behavior factor was measured using five indicators; seatbelt usage (SB), never drive against the traffic flow (AG), never use phone while driving (PH), never DD, and speeding (SP). All variables were found to be highly significant at a 0.001 level (except for SB, which was significant at a 0.01 level), and all were found to positively influence (β = 0.305) the WTP. Therefore, it could be surmised that respondents who often wore seatbelts were more willing to spend on traffic safety than respondents who rarely wore a seatbelt, respondents who never drove against the traffic flow were more likely to pay for accident risk reduction that respondents who often drove against traffic, respondents who never used their phone while driving were more likely to spend on traffic risk reduction than respondents who frequently used their phone while driving, respondents who never drove after drinking alcohol were more willing to pay for traffic accident risk reduction than respondents who often drove after drinking, and respondents who drove at no more than 70 kph were more willing to spend on accident risk reduction than respondents who often drove at more than 70kph. Therefore, these results indicated that respondents who obeyed traffic rules and regulations were more willing to pay for fatality risk reduction than respondents with risky behaviors were. In addition, DD had the highest parameter estimate value (β = 0.700) and SB had the lowest parameter estimate magnitude (β = 0.198), indicating that the never driving drunk indicator had the strongest influence on good driving behavior. A similar result was found in Moen (2007), who concluded that car drivers with a bad attitude toward traffic rules were less willing to pay for road accident risk reduction.

Age was found to be significant at a 0.05 level and had a negative influence (β = −0.010) on the WTP, suggesting that older respondents were less willing to pay for road accident fatality risk reduction, which was similar to previous studies in Sweden and Thailand (Andersson 2007, Chaturabong et al., 2011). Another possible explanation for the age effect on WTP was given in Andersson (2007), who speculated that older people had a lower WTP for mortality risk reduction as they had less time to live. Other possible reasons that older respondents were less willing to pay are; (1) as they rarely drove at high speed, they might have thought that they did not need to install a speed control device for risk reduction; and (2) they might think that their probability of death due to health problems was higher than the probability of death due to traffic accidents. As younger drivers might be accustomed to driving fast, they might have thought that it was better to install a speed controlled device so as not to exceed the speed limit.

The risk perception factor was measured by the accident experience of family or friends in the previous 2 years (FAE) and the perceived accident risk (PRI). All variables were found to be significant at a 0.001 level and were positively associated with that factor. In addition, the risk perception factor was found to positively influence ($\beta = 0.542$) the WTP, suggesting that respondents who believed that their accident risk was average or higher than average were more willing to pay for road safety than respondents who believed their accident risk to be lower than average. An alternative result was reported by Andersson and Lindberg (2009), who found that the WTP was lower in respondents who perceived their risk was lower than average. Further, respondents whose family or close friends had had an accident in the previous 2 years were more willing to pay for accident risk reduction, which was in line with previous studies in Sweden and France (Andersson and Lindberg, 2009; Haddak, 2016), both of which reported that WTP was higher in respondents who had had traffic accident experiences. The PRI had a higher magnitude parameter estimate (β = 0.782) than family or friend accident experience (β = 0.256), with the risk perception factor having the strongest influence on the WTP (β = 0.542).

Household income was found to have the greatest influence on the socioeconomic factor, while having never been involved in drink driving had the greatest influence on good driving behavior and perceived risk had a greater influence on the risk perception factor. Overall, the risk perception factor was found to have the greatest influence on the WTP for traffic accident fatality risk reduction.

Table 3.5 Definition of observed variables.

Code	Definition	Category
G	Gender	1 Male, 0 Female
A	Age	Continuous
FS	Family status	1 if married, 0 single
E1	Education level 1	1 if ≤ High School, 0 otherwise
E2	Education level 2	1 if Diploma or Bachelor, 0 otherwise
E3	Education level 3	1 if Master and above, 0 otherwise
O1	Occupation 1	1 if Student, 0 otherwise
O2	Occupation 2	1 if Government staff, 0 otherwise
O3	Occupation 3	1 if Private employee, 0 otherwise
O4	Occupation 4	1 if Private employer, 0 otherwise
I1	Individual income level 1	1 if ≤ 83, 0 otherwise
I2	Individual income level 2	1 if 84–166, 0 otherwise
I3	Individual income level 3	1 if 167 – 250, 0 otherwise
I4	Individual income level 4	1 if > 250, 0 otherwise
HI1	Household income level 1	1 if ≤ 166, 0 otherwise
HI2	Household income level 2	1 if 167–250, 0 otherwise
HI3	Household income level 3	1 if 251–416, 0 otherwise
HI4	Household income level4	1 if > 416, 0 otherwise
HM	Household member	Continuous
MC	No of motorcycle	Continuous
C	No of car	Continuous
CM	Compelling (school or work)	1 if School or work, 0 otherwise
VEH	Type of vehicle	1 if Private car, 0 otherwise
ETF	Exposure to the traffic (driving frequency)	1 if often, 0 otherwise
SB	Seatbelt usage	1 if often, 0 otherwise
AG	Driving against traffic flow	1 if never, 0 otherwise
PH	Speak phone while driving	1 if never, 0 otherwise
DD	Drunk driving	1 if never, 0 otherwise
SP	Usual operating speed	1 if ≤ 70 kph, 0 otherwise
PEA	Personal experience on accident	1 if had accident, 0 otherwise
FEA	Family or friends had accident	1 if had accident, 0 otherwise
PRI	Perceived risk of accident	1 if average or higher than average risk, 0 lower than average risk
WTP	Willingness to pay	Continuous

Table 3.6 Correlation of candidate variables.

	G	A	E3	HI4	HM	C	SB
G	1.00	.019	−.132*	.010	−.110*	−.240**	−.048
A		1.00	.092	.007	−.073	−.035	−.103
E3			1.00	.162**	−.161**	.171***	−.144**
HI4				1.00	.164**	.359***	.157**
HM					1.00	.211***	.015
C						1.00	.174**
SB							1.00

	AG	PH	DD	SP	FAE	PRI	WTP
G	−.123*	−.134*	−.303***	−.191***	.010	−.014	−.098
A	−.005	.017	.003	−.005	−.040	−.069	−.131*
E3	−.058	−.009	−.061	−.275***	−.003	.072	.055
HI4	−.034	−.107*	−.046	−.069	.049	.144**	.196***
HM	.034	.062	.067	.118*	.068	.065	.169**
C	.022	−.153**	.025	−.031	.140**	.096	.177***
SB	.083	−.003	.126*	.080	−.102	−.108*	.019
AG	1.00	.243***	.238***	.105*	−.075	−.107*	.243**
PH		1.00	.254***	.049	−.175**	−.136*	.031
DD			1.00	.158**	−.150**	−.065	.142**
SP				1.00	−.076	−.172**	−.065
FAE					1.00	.175**	.086
PRI						1.00	.398***
WTP							1.00

Notes: *p<0.05, **p<0.01, ***p<0.001

Table 3.7 Sample characteristics of candidate variables.

Code	Variable	M	SD	Sk Stat.	Sk Std. Err	Ku Stat.	Ku Std. Err
G	Gender	0.78	0.412	−1.384	.129	−0.085	.258
A	Age	37.92	10.470	0.520	.129	0.012	.258
E3	Master and above	0.30	0.459	0.874	.129	−1.244	.258
HI4	Household income level 4	0.44	0.497	0.250	.129	−1.948	.258
HM	Household member	3.66	1.365	0.299	.129	−.078	.258
C	Number of car	1.04	0.726	0.685	.129	.815	.258
SB	Seatbelt usage	0.54	0.499	−0.158	.129	−1.986	.258
AGT	Against traffic flow	0.64	0.481	−0.588	.129	−1.664	.258
PH	Speaking phone	0.23	0.422	1.286	.129	−.347	.258
DD	Drunk driving	0.62	0.487	−0.475	.129	−1.784	.258
SP	Speed	0.62	0.487	−0.475	.129	−1.784	.258
FAE	Family or friend accident experience	0.32	0.467	0.774	.129	−1.409	.258
PRI	Perceived risk	0.38	0.485	0.512	.129	−1.747	.258
WTP	Willingness to pay	8.861	.832	.194	.129	.367	.258

Note: M = mean, SD = standard diviation, Sk = skewness, Ku = kurtosis

Table 3.8 Parameter estimate of SEM.

Code	Factor/ Indicator	β	S.E.	Z
	Measurement Model			
	Socioeconomic Characteristic *was measured by*;			
E3	Master and above	0.268	0.107	2.498*
HI4	Household income level 4 (> 416)	0.619	0.203	3.051**
HM	Household member	0.260	0.108	2.408*
C	Number of car	0.517	0.145	3.569***
	Good Driving Behavior *was measured by*;			
SB	Seatbelt usage (often)	0.198	0.061	3.268**
AG	Against traffic flow (never)	0.356	0.066	5.371***
PH	Speaking phone (never)	0.341	0.064	5.335***
DD	Drunk driving (never)	0.700	0.082	8.549***
SP	Speed (≤ 70kph)	0.416	0.081	5.155***
	Risk perception *was measured by*;			
PAE	Family or friend accident experience	0.256	0.067	3.846***
PRI	Perceived risk	0.782	0.114	6.885***

Table 3.8 Parameter estimate of SEM (Continued).

Code Factor/ Indicator	β	S.E.	Z
Path Model			
Gender (Male) → Good Driving Behavior	−0.426	0.061	−7.040***
Socioeconomic Characteristic → WTP	0.175	0.087	2.006*
Good Driving Behavior → WTP	0.305	0.092	3. 304***
Risk perception → WTP	0.542	0.117	4.614***
Age → WTP	−0.010	0.005	−2.220*

Table 3.9 Direct effect, indirect effect and total effect to WTP.

Observed/ Latent variables	Indirect Effect to WTP	Direct effect to WTP	Total Effect to WTP by latent variable /indicator
Socioeconomic characteristic			
E3 HI4 HM C	-	0.175	0.175
Good driving behavior			
SB AG PH DD SP	-	0.305	0.305
Risk perception			
FAE PRI	-	0.542	0.542
A	−0.010		−0.010
G	−0.426 x 0.305 = −0.130	-	−0.130

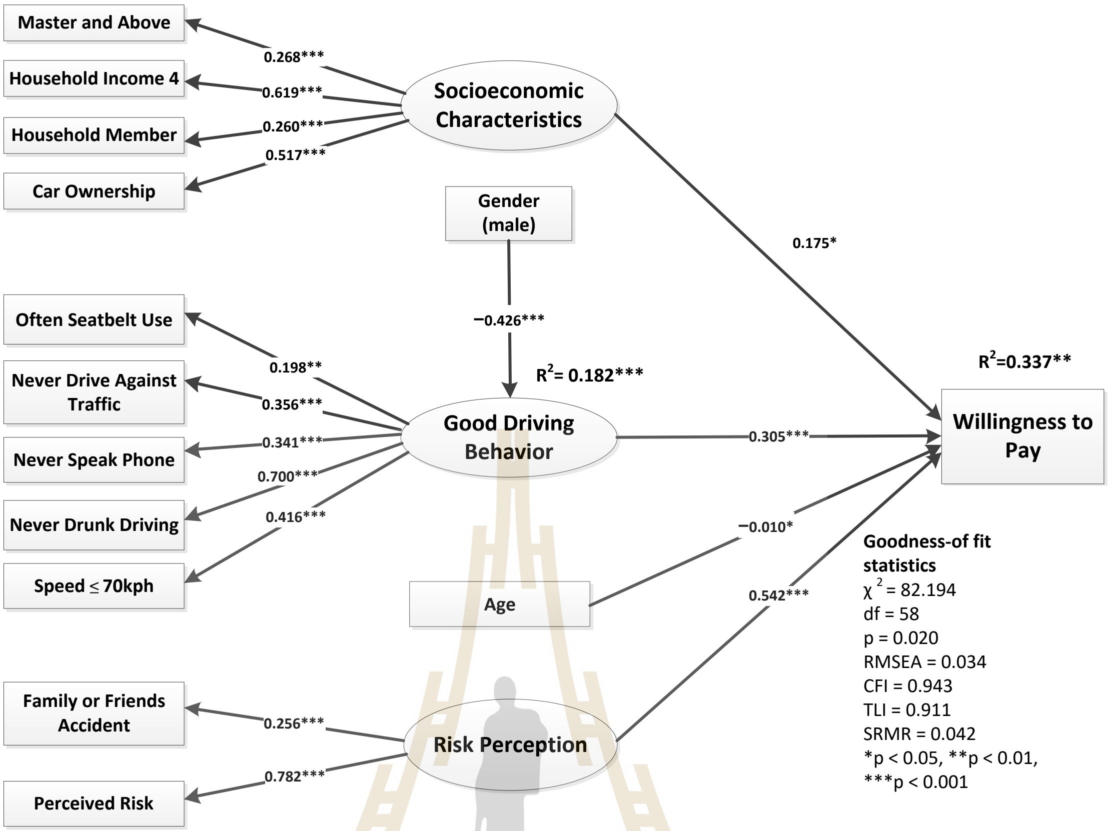

Figure 3.1 SEM of car drivers' WTP for fatality risk reduction

3.5 Conclusions

This study examined the subjective value of statistical life in Myanmar car drivers using a WTP and CV approach. Data collection was conducted using face-to-face interviews with 385 car drivers from seven major regions in Myanmar. The direct and indirect effects of the car driver's characteristics, behavior, and attitude toward the WTP were assessed using SEM.

The estimated VSL was found to have a mean value of MMK 195.771 million (US$ 0.163 million) and a median value of MMK 104.167 million (US$ 0.087 million), which was much lower than in developed countries, but generally comparable with other developing countries. Age and gender (male) were found to negatively influence the WTP, whereas socioeconomic characteristics (higher educated people, higher household income, number of household members, and car ownership), good driving behaviors (seatbelt usage, never drive against the traffic, never use phone, never DD, and drive at speeds less than 70 kph), and risk perception factors (accident experience and perceived risk) positively influenced the WTP, with the risk perception factor having the strongest influence on the WTP. This study is useful for government decision making for budget allocations and for the establishment and implementation of suitable road safety policies.

3.6 Study limitation and future study

This study used the same risk value for the whole population. Further, as the majority were private car drivers with higher education and higher incomes, the results may differ from other driver groups such as drivers of public vehicles. In future studies, public vehicle drivers with various risk reduction levels should be surveyed to determine scale insensitivity. The payment mechanism should also be designed for the public road safety aspect.

3.7 Acknowledgements

The project was funded by the Suranaree University of Technology Research and Development Fund.

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CHAPTER IV

WILLINGNESS TO PAY FOR MORTALITY RISK REDUCTION FOR TRAFFIC ACCIDENTS IN MYANMAR

4.1 Abstract

The dramatic increase in vehicle ownership in Myanmar over the past few years has resulted in an alarming increase in traffic accidents. Thus, road safety at the national level needs to be improved urgently in order to reduce the costs associated with traffic accidents and to assist policy makers in making economically efficient resource allocation decisions for road safety improvements. This research was conducted to determine the costs related to fatality risk reductions using a willingness to pay (WTP) approach for motorcyclists, car drivers, and bus passengers in Myanmar. Face-to-face interviews with contingent valuation (CV) and a payment card questionnaire approach was employed for the data collection; multiple linear regression analyses were conducted to determine the factors influencing WTP. The resulting median and mean for the value of statistical life (VSL) were found to be MMK 118.062 million (US$ 98,385) to MMK 162.854 million (US$ 135,712), respectively. Therefore, the total cost of death was estimated to range from MMK 594.681 billion (US$ 495.567 million) to MMK 820.296 billion (US$ 683.580 million) in 2015. In addition, the WTP was found to be significantly associated with age, family status, education, occupation, individual income, household income, the

vehicle used, exposure to traffic, drunk driving, personal experiences, and the perceived risk of traffic accidents. This study might be helpful in prioritization of road safety related projects to get greatest benefit by choosing most cost effective projects. This study might assist the decision-making for road safety budget allocations and policy development.

4.2 Introduction

4.2.1 Background

Statistics published by the World Health Organization reveal that over 1.2 million people are killed and around 50 million people are injured annually due to road accidents, globally. Although the number of registered vehicles in low- and middle-income countries is only 54% of the world's registered vehicles, over 90% of the world's road traffic deaths occur in these countries. Road traffic deaths in high-income countries are therefore half to that of low-income countries, which has been attributed to the successful implementation of road safety improvement programs (World Health Organization, 2015).

In Myanmar, similar to other low-income, developing countries, road accidents are one of the major causes of death. The number of vehicles on the roads increased dramatically after the relaxation of regulations regarding automobile imports in 2011. With this increase, there has been a commensurate rise in road accidents over the past five years. The 2015 statistics from the Road Transport Administration Department (RTAD) under the ministry of transport and communications in Myanmar state that the number of registered vehicles reached 5,541,361, i.e., more than double the registrations in 2011 (Central Statistical

Organization, 2016). Consequently, traffic accidents resulting in deaths and injuries have significantly increased, as shown in Figure 4.1. In 2003, there were 5,369 traffic accidents, which increased to 15,676 by 2015, thrice as that in 2003. In addition, the number of fatalities and injuries was over three times higher, rising from 1,172 and 8,082 in 2003 to 5,037 and 25,612 in 2015 (Central Statistical Organization, 2016).

Therefore, road safety has become a major concern in Myanmar, with experts from the Asian Development Bank estimating that fatalities could more than double over the next 5 to 10 years unless immediate action is taken. This indicates an urgent need to act upon road safety improvement (Asian Development Bank, 2016).

Figure 4.1 Trends in reported road traffic accident in Myanmar (Road Transport Administration Department, 2016)

Road accidents have serious consequences which include deaths, injuries, disabilities, material damages, pain, grief and suffering (Komba, 2006; Partheeban, Arunbabu, & Hemamalini, 2008; Haddak, Lefèvre, & Havet, 2016). Therefore, traffic accidents have considerable negative economic and social impacts on the accident victims, their family, friends, as well as on the nation as a whole (Gopalakrishnan, 2012; Niroomand and Jenkins, 2016). Further, the increasing number of traffic accidents results in increasing economic burden on the country as well as on the victim's families (Asian Development Bank, 2005; Haddak et al., 2016).

Road safety actions are difficult to justify without knowing the monetary benefits of road safety improvements (Bhattacharya et al., 2007). Therefore, as it is widely recognized that accident costs need to be estimated to perceive the scale of the existing problem, it is imperative to evaluate traffic accident costs for developing appropriate road safety policies (Jacobs, 1995; de Blaeij, Florax, Rietveld, & Verhoef, 2003; Silcock, 2003).

Compared with other developing countries, in Myanmar, there has been little road safety research focusing on the true costs of road accidents. This has been mainly because of the lack of reliable data to assist decision makers in taking relevant actions. Therefore, determining the true costs of traffic accidents in Myanmar is essential: (1) to determine the overall economic losses associated with road accidents; (2) to perceive the scale of the problem and the benefits derived from prevention policies; and, (3) to examine the determinants for the willingness to pay (WTP) in order to support key stakeholders develop better road safety policies.

4.2.2 Road safety in Myanmar

Myanmar is the largest country in mainland Southeast Asia. It boarders Bangladesh, India, China, Lao People's Democratic Republic (Lao PDR), and Thailand. The country had a population of 52.449 million in 2015 (Central Statistical Organization, 2016) within 676,578 km^2. According to statistics from the World Bank for 2015, the annual per capita gross national income (GNI) of Myanmar was US$ 1190, and the gross domestic product (GDP) was US$ 59.687 billion (World Bank, 2018).

The main mode of long distance travel is road transportation, which accounts for 90% of freight and 86% of passenger transportation (Asian Development Bank, 2016). The country's road network has a length of 151,298 km and only 39,076 km is paved (British Chamber of Commerce, 2017). Around 20 million people are living without basic road access. Moreover, road conditions in Myanmar are very poor, with deficient surface conditions, narrow widths, and a lack of safety features due to underinvestment in road infrastructure. Thus, maintenance or rehabilitation is urgently needed to retrofit the existing roads and improve safety (Asian Development Bank, 2016). Due to poor road conditions in Myanmar, factors contributing to road crashes might be higher than those in other countries; however, no previous research exists regarding contributing factors in road crashes in Myanmar. According to data reported in the Myanmar Statistical Yearbook 2016, regarding causes of traffic accidents, factors contributing to road crashes included the following: (1) driver carelessness (65.7%); (2) traffic rule violations of pedestrians and passengers (7.5%); (3) vehicle defects (4.9%); (4) road defects (1.9%); and (5) other factors (20%).

Regarding vehicle conditions, most (about 90%) vehicles are secondhand and are imported from used vehicle markets in Japan. These are usually right-hand drive vehicles, even though Myanmar roads are suitable for left-hand drive vehicles. This creates more road crashes because drivers cannot see traffic coming from the opposite side while overtaking other vehicles. According to the RTAD report, more than 80% of total registered vehicles are motorcycles, which cause more than half of total road crashes and around half of total road traffic deaths (Asian Development Bank, 2016). Additionally, bicycles, motorcycles, and pedestrians accounted for nearly 60% of road traffic deaths. In 2013, one third of injured patients who were admitted to hospitals were victims of road crashes (Asian Development Bank, 2016). Public Health Statistic (2017) also reported that road injuries were the third leading cause of premature death in 2016. Furthermore, road crashes were the first leading cause of death among 15–29-year-olds, and the road traffic mortality rate per 100,000 people increased more than doubled from 2010 to 2016 (Public Health Statistics, 2017).

Experts from ADB estimated that the economic loss due to road crashes was between 1% and 1.5% of the total GDP in Myanmar (though no detailed calculation or method was mentioned). The ADB recommended an increase in investments in the transport sector of 3%–4% of GDP, up from 1% to 1.5%, in line with other countries such as Thailand and Vietnam. Myanmar is in the initial stage of road safety awareness, and many deficiencies exist that should be addressed for improvement, such as the poor crash data system, shortcomings in relevant legislation, and the need for more safety management funding (Asian Development Bank, 2016).

4.2.3 Literature review on previous related research on developing countries

Chaturabong, Kanitpong, & Jiwattanakulpaisarn (2011) estimated the value of statistical life (VSL) and the value of statistical injury (VSI) for motorcyclists in Thailand using the WTP-CV approach. Questionnaire surveys were conducted in Bangkok and at surrounding areas in several different locations, such as universities, schools, private companies, and government offices. Participants included 1,015 motorcyclists who were randomly selected. The mean WTP values were calculated using simple arithmetic means, and the factors influencing WTP were observed using regression analysis. The estimated VSL ranged from \$0.17 million to \$0.21 million, and the VSI ranged from \$0.08 million to \$0.10 million. Individuals with lower incomes, older people, and male motorcyclists were less willing to pay, while government officers and motorcyclists who often wore a helmet were more willing to pay for their fatality risk reduction.

Bhattacharya, Alberini, & Cropper (2007) calculated the VSL of commuters in Delhi using the WTP-CV approach. Commuters aged 18–65 years and with at least an 8th grade education, including pedestrians, motorcyclists, and bicyclists, were interviewed as part of the urban household population. Surveys were conducted in 2005 with 1,200 respondents. The determinants of the WTP were examined using probit regression analysis. The estimated VSL was \$0.15 million. Income, education, and exposure to traffic positively influenced the WTP, while household size negatively influenced the WTP.

Yusof, Nor, & Mohamad (2013) approximated fatal injury costs due to road accidents in Malaysia using the WTP with the conjoint analysis (CA) design technique. 4,000 respondents, including car drivers and motorcyclists, were interviewed in 13 states of Malaysia. The factors influencing the WTP were analyzed using linear regression analysis. Income, vehicle ownership, occupation, race, risk perception, gender, and accident experience were statistically significant and influenced the WTP. The estimated VSL ranged from $0.36 million (MYR 1.15 million) to $0.45 million (MYR 1.45 million) using the CA, and that value was comparable with the VSL of the previous study using the CV approach.

4.2.4 Literature review on methods for accident cost approximation

Jacobs (1995) and Silcock (2003) described the different approaches to accident costing, such as the human capital (HC) approach, the net output approach, the life insurance approach, and the WTP approach; of these, the HC and WTP approaches have been used most commonly in the last few decades.

The HC approach focuses on the discounted value of the loss of output from the victim but does not consider the loss of quality of life (Chaturabong et al., 2011; Ainy, Soori, Ganjali, & Baghfalaki, 2015; Haddak et al., 2016). WTP, on the contrary, attempts to approximate the maximum cost that individuals would need to pay for reducing the risk of a fatality or injury and is based on an individual's subjective preferences and perceptions (Rizzi and Ortúzar, 2006). In recent years, the subjective WTP approach has been used to value road safety in numerous developed countries rather than the HC approach, which has been heavily criticized by several economists (Hensher, Rose, & Ortúzar, 2009) because of its serious restrictions in assessing socioeconomic issues and its inconsistency with cost-benefit analyses (Elvik, 1995).

There are two major ways to extract the WTP: revealed preference (RP) and stated preference (SP). Although SP can be used to value both market goods and non-market goods, RP can be used only for market goods available easily in the market (Vloerbergh, Fife-Schaw, Kelay, Chenoweth, Morrison, & Lundehn, 2007). The RP method also extracts people's actual behaviors and choices (Bateman, Carson, Day, Hanemann, Hanleys, Hett, Jones-Lee, Loomes, Mourato, & Ozdemiroglu, 2002; Svensson and Vredin Johansson, 2010).

SP can also be used when the required data for RP is unavailable and for valuing the non-market impacts (Bateman et al., 2002). Strand (2002) confirmed the suitability of SP to assess people's road safety WTP as it has a public goods aspect that allows an analysis of how safety improvements can affect the statistical risk of each person. SP can also be categorized into two approaches: choice modeling (CM) and contingent valuation (CV). In the CM approach, the preferred characteristics are chosen by the respondents from several options, such as different attribute levels for travel time, costs and accident risks (Bateman et al., 2002). However, the CM approach was felt to be unsuitable for Myanmar respondents, as they may just choose randomly without due consideration.

Whittington (1998) stated that the CV approach has mostly been used to estimate "preferences for goods or services for which a conventional market does not exist" (Whittington, 1998). Therefore, SP-CV is the most suitable approach for accident costing. The most widely used methods for designing a WTP-CV questionnaire are open-ended, dichotomous choice, and payment card format, each of which has its own strengths and weaknesses (Reaves, Kramer, & Holmes, 1999; Bateman et al., 2002). Reaves et al. (1999), Bateman et al. (2002), Svensson and

Vredin Johansson (2010) found that the payment card format could ease the valuation process for respondents, especially for those with a lower cognitive ability, and provide data collection efficiencies, resulting in higher response rates and more reliable WTP values. Therefore, this study used a WTP-CV payment card method for collecting data.

From the literature review, a WTP-CV payment card questionnaire design was found to be the most suitable method for Myanmar respondents, many of whom have a low educational level and are unfamiliar with risk reduction valuations. Due to the lack of accurate and detailed data, no such research has been previously conducted, making this study the pioneer WTP traffic accident costing research in Myanmar.

This research primarily aimed to estimate the economic loss resulting from traffic-related deaths to determine the magnitude of the traffic accident problem and to assess the influence of WTP for providing information to policy makers in the road safety decision-making process. In this paper, a contingent valuation-payment card questionnaire approach was used to elicit the WTP for fatality risk reduction by Myanmar road users. A VSL concept was also employed to estimate the traffic accident costs in Myanmar for 2015. Multiple linear regression analyses were then conducted to assess the factors influencing WTP.

4.3 Materials and methods

In this study, a WTP-CV questionnaire using the payment card method was applied to estimate the willingness to pay for road traffic fatality risk reduction. The respondents were categorized into three road-user groups; motorcyclists, car drivers, and intercity bus passengers. As Myanmar respondents were unfamiliar with the WTP concept and risk reduction values, post mail and email surveys were not found to be suitable. Therefore, face-to-face interviews were the only way to ensure a complete understanding of the questionnaire so as to choose an appropriate WTP value (Yusof et al., 2013).

First, the interviewer explained the reasons for the questionnaire, the research, the importance of road safety, the impact of traffic accidents and the road accident fatality rate to the respondents. The road accident fatality risk was calculated from the data reported by the RTAD in 2015. As road traffic deaths by road-user type were unavailable, the fatality risks were determined from the number of deaths in the country divided by the country’s population. Therefore, the same risk value was used for all road users in the questionnaire. A 50% risk reduction for fatalities was set on the basis of the Myanmar national goal for road safety improvement; the VSL was evaluated from the average of the mean and median WTP for the three road-user types divided by the risk changes; and the fatality road accident costs were calculated for 2015. Finally, multiple linear regressions were used to analyze the factors influencing the WTP.

4.3.1 Questionnaire design

The respondents were informed that the goods or services being valued in the WTP question were hypothetical and were only used as an example for easy risk reduction valuation. The primary focus of the WTP questionnaire was to elicit the maximum amount an individual would be willing to spend on reducing their road accident mortality risk by 50% each year.

The questionnaire comprised five sections: (1) socioeconomic characteristics; (2) travel behavior and exposure to traffic; (3) driving behavior; (4) accident experience and perceived risk; and (5) a WTP valuation question to reduce individual traffic accident fatality risks (Haddak et al., 2016). The payment card format with minor modifications is depicted in Figure 4.2. The detailed content included in the above categories is explained in the following.

What is the maximum amount of **extra money** that you would spend for **Option B** (**for 50%** risk reduction of the fatality in the road accident)? Please tick (✓) / write the amount that you can pay at below;					
Myanmar Kyat (MMK)					
0	50	100	200	300	400
500	750	1000	1250	1500	2000
3000	4000	5000	7000	9000	11000
13000	15000	18000	20000	25000	30000
35000	40000	45000	50000	More than 50000	
or ………… MMK. (Any other amount which is not mentioned above)					

Figure 4.2 Payment card format

4.3.1.1 Socioeconomic characteristics

This section extracted general information about the respondents such as their sex, age, marital status, education, occupation, individual income, household income, household size, and vehicle ownership (Norinder, Hjalte, & Persson, 2001, Chaturabong et al., 2011; Abdallah, El Hakim, Wahdan, & El Refaeye, 2016; Haddak et al., 2016).

4.3.1.2 Travel behavior and exposure to traffic

The travel behavior of the road users was assessed, including their trip purpose, vehicle used, and exposure to traffic (Norinder et al., 2001; Chaturabong et al., 2011; Haddak et al., 2016).

4.3.1.3 Driving behavior

The driving behavior of the motorcyclists and car drivers, and the riding behavior of the intercity bus passengers were collected, which covered helmet or seatbelt usage, driving against traffic flow, driving speed, speaking on the phone while driving, and drunk driving (Chaturabong et al., 2011; Haddak et al., 2016).

4.3.1.4 Accident experience and perceived risk

Perceived risks and direct (personal) and indirect (family or friend) experience of traffic accidents were collected (Norinder et al., 2001; Bhattacharya et al., 2007; Haddak et al., 2016).

4.3.1.5 WTP questionnaire

This critical part of the questionnaire elicited the monetary valuation for an individual’s fatality risk reduction. In this section, the respondents needed to express their WTP for a fatality road accident risk reduction. The WTP questionnaires were designed on the basis of previous research (Jones-Lee, Hammerton, & Philips, 1985; Chaturabong et al., 2011) and three different WTP questionnaires were designed for motorcyclists, car drivers, and intercity bus passengers, as follows:

The interviewer requested the motorcyclists to consider buying a new helmet when riding a motorcycle and were given two choices (Helmet A and

Helmet B), each of which had a one year warranty for head-injury safety but had different prices per the safety quality. Helmet A cost MMK 5,000, with the probability of death due to head injury being eight deaths per 100,000 people each year. However, the probability of death due to head injury with Helmet B was four deaths per 100,000 people each year. Therefore, as Helmet B was able to reduce the probability of head-injury death by 50% (Chaturabong et al., 2011), respondents were asked about the extra amount they would be willing to pay for Helmet B.

The car drivers were asked to imagine that if they installed a safety device such as a speed-control device in their car, the probability of death due to a road accident could be reduced by 50% from eight to four deaths per 100,000 people each year. If they were required to rent the safety device annually, respondents were asked to estimate the amount they would be willing to pay (Norinder et al., 2001; Svensson and Vredin Johansson, 2010).

The intercity bus passengers were requested to envisage that they needed to board on a bus from Yangon, a business city situated in southern Myanmar, to Mandalay, the cultural city in the middle of Myanmar, located over 600 km from Yangon. Bus passengers had two alternatives (Bus A and Bus B), with the bus ticket price based on the bus condition (e.g., speed-control devices and good tires), and the experience of the driver in terms of safety as most accidents occur because of tire blowouts, speeding, and sleepy drivers. The risk of a fatality when traveling on Bus A was eight deaths per 100,000 people with a ticket costing MMK 10,000 per trip. The probability of death when traveling by Bus B was four deaths per 100,000 people, half the risk of Bus A (Jones-Lee et al., 1985; Chaturabong et al., 2011). Respondents were asked to estimate the amount they would be willing to pay for a Bus B ticket for a 50% reduction in the accident risk of being killed while traveling.

4.3.2 Data collection

The questionnaires were translated into Myanmar and a pilot test with 15 respondents for each road-user type was conducted in October 2016 to investigate the respondents' understanding of the questionnaire. The questionnaires were then edited per the respondents' comments. Data was collected from November 2016 to January 2017 in seven main regions: Nay Pyi Taw, Yangon, Mandalay, Magway, Sagaing, Bago, and Ayeyawady, all of which have a high population and a high accident occurrence. This study targeted respondents who had been exposed to traffic as they were the main beneficiaries of road safety programs. Respondents were selected using the stratified random sampling technique for road-user categories. They included motorcyclists, car drivers, and bus passengers who lived in urban areas in the seven major regions. Respondents over 18 years and who had at least an 8th grade education were interviewed in order to understand risk information and the WTP question. The number of respondents for each region was determined based on the population and the number of registered vehicles in each region. Prior to the interviews, the reasons for the questionnaire and the research were explained to the respondents. Additionally, the importance of road safety, the impact of traffic accidents, and the road accident fatality rate in Myanmar were explained. Then, the interviewer asked the respondents about their socioeconomic characteristics, travel and driving behaviors, experience and risk perception, and the WTP value for a 50% fatality risk reduction. Face-to-face interviews were conducted at different locations, such as government offices, private companies, schools, universities, staff dormitories, homes, and streets. Green (1991) suggested that the minimum sample size should be eight times the number of predictors, plus 50 for multiple correlations, and for partial correlations, 104 plus the number of predictors should be used. Field (2013) has also stated that the required sample size for multiple regression analysis should be 10 times the number of predictors. The number of predictors were 34, 34, and 30 for motorcyclists, car drivers, and bus passengers, respectively. Based on Green's (1991) suggestion, the minimum sample size for multiple correlation was 322 for motorcyclists and car drivers and 290 for bus passengers. After excluding the respondents with zero WTP, the sample sizes used in the analyses included 420 motorcyclists, 356 car drivers, and 401 bus passengers, which were sufficient samples for the analyses. The total sample used in this study was 1,222 respondents, including 429 motorcyclists, 385 car drivers, and 408 intercity bus passengers.

4.3.3 Accident cost methodology

The VSL concept was applied for the accident costing (Persson, Norinder, Hjalte, & Gralen, 2001), which is defined as the total amount of money an individual is willing to pay to avoid the expected occurrence of one fatality (Hensher et al., 2009; Chaturabong et al., 2011). VSL can be estimated as the mean or median value of the WTP divided by the change in the risk (Δρ) (Mohd Fauzi, Nor Ghani, Radin Umar, & Ahmad Hariza, 2004; Andersson, 2007; Svensson and Vredin Johansson 2010; Yusof et al., 2013). The formula for estimating VSL is shown in Equation 4.1.

$$\text{VSL}=\frac{\text{mean or median WTP}}{\Delta\rho} \qquad 4.1$$

VSL: Value of statistical life

WTP: Willingness to pay

$\Delta\rho$: Change in risk for fatalities

4.3.4 Analyzing the WTP determinants

Multiple regression analysis is widely used for various research objectives, including the followings: (1) to predict one variable using combined knowledge from several other variables; (2) to decide which variables of a larger set are better predictors of certain criterion variables; (3) to determine how much more effectively we can predict a variable when adding one or more predictor variables to the analysis; (4) to examine the relationship of one variable to a set of other variables; and (5) to statistically explain the variance of one variable using a set of other variables (Meyers, Gamst, & Guarino, 2006). Generally, multiple regression analysis can serve an explanatory as well as a predictive purpose (Meyers et al., 2006). Regarding the data set, multiple regression analysis can be used when dependent variables (DV) are continuous and independent variables (IV) are continuous or dichotomous (Tabachnick and Fidell, 2007). The objective of the present study was to examine factors influencing the WTP without the intention of predicting the WTP. The data set in this study had a continuous DV and continuous and dichotomous IVs. Thus, the use of multiple regression analysis was suitable in this study as in other previous research (Persson et al. 2001, Andersson 2007, Chaturabong et al. 2011, Mofadal, Kanitpong, & Jiwattanakulpaisarn, 2015). Multiple linear regression analysis was employed to determine the variables influencing WTP for fatality risk reduction. WTP values were transformed into natural logarithm to get better normality before analysis. Three separate models for motorcyclists, car drivers and intercity bus passengers were analyzed using Social Package for Statistical Science (SPSS) software.

Specification of the empirical model is as follows:

$$
\begin{aligned}
\text{Log (WTP)}_i = {} & b_0 + b_1 GEN_i + b_2 AGE_{1i} + b_3\, AGE_{2i} + b_4\, AGE_{3i} \\
& + b_5\, AGE_{4i} + b_6\, FAMST_i + b_7\, EDU_{1i} + b_8\, EDU_{2i} \\
& + b_9\, EDU_{3i} + b_{10}\, OCCUP_{1i} + b_{11}\, OCCUP_{2i} \\
& + b_{12}\, OCCUP_{3i} + b_{13}\, OCCUP_{4i} + b_{14}\, IDINC_{1i} \\
& + b_{15}\, IDINC_{2i} + b_{16}\, IDINC_{3i} + b_{17}\, HHINC_{1i} \\
& + b_{18}\, HHINC_{2i} + b_{19}\, HHINC_{3i} + b_{20}\, HHMEMB_i \\
& + b_{21}\, NOMC_i + b_{22}\, NOCAR_i + b_{23}\, COMPEL_i \\
& + b_{24}\, MAINVEH_i + b_{25}\, EXPORT_i + b_{26}\, HELMET_i\, / \\
& b_{26}\, SEATBELT_i + b_{27}\, AGTR_i + b_{28}\, PHONE_i + b_{29}\, ALC_i \\
& + b_{30}\, SPEED_i + b_{31}\, PERACEXP_i + b_{32}\, FAMACEXP_i + \\
& b_{33}\, FRIACEXP_i + b_{34}\, PERRISK_i \qquad (4.2)
\end{aligned}
$$

WTP_i = Willingness to pay for i^{th} person

b_0 to b_{34} = unstandardized coefficient of the model

The definition of independent variables were shown in Table 4.6.

4.4 Results and discussion

4.4.1 Descriptive statistics of respondents

The descriptive statistics for the respondents are discussed briefly in the following. There were 1,222 respondents in total; 429 motorcyclists, 385 car drivers, and 408 intercity bus passengers. The socioeconomic characteristics, travel behavior, driving behavior, accident experience, and accident risk perceptions are depicted in Tables 4.1, 4.2, and 4.3. It can be seen that the proportion of males was higher among the car drivers and that of females was higher among the bus passengers. A high percentage (66.9% of motorcyclists, 49.6% of car drivers, and 77.9% of intercity bus passengers) of respondents comprised diploma or bachelor degree holders, with 30.1% of the car drivers holding a Master's degree and above. Most bus passengers (58.3%) and motorcyclists (64.6%) included government staff; however, only 24.7% of the car drivers worked for the government. Car drivers included private employees (31.7%) or others (33.5%) such as private employers, housewives, or pensioners. Among the car drivers, 48.6% earned US$ 167–416 monthly (1US$ = MMK 1200). Further, 49.2% of the motorcyclists and 51.7% of the bus passengers earned US$ 84–166 monthly. Lesser car drivers were in the ≤ US$ 250 monthly household income level but more were in the >US$ 833 monthly household income level. Most (82.1% to 88.7%) respondents had a trip purpose of traveling to school or work and only 6.8% to 29.9% had experienced a traffic accident in the last two years. For the perceived risk to accident variable, 57.8% to 74.6% of the respondents believed that their accident risk was lower than the average risk, with only 3.6% to 11.3% of the respondents perceiving that their accident risk was average or higher than average. Similar results were also observed in earlier studies (Jones-

Lee and Whittaker, 1989; Andersson and Lundborg, 2007), which explained that the observed underestimation of fatality risks might be due to “optimism bias or availability heuristic” as most people considered that negative consequences were less likely to occur because their way of living was safer than others.

Table 4.1 Socioeconomic characteristics of respondents.

Socioeconomic characteristics		Motorcyclist		Car Driver		Intercity Bus Passenger	
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Gender	Male	198	46.2	303	78.7	111	27.2
	Female	231	53.8	82	21.3	297	72.8
Age (year)	≤ 20	28	6.5	9	2.3	38	9.3
	21–30	206	48.0	85	22.1	136	33.3
	31-–40	117	27.3	156	40.5	108	26.5
	>40	78	18.2	135	35.1	126	30.9
Marital Status	Single	249	58.0	107	27.8	246	60.3
	Married	180	42.0	287	72.2	162	39.7
Education	≤ High-school	88	20.5	78	20.3	55	13.5
	Diploma or Bachelor	287	66.9	191	49.6	318	77.9
	≥ Master	54	12.6	116	30.1	35	8.6
Occupation	Student	44	10.3	21	10.1	60	14.7
	Government staff	277	64.6	212	24.7	238	58.3
	Private employee	80	18.6	43	31.7	82	20.1
	Others	28	6.5	109	33.5	28	6.9

Table 4.1 Socioeconomic characteristics of respondents (Continues).

Socioeconomic characteristics		Motorcyclist		Car Driver		Intercity Bus Passenger	
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Individual Income (US$)	≤ 83	104	24.2	39	10.1	87	21.3
	84–166	211	49.2	95	24.7	211	51.7
	167–416	106	24.7	187	48.6	95	23.2
	417–833	6	1.4	30	7.8	11	2.7
	>833	2	0.5	34	8.8	4	1.0
Household Income (US$)	≤ 250	209	48.7	78	20.3	149	36.5
	251–416	143	33.3	136	35.3	148	36.3
	417–583	48	11.2	60	15.6	53	13.0
	584–833	15	3.5	35	9.1	31	7.6
	> 833	14	3.2	76	19.8	27	6.6
Household member	≤ 3	162	37.8	190	49.4	150	36.8
	4–5	179	41.7	162	42.0	178	43.6
	> 5	88	20.5	33	8.6	80	19.6
No of Motorcycle	≤ 2	352	82.1	362	94.0	386	94.6
	≥ 3	77	17.9	23	6.0	22	5.4
No of Car	Do not have Car	361	84.1	70	18.2	286	70.1
	Have car	68	15.9	315	81.8	122	29.9

A comparison of the mean of the most important demographic characteristic in our sample with the average of the Myanmar population was as follows: the mean age of respondents in this study was 35, which is comparable to the average age of the adult population of Myanmar, which was 38 (CSO, 2016). According to World Bank data, Myanmar's gross national income (GNI) per capita was US$ 1190 in 2015, which was much lower than the mean individual income in the sample, US$ 2600 per year. However, the average household income of US$ 4998 (multiplying average household size 4.2 with GNI) in the Myanmar population was comparable to the mean household income of US$ 5030 per year, which was the most significant factor in this study. However, the level of education in the sample was much higher than the average education of the Myanmar population. In the sample, only 18% of the respondents had up to a high school education, while less than 20% of the Myanmar population had studied beyond high school (The Myanmar Time, 2015). Moreover, vehicle ownership in our sample was higher than the number of households that had vehicles as reported in the 2014 Myanmar census. More than three fourth (87%) of respondents had a motorcycle or car in their household, while nearly half of the Myanmar population had those types of vehicles in their households (Department of Population, 2014).

Table 4.2 Travel behavior and driving behaviour.

Travel / Driving Behavior		Motorcyclist		Car driver		Intercity bus passenger	
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Trip Purpose	Non-compelling	69	16.1	69	17.9	46	11.3
	Compelling (school, work)	360	83.9	316	82.1	362	88.7
Main Vehicle Used	Main Vehicle / Private car (Others)	394 (35)	91.8 (8.2)	313 (72)	81.3 (18.7)	277 (131)	67.9 (32.1)
Riding / Driving frequency	Not often	79	8.4	101	26.6	51	12.5
	Often	350	81.6	284	73.8	357	87.5
Helmet /Seatbelt Usage	Never	9	2.1	36	9.4	206	50.5
	Rarely	10	2.3	61	15.8	84	20.6
	Sometimes	49	11.4	83	21.6	62	15.2
	Frequently	95	22.1	77	20.0	32	7.8
	Always	266	62.0	128	33.2	24	5.9
Riding Against Traffic	Frequently	2	0.5	-	-		
	Sometimes	19	4.4	9	2.3		
	Rarely	138	32.2	128	33.2		
	Never	270	62.9	248	64.4		
Speak Phone	Frequently	1	0.2	15	3.9		
	Sometimes	40	9.3	110	28.6		
	Rarely	125	29.1	171	44.1		
	Never	263	61.3	89	23.1		
Drink Driving	Frequently	1	0.2	2	0.5		
	Sometimes	32	7.5	29	7.5		
	Rarely	59	13.8	128	33.3		
	Never	337	78.6	226	58.7		
Usual Operating Speed Motorcycle / Car	> 50kph / > 70kph	50	11.7	46	37.9		
	≤ 50kph / ≤ 70kph	379	88.3	239	62.1		

Table 4.3 Accident experience and perceived risk.

Accident experience and risk perception			Motorcyclist		Car driver		Intercity bus passenger	
			Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Accident experience	Personal	No	366	85.3	349	90.6	376	92.2
		Yes	63	14.7	36	9.4	32	7.8
	Family	No	400	93.2	359	93.2	374	91.7
		Yes	29	6.8	26	6.8	34	8.3
	Friend	No	319	74.4	270	70.1	328	80.4
		Yes	110	25.6	115	29.9	80	19.6
Perceived risk of accident	< average risk		320	74.6	251	65.2	236	57.8
	= average risk		93	21.7	120	31.2	126	30.9
	> Average risk		16	3.7	14	3.6	46	11.3
Total Sample			429		385		408	

Table 4.4 WTP value for 50 percent risk reduction in fatality.

Road User	Mean MMK(US$)	Median MMK(US$)	SD MMK(US$)	Skewness	SE of Skewness	Sample size	No (%) zero WTP
1.Motorcyclist	7809 (6.51)	7000 (5.83)	4964 (4.14)	0.76	0.118	429	9 (2.1)
2.Car Driver	9397 (7.83)	5000 (4.17)	10548 (8.79)	2.54	0.124	385	29 (7.5)
3.Bus Passenger	6246 (5.21)	5000 (4.17)	3648 (2.89)	0.43	0.121	408	7 (1.7)
Average (1+2+3)	7817 (6.56)	5667 (4.72)				1222	45 (3.7)

Note: MMK= Myanmar Kyat, 1US$ = 1200 MMK

4.4.2 Mean and median WTP values for 50% fatality risk reduction

The mean and median WTP values for a 50% fatality risk reduction are listed in Table 4.4. A lower percentage of motorcyclists (2.1%), car drivers (7.5%), and bus passengers (1.7%) selected a zero WTP. As a higher percentage of car drivers nominated a zero WTP, the car drivers may have been influenced by the example in the questionnaire. Drivers who were accustomed to driving slowly may also have thought that they did not need to install a speed control device, and some respondents may also have believed that the main cause of accidents was the driver and not the car. The mean values for the WTPs were MMK 7,809 (US$ 6.51), MMK 9,397 (US$ 7.83), and MMK 6,246 (US$ 5.21) for motorcyclists, car drivers, and intercity bus passengers, respectively. The median WTP values were MMK 7,000 (US$ 5.83), MMK 5,000 (US$ 4.17) and MMK 5,000 (US$ 4.17) for motorcyclists, car drivers, and intercity bus passengers, respectively, significantly lower than the mean WTP values. The car driver WTP was the highest, while the bus passenger WTP was the lowest. The disparity in the WTP could be explained to some extent by the differences in incomes as the car drivers belonged to a higher-income group. The average mean and median WTP values were MMK 7,817 (US$ 6.56) and MMK 5,667 (US$ 4.72), respectively, for the three road-user types.

4.4.3 VSL and accident cost

The Road Transport Administration Department (RTAD) (2016) statistics reported that in Myanmar in 2015, which has a population of 52.449 million, there were 15,676 accidents that resulted in 5,037 deaths and 25,612 injuries; a traffic fatality rate of 9.6 deaths per 100,000 population. The value of ($\Delta\rho$) for a 50% risk reduction in traffic deaths was 4.8 people per 100,000 people (Central Statistical

Organization, 2016). On the basis of average value of the mean and median WTP values shown in Table 4.4, the VSL was estimated from the equation in section 2.3 and the accident cost was calculated by multiplying the VSL and the total number of traffic deaths in 2015, as shown in Table 4.5. It can be seen that the estimated VSL for Myanmar road users ranged from MMK 118.062 million (US$ 98,385) to MMK 162.854 million (US$ 135,712), and the accident cost ranged from MMK 594.681 billion (US$ 495.567 million) to MMK 820.296 billion (US$ 683.580 million).

Table 4.5 VSL and accident cost of fatality in 2015.

	WTP MMK (US$)	$\Delta\rho$ (x 100,000 pop)	VSL MMK x 10^6 (US$ x 10^3)	Total no of fatality	Accident cost MMK x 10^9 (US$) x 10^6
Mean	7817 (6.56)	4.8	162.854 (135.712)	5037	820.296 (683.580)
Median	5667 (4.72)	4.8	118.7062 (98.385)	5037	5954.681 (495.567)

4.4.4 Determinants of WTP

As the WTP values in Table 4.4 were slightly skewed, especially for car drivers, the WTP values were transformed into a natural logarithm for better normality before the analysis. As only 1.7% to 7.5% of the respondents gave zero WTP values, these data were dropped from the regression analyses.

Table 4.6 Definition of independent variables.

Independent Variable	Definition	Category
GEN	Gender	1 Male, 0 Female
AGE1	Age level 1	1 if ≤ 20, 0 otherwise
AGE2	Age level 2	1 if 21–30, 0 otherwise
AGE3	Age level 3	1 if 31–40, 0 otherwise
AGE4	Age level 4	1 if > 40, 0 otherwise
FAMST	Family status	1 if married, 0 single
EDU1	Education level 1	1 if ≤ High School, 0 otherwise
EDU2	Education level 2	1 if Diploma or Bachelor, 0 otherwise
EDU3	Education level 3	1 if Master and above, 0 otherwise
OCCUP1	Occupation 1	1 if Student, 0 otherwise
OCCUP2	Occupation 2	1 if Government staff, 0 otherwise
OCCUP3	Occupation 3	1 if Private employee, 0 otherwise
OCCUP4	Occupation 4	1 if Private employer, 0 otherwise
IDINC1	Individual income level 1	1 if ≤ 166, 0 otherwise
IDINC2	Individual income level 2	1 if 167–250, 0 otherwise
IDINC3	Individual income level 3	1 if > 250, 0 otherwise
HHINC1	Household income level 1	1 if ≤ 250 (MC,BP), 1 if ≤ 416 (CD), 0 otherwise
HHINC2	Household income level 2	1 if 251–416 (MC,BP), 1 if 417–833 (CD), 0 otherwise
HHINC3	Household income level 3	1 if > 416 (MC,BP), 1 if > 833 (CD), 0 otherwise
HHMEMB	Household member	Continuous
NOMC	No of motorcycle	Continuous
NOCAR	No of car	Continuous
COMPEL	Compelling (school or work)	1 if School or work, 0 otherwise
MAINVEH	Main vehicle used	1 if Motorcycle (bus for bus passenger), 0 otherwise
VEH	Type of vehicle	1 if Private car (CD), 0 otherwise

Note: MC = Motorcyclist, CD = Car driver, BP = Intercity bus passenger

Table 4.6 Definition of independent variables (Continued).

Independent Variable	Definition	Category
EXPOTR	Exposure to the traffic (riding/driving frequency)	1 if often, 0 otherwise
HELMET	Helmet usage	1 if often, 0 otherwise
SEATBELT	Seatbelt usage	1 if often, 0 otherwise
AGTR	Driving against traffic flow	1 if never, 0 otherwise
PHONE	Speak phone while driving	1 if never, 0 otherwise
ALC	Drink driving	1 if never, 0 otherwise
SPEED	Usual operating speed	1 if ≤ 50 kph (MC), 1 if ≤ 70 kph (CD), 0 otherwise
PERACEXP	Personal experience on accident	1 if had accident, 0 otherwise
FAMACEXP	Family had accident	1 if had accident, 0 otherwise
FRIACEXP	Friend had accident	1 if had accident, 0 otherwise
PERRISK	Perceived risk of accident	1 if average or higher than average risk, 0 lower than average risk

Note: MC = Motorcyclist, CD = Car driver, BP = Intercity bus passenger

Table 4.7 shows the results of the multiple linear regression analyses for motorcyclists, car drivers, and bus passengers, in which the dependent variables comprised the natural WTP logarithms and the independent variables comprised the socioeconomic characteristics, travel behavior, driving behavior, accident experience, and risk respondent perceptions, as depicted in Table 4.6. Scatter plots for the standardized residual versus fitted values and independent variables, the normal probability plot, and the variance inflation factors (VIF) were assessed to confirm model validity. No patterns were found in the scatter plot for the standardized residuals against the fitted values and there was no evident deviation from normality in the normal Q-Q plot, and all VIF values were less than 5 (Rogerson, 2001).

Table 4.7 Results of multiple linear regression analysis on natural logarithm of WTP.

Independent Variable	Motorcyclist			Car Driver			Intercity Bus Passenger		
	b	β	t-Test	b	β	t-Test	b	β	t-Test
GEN	0.119	0.083	1.392	0.001	0.000	0.004	0.020	0.013	0.278
AGE1	0.150	0.052	0.967	0.353	0.067	1.114	0.043	0.017	0.274
AGE2				0.189	0.094	1.491			
AGE3	-0.094	-0.059	-1.129				-0.033	-0.021	-0.385
AGE4	-0.223	-0.119	-2.186**	0.035	0.020	0.338	-0.078	-0.052	-0.850
FAMST	0.209	0.144	2.712**	-0.009	-0.005	-0.076	0.135	0.096	1.848*
EDU1				-0.042	-0.020	-0.330			
EDU2	0.301	0.198	3.131***				0.250	0.149	2.372**
EDU3	0.691	0.322	4.739***	0.012	0.007	0.097	0.428	0.173	2.771***
OCCUP1	-0.605	-0.258	-4.401***	-0.266	-0.072	-1.039	-0.279	-0.140	-1.837*
OCCUP2				-0.045	-0.027	-0.293	-0.102	-0.073	-1.081
OCCUP3	0.000	0.000	0.003	-0.153	-0.058	-0.895			
OCCUP4				0.075	0.032	0.460			
IDINC2	0.078	0.031	0.535	0.211	0.118	1.801*	0.057	0.032	0.636
IDINC3	0.176	0.094	1.839*	-0.047	-0.027	-0.307	-0.036	-0.015	-0.276
HHINC2	0.232	0.153	2.965***	0.268	0.138	2.456**	0.415	0.289	5.562***
HHINC3	0.324	0.174	3.105***	0.139	0.066	0.952	0.760	0.493	8.445***
HHMEMB	-0.002	-0.005	-0.099	0.024	0.039	0.697	-0.027	-0.063	-1.240
NOMC	-0.063	-0.077	-1.397	-0.001	-0.001	0.012	0.003	0.005	0.093
OWNCAR	-0.005	-0.003	-0.052	0.053	0.046	0.654	0.060	0.051	1.061
COMPEL	0.008	0.004	0.080	-0.057	-0.026	-0.499	-0.101	-0.047	-0.850
MAINVEH	0.096	0.036	0.769	0.091	0.043	0.617	-0.149	-0.102	-2.002**
EXPOTR	0.068	0.036	0.763	0.174	0.093	1.714*	0.061	0.030	0.574
HELMET	0.004	0.002	0.038					0.059	1.182
SEATBELT				0.019	0.011	0.206	-0.059	-0.030	-0.651

Note: ***, **, * indicate significance at the 1%, 5% and 10% levels, respectively. b, β = Unstandardized and standardized coefficient,

Table 4.7 shows the results of the multiple linear regression analyses for motorcyclists, car drivers, and bus passengers, in which the dependent variables comprised the natural WTP logarithms and the independent variables comprised the socioeconomic characteristics, travel behavior, driving behavior, accident experience, and risk respondent perceptions, as depicted in Table 4.6. Scatter plots for the standardized residual versus fitted values and independent variables, the normal probability plot, and the variance inflation factors (VIF) were assessed to confirm model validity. No patterns were found in the scatter plot for the standardized residuals against the fitted values and there was no evident deviation from normality in the normal Q-Q plot, and all VIF values were less than 5 (Rogerson, 2001). Therefore, the models in this research were shown to hold with the multiple linear regression assumptions.

The results presented in Table 4.7 show that the variables significantly correlating with the WTP were age, family status, education, occupation, individual income, household income, the vehicle used, exposure to traffic, drunk driving, personal experience of an accident, and perceived accident risk.

Among the individual characteristics, age was found to be significant and negatively associated with WTP for motorcyclists, which suggested that older motorcyclists were less willing to pay for accident risk reduction. This result was consistent with findings in previous studies conducted in Sweden and Thailand (Andersson 2007, Chaturabong et al. 2011) and contradicted the findings in Mofadal et al. (2015), who found that older pedestrians tended to pay a higher amount for safety than younger people. The results of Svensson (2009) also had an inconsistent age pattern between the two surveys as did the findings in Evans and Smith (2006) who concluded that the age factor affected VSL differently. Family status was another positive significant factor for motorcyclists and bus passengers, which indicated that married people were willing to pay more for road safety than unmarried people. This finding was different from a study of Sudanese pedestrians (Mofadal et al., 2015) that found married people are less willing to pay for safety than single people.

Education was also significantly and positively related to WTP for motorcyclists and bus passengers. The magnitude of the positive coefficient for EDU3 was higher than EDU2, indicating that respondents with a Master's or PhD degree were more willing to pay higher accident risk reduction premiums than diploma or bachelor degree holders. This result confirmed the results of previous research (Bhattacharya et al., 2007; Dissanayake, 2010; Mofadal et al., 2015) that found that highly educated people to be more willing to pay for risk reduction than intermediate or lowly educated people. Occupation was also significantly and negatively associated with the WTP of motorcyclists and bus passengers. The potential explanation of the negative coefficient in OCCU1 was that students, who have little or no income, were less willing to pay accident risk reduction than government staff and private employees, who have incomes. A similar result was found in a study on motorcycle accident costs in Thailand (Chaturabong et al., 2011). Yusof et al. (2013) also concluded that different employment sectors affected the VSL differently.

For individual income, IDIN2 and IDIN3 were found to be significant and positively related with the WTP of motorcyclists and car drivers. This finding confirmed those in earlier studies (Persson et al., 2001; Bhattacharya et al., 2007; Chaturabong et al., 2011; Yusof et al., 2013) that reported wealthier respondents to be more willing to pay for their safety than respondents with lower incomes. As expected, household income was a significant factor for an increased WTP for all road users. The positive coefficients increased from HHINC2 to HHINC3 (except for car drivers), which revealed that people from higher-income families are willing to invest more in road safety than people from low-income families. This result supported the findings in previous research (Persson et al., 2001; Andersson, 2007; Mofadal et al., 2015) that concluded that WTP increased with an increase in household income.

The coefficient estimate for exposure to traffic was positively and statistically significant with the WTP of car drivers, indicating that people who drive very often are likely to pay more for risk reduction. This result supported earlier research from Sweden (Andersson, 2007). A study by Bhattacharya et al. (2007) also reported that the VSL of people with a higher traffic exposure was thrice to that of people with a lower traffic exposure. The coefficient for the perceived risk of a traffic accident was also positive and highly significant for car drivers, suggesting that car drivers who believe their accident risk is average or higher than average are more willing to pay for road safety compared with drivers with a low accident risk perception. A similar result was found in the previous study in Sweden (Andersson and Lindberg, 2009) that found that a lower WTP was observed in respondents who had a lower perceived risk.

As regarded by driving behavior, no variables had any significant impact on the WTP, except for drunk driving for car drivers. The drunk driving variable was significant and positively associated with the WTP of car drivers, indicating that car drivers who never drank before driving were more willing to pay for risk reduction. An alternative result was reported by Chaturabong et al. (2011) who found that motorcyclists with alcohol-impaired driving were less willing to pay for severe injury risk reduction. The variable for the vehicle used was significant and negatively influenced the WTP of bus passengers. A possible reason for the negative coefficient was that main bus users, who may have a lower income than the other bus users who use motorcycle or car sometimes, want to pay less for their safety.

For accident experience, only the personal experience of a traffic accident was found to be significant and positively related to bus passenger WTP, which suggested that bus passengers who had experienced prior road accidents were more willing to pay for risk reduction than passengers who had not experienced them. This result was compatible with findings in previous research (Mohd Fauzi et al., 2004; Andersson and Lindberg, 2009; Dissanayake, 2010; Haddak et al., 2016). However, in contrast, Chaturabong et al. (2011) found that motorcyclists who had experienced a road accident were less willing to pay compared with more inexperienced motorcyclists.

4.5 Conclusions

This paper examined the economic losses related to road traffic deaths in Myanmar using a WTP with a CV approach. The impact of the road user's characteristics such as socioeconomic status, travel behavior, driving behavior, accident experience, and risk perception; on WTP for accident risk reduction were then analyzed. The data collection was conducted in seven major regions; Nay Pyi Taw, Yangon, Mandalay, Magway, Sagaing, Bago, and Ayeyawady, of Myanmar using face-to-face interviews with 1,222 motorcyclists, car drivers, and bus passengers. In this study, traffic safety facilities such as helmets, speed controlled devices, and safer buses with well-trained drivers were applied as different scenarios for the three types of road users. A modified payment card was employed to determine the WTP value.

Per the WTP mean and median values, the Myanmar road-user VSL was estimated to range from MMK 118.062 million (US$ 98,385) to MMK 162.854 million (US$ 135,712), with the total cost of traffic deaths for 2015 ranging from MMK 594.681 billion (US$ 495.567 million) to MMK 820.296 billion (US$ 683.580 million). In this study, the positively significant determinants for Myanmar's road users were found to be family status, education level, individual income, household income, exposure to traffic, drunk driving, personal accident experience, and perceived traffic accident risk. Of these, household income and education (except for car drivers) were found to strongly influence the WTP. However, older people, main bus users, and students were found to be less willing to pay. Possible reasons why older people had less WTP were that they had less remaining life left, and they might have believed that the probability of death due to other health problems may be higher than that of traffic death. Moreover, another possible reason for less WTP of students in motorcyclist and bus passenger models was that they were young and, therefore, were at the age of risk-taking behavior, and they did not have their own income. Young motorcyclists might also overestimate their riding ability.

In car driver model, we found that individual income level 2 and household income level 2 were positive and significantly influenced the WTP, and education did not influence the WTP. Possible reasons for the influence of household income and the lack of influence of education on the WTP include the followings: (1) some drivers might emphasize the commodity (speed-controlled device) and drive only in urban areas with slow speed, thinking that they do not need to install a speed-controlled device. Thus, their WTP might not have significantly increased with their household income and (2) higher income was not significantly related to higher education (master's or Ph.D.) in car drivers in the data, even though education (up to high school) had a positive relationship with the lower income level of the Myanmar population (especially in rural areas). As an example, the education (bachelor's and above) of government staff is higher than private employees; however, the salary of government staff is lower than that of private employees in Myanmar. The income of respondents with a master's degree or Ph.D. may not be higher than respondents with a bachelor's degree. Similarly, the income of private employers was higher than government staff; however, their education level was lower than government staff. The proportion of private employers and private employees was higher in the car model, whereas the proportion of government staff was higher in the motorcyclist and bus passenger model. The trend of education and income levels of car drivers was different than other models. This may reflect choosing the WTP for risk reduction and may require additional in-depth study for results.

The VSL in this study can be used as an input in benefit cost analysis to compare the benefit of preventing loss of life with the cost of road safety measures, which include the followings: (1) eliminating sharp curves on the road to reduce the number of overturning vehicles; (2) adding rumble strips to the expressway to reduce the number of vehicles that veer off the road; (3) widening the carriageway width to provide sufficient space for passing vehicles; (4) building pedestrian bridges to eliminate hazardous pedestrian crossing; and (5) separating motorcycle and bicycle lanes by widening shoulder widths to reduce motorcycle/bicycle and car crashes. Identifying the most cost-effective projects will allow for the greatest benefit. The

VSL is also useful in the decision-making process of allocating scare resources. This can aid in the creation of effective methods at the national level and allow for an equivalent benefit from the prevention of road injuries and other national investments such as healthcare systems. Myanmar road authorities can increase the budget allocation for road safety by perceiving the amount of economic loss due to road traffic death from this research. To increase WTP for road accident risk reduction, road safety authorities need to educate more and do more road safety campaign to increase awareness and risk perception on road safety by specifying specific target group of road users based on the research such as students.

This study provided the figures for the cost of road traffic deaths for 2015 and examined the behavior and attitudes of Myanmar's road users toward traffic accident risk. These findings are helpful for stakeholders and policy makers when assessing the impact of the traffic accidents and when making decisions about budget allocations and policies to improve road safety in Myanmar.

4.6 Limitations

Currently, the number of deaths by road-user categories is not available; therefore, the road accident fatality risk was calculated on the basis of the whole population in Myanmar. Moreover, accidents and deaths may be underreported as they are in other developing countries. This study did not make adjustments for this shortcoming. The main limitation of this study was the difference in individual income and education. The level of individual income in this study was two times higher than the Myanmar GNI per capita in 2015. The mean level of education in this study was higher than average of the Myanmar population as people with a lower education level had a difficult time understanding WTP question. Thus, the VSL for the whole Myanmar population might be lower than the VSL in this study. Pedestrians, bicyclists, and bus and truck drivers were not included in this survey.

4.7 Acknowledgement

The project was funded by the Suranaree University of Technology Research and Development Fund. The authors would like to thank anonymous reviewers for their valuable comments included in earlier drafts of this paper. The authors would like to thank Enago (www.enago.com) for the English language review.

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CHAPTER V

WILLINGNESS TO PAY FOR TRAFFIC ACCIDENT RISK REDUCTION FOR NON-FATAL INJURIES IN MYANMAR

5.1 Abstract

The rapid rise in vehicle ownership in Myanmar since 2011 has resulted in a dramatic increase in traffic accidents, deaths, and injuries, which has had a significant impact on families and the economy. This study estimates the economic losses from road accidents in Myanmar to assess the scale of the road safety problems and to examine road users' road safety perceptions. A contingent valuation method using a payment card format was employed to elicit the road users' willingness to pay (WTP) for serious injury risk reduction, after which multi-nominal logistic regression (MNL) analyses were employed to determine the factors influencing WTP. The value of the statistical injury (VSI) was found to range from MMK 38.387 million (US$ 31,989) to MMK 44.205 million (US$ 36,837), with the total cost of serious traffic injuries for 2015 ranging from MMK 542.113 billion (US$ 451.761 million) to MMK 624.264 billion (US$ 520.220 million). It was found that age, education, number of household members, income, household income, motorcycle ownership, seatbelt usage, and direct and indirect accident experience had significant influences on the WTP for serious injury risk reduction, of which household income was found to have the strongest

influence. The results of this study could assist in making road safety policy decisions to improve road safety.

5.2 Introduction

Road accidents have become a growing problem worldwide. More than 1.2 million people are killed and around 50 million people injured in road accidents each year (World Health Organization, 2015). In spite of rising vehicle ownership in high-income countries, the traffic accident death rate has been falling due to the successful road safety interventions. However, in low and middle income countries, the traffic baccident death rate continues to rise and was reported as being twice as high as in high-income countries (World Health Organization, 2015).

A recent study on Myanmar transport sector policies on road safety by ADB reported that the road safety situation in Myanmar was at a critical state. The rapid increase in vehicle ownership in Myanmar has meant that there are many inexperienced drivers on the road, which has resulted in an alarming increase in traffic accidents, traffic deaths, and injuries (Asian Development Bank, 2016). The road traffic accident trend recorded by traffic police is shown in Table 5.1. It can be seen that the number of accidents, injuries, and deaths increased 2.7, 2.7, and 3.9 times within ten years (from 2005 to 2015), with the ratio of the number of deaths, serious injuries, and slight injuries being 1:2.8:2.3 in 2015, and the percentage of serious injuries to total injuries being 55% (Central Statistical Organization, 2016), which was significantly higher than in India, Sweden and the United States (Evans, 1991; Verghese, 1991; Martinez, 1997); however, this may have been because of the underreporting of accidents that only resulted in slight injuries. A Ministry of Health report from 2013 reported that one-third of injuries in patients admitted to government hospitals were the result of road accidents. Therefore, traffic accidents have become a major public health issue and a heavy socio-economic burden both on the victims' families and the nation. As Myanmar's road safety awareness is in an initial phase, there is a general weakness in the road safety management system as there is a poor data recording system, weak legislation, and insufficient road safety education funding. (Asian Development Bank, 2016). Therefore, there is an urgent need to take action to curb the rise in traffic accidents. To ensure the successful implementation of road safety interventions, substantial management funding is required. To this end, this study seeks to estimate the economic losses caused by traffic injuries (and specifically serious injuries) to determine the full magnitude of the problem and assist decision makers in deciding on the appropriate funding for road safety improvements.

Table 5.1 Traffic accident trend in Myanmar (Traffic Police).

Year	No. of accident	No of slight injury (SL)	No of serious injury (SE)	No of death (D)	No of total injury (TIJ)	D:SE:SL	% of SE/TIJ
2005	5755	4721	4899	1283	9620	1:3.8:3.7	50.93
2010	9020	6498	9515	2461	16013	1:3.9:2.6	59.42
2011	10123	9258	7822	2796	17080	1:2.8:3.3	45.80
2012	11675	7823	11861	3422	19684	1:3.5:2.3	60.26
2013	13912	12736	10642	3721	23378	1:2.9:3.4	45.52
2014	14997	10992	11092	4144	22084	1:2.7:2.7	50.23
2015	15677	11490	14122	5037	25612	1:2.8:2.3	55.14

Jones-Lee (1976) categorized six methodologies for estimating accident costs; (1) the gross output or human capital (HC) approach, (2) the net output approach, (3) the life insurance approach, (4) the court award approach, (5) the implicit public sector valuation approach, and (6) the value of risk change or willingness to pay (WTP) approach (Jones-Lee, 1976; Jacobs, 1995; TRL, 2003). Of these, the HC and WTP approaches have been the most widely used for traffic accident costing. The HC approach focuses mainly on the loss of production due to traffic injuries and estimates the impact of the losses associated with death or injury which include the loss of output, medical costs, property damages, and administrative costs. In recent years, an arbitrary percentage has sometimes been added to the total costs to reflect the human costs associated with the pain, grief, and suffering (Jones-Lee, Loomes, O'reilly, & Philips, 1993; Jacobs, 1995; TRL, 2003). Up to 2015 in Myanmar, for example, not all medical costs were provided by government hospitals and victims needed to buy some medicines from the drug stores outside the hospitals. Moreover, because of the poor data recording system, the detailed data required for the HC approach is very difficult to extract (Mohan, 2002). Therefore, this study estimated the traffic injury costs using the WTP approach. The WTP approach focuses on individual preferences and perceptions and assesses the maximum amount individuals are willing to pay to reduce their risk of loss of life or injury (Mishan, 1971; Weinstein, Shepard, & Pliskin, 1980; Haddak, Lefèvre, & Havet, 2016). The two main categories associated with the WTP approach are revealed preference (RP) and stated preference (SP) (Strand, 2002). As the RP assesses an individual’s actual behavior and choices, it has been mainly used in market related research (Andersson, 2005), which has been found to be difficult to conduct in developing countries (Bhattacharya, Alberini, & Cropper, 2007). SP, however, can be used for both market and non-market goods (Bateman, Carson, Day, Hanemann, Hanleys, Hett, Jones-Lee, Loomes, Mourato, & Ozdemiroglu, 2002); therefore, as road safety valuations are non-market goods, SP was chosen as the most suitable approach to gain the risk reduction valuation for traffic accidents in Myanmar. The SP approach uses questionnaires in which people are asked about their WTP for hypothetical risk reductions. The two main SP categories are choice modeling (CM) and contingent valuation (CV). In the CM approach, people need to choose from different levels of service or goods attributes (Bateman et al., 2002). However, CM was seen to be appropriate for Myanmar participants as people may have chosen a WTP value randomly. In the CV approach, participants are directly asked to give the maximum amount they would be willing to pay for changes in the quality of a non-market good or service (Bateman et al., 2002). Whittington (1998) reported that CV was mostly used in valuing goods not available in a regular market (Whittington, 1998). Therefore, the CV approach was deemed suitable for accident costing in Myanmar. There are several CV formats that can be used to elicit WTP such as open-ended, bidding games, or payment cards. Of these, as the payment card format avoids anchorage bias, reduces outliers, and eases the valuation task, it has been seen as superior to the other formats (Bateman et al., 2002; Vloerbergh, Fife-Schaw, Kelay, Chenoweth, Morrison, & Lundehn, 2007).

Therefore, as a result of the literature review, a WTP-CV approach using a payment card was used to elicit people's willingness to pay for serious injury risk reduction. The value of statistical injury (VSI) and the accident costs for serious injury in 2015 were estimated and the factors affecting WTP were then examined using multi-nominal logistic regression. This research was the first attempt to estimate the costs associated with serious injuries from road accidents in Myanmar.

5.3 Materials and methods

In this study, a WTP-CV questionnaire with a payment card format was used to elicit the WTP for severe injury road accident risk reduction. Participants were classified into three road-user groups; car drivers, motorcyclists, and intercity bus occupants. As the risk reduction valuation and WTP concept were very new for Myanmar road users, face-to-face interviews were seen as the most suitable approach to ensure complete comprehension of the questionnaire so that participants would select a suitable WTP.

Prior to the interviews, participants were given a reason for asking the questionnaire; the numbers of road accidents, fatalities, serious injuries, accident trends in Myanmar, and traffic accident consequences. The serious injury risk value was calculated from the reported traffic police data in 2015. As data on the number of serious injuries by road-user type were not obtainable, the serious injury risk was calculated from the total number of serious injuries from road accidents divided by the population in Myanmar in 2015.

5.3.1 Questionnaire design

The questionnaires were designed based on prior studies and had four sections. The first section collected socio-economic participant data: gender, age, marital status, education, occupation, income, and vehicle ownership (O'Reilly, Hopkin, Loomes, Jones-Lee, Philips, Mcmahon, Ives, Soby, Ball, & Kemp, 1994). The second section gathered information about the riding/driving behaviors of the participants: seatbelt/helmet usage, driving against traffic flow, drunk driving, phone-usage while driving, and speeding. The third section assessed accident experiences and risk perceptions: direct (personal) and indirect (family, friends or relatives) accident experiences (O'Reilly et al., 1994) and the participant's view on their own road accident probability. The last section was the critical part of the questionnaire which extracted the individual's annual WTP for serious injury risk reduction. In this section, participants were told that the goods or services to be valued in the WTP questions were hypothetical and given as an example to make their risk reduction valuation easier. Three distinct WTP questionnaires were designed for car drivers, motorcyclists, and intercity bus occupants.

The car drivers were requested to imagine that they needed to take a highway trip (eg., from Yangon to Mandalay) once a year. On that route, the probability of being seriously injured in an accident was 26 per 100,000 people and the toll fee for a passenger car (PC) was 5000 MMK per trip. If the road were improved with fencing, widening, resurfacing etc., the probability of being seriously injured in an accident would reduce to 13 per 100,000 people and the PC toll fee would increase. The participants were then asked the maximum extra toll fee that they would be willing to pay for a severe injury risk reduction of 50%.

The motorcyclists were asked to imagine that they were required to buy a new motorbike helmet and were provided with a choice of two helmet types (Helmet A and Helmet B) with different prices depending on the severe head injury safety quality (Bhattacharya et al. 2007, Chaturabong, Kanitpong, & Jiwattanakulpaisarn, 2011). Each helmet had a one year warranty for head injury safety. Helmet A had a probability of severe head injury of 26 per 100,000 people each year and cost 5000 MMK, and Helmet B had a probability of severe head injury of 18 per 100,000 people each year and could reduce the risk of severe head injury by 50%. Participants were then asked the maximum extra amount they would be willing to pay for Helmet B.

Bus occupants were requested to imagine that they were accustomed to going on a highway trip once a year and they needed to take a bus (eg., from Yangon to Mandalay). The bus occupants had two alternatives (Bus A and Bus B) that had different ticket prices based on bus safety quality (eg., installed speed control devices, seatbelts, good tires) and driver experience (Jones-Lee, Hammerton, & Philips, 1985; Chaturabong et al., 2011). The risk of severe injury by traveling on Bus A was 26 per 100,000 people while that of Bus B was 13 per 100,000 people each year; that is, traveling on Bus B could reduce the risk of severe injury by 50%. If the ticket price of Bus A was 5000 MMK per trip, participants were asked to estimate the maximum extra amount they would be willing to pay for a Bus B ticket.

5.3.2 Data collection

The questionnaires were translated into Myanmar and pilot tested to ensure participant understanding, after which the questionnaires were revised based on the pilot participants' comments. Data were gathered in seven major regions: Ayeyarwady, Yangon, Bago, Nay Pyi Taw, Mandalay, Magwe, and Sagaing. Participants were randomly selected and the face-to-face interviews performed at several locations such as universities, student dormitories, government offices, company offices, and staff dormitories. A total of 1182 participants; 385 car drivers, 393 motorcyclists, and 404 bus occupants; were interviewed from October 2016 to January 2017. Based on Hosmer Jr, Lemeshow, & Sturdivant (2013), the minimum sample size for an MNL analysis should be at least ten times the independent variables but twenty times was preferable (Hosmer Jr et al., 2013). As there were 14 to 18 independent variables, the minimum sample required for the MNL analysis was 140 to

180; therefore, the sample size used in this study was more than twenty times the number of independent variables.

5.3.3 Accident costing methodology

The VSI was used for the accident costing, which is the integrated amount of a person's WTP to prevent the expected occurrence of one statistical injury (Chaturabong et al., 2011). The VSI can be calculated as the mean or median value of WTP divided by the risk change (Δρ) (Persson, Norinder, Hjalte, & Gralen, 2001; Svensson, 2009a) as shown in equation 5.1.

$$\text{VSI} = \frac{\text{mean or median WTP}}{\text{Change in risk } (\Delta\rho)} \tag{5.1}$$

5.3.4 Analyzing the WTP determinants

Multi-nominal logistic (MNL) regression is an extension of binary logistic regression and can be used when the dependent variable has more than two categories (Bayaga, 2010; Starkweather and Moske, 2011). MNL has been found to be a suitable method when the response variables are categorical and the explanatory variables are categorical or continuous or both (Bayaga, 2010; Starkweather and Moske, 2011). MNL has been found to be superior to multiple regression analysis because of its robustness to violations of linearity assumptions and multivariate normality (Bayaga, 2010). Therefore, this study used MNL to examine the factors influencing the WTP for serious injury risk reduction. Prior to the analysis, the WTP values were grouped into WTP low, medium, and high categories for each road-user group, with the high WTPs being used as the reference category. The Social Package for Statistical Science software (SPSS) was then used to analyze the three separate models: car drivers, motorcyclists, and intercity bus occupants.

5.4 Results and discussions

5.4.1 Descriptive statistics of participants

The participant characteristics are presented in Table 5.2. The majority of car drivers were male (78.7%) and most motorcyclists (68.7%) and bus occupants (79.0%) were female. Just under half the motorcyclists (48.1%) and bus occupants (43.3%) were aged 21–30 years and a large minority of car drivers (40.5%) were aged 31–40 years. Most car drivers were married (72.2%) and most motorcyclists (74.3%) and bus occupants (68.8%) were single. Many participants were government staff (44.3% of motorcyclists, 55.1% of car drivers, and 61.1% of bus occupants) with most being diploma or bachelor degree holders (64.6% of motorcyclists, 49.6% of car drivers and 63.4% of bus occupants). Monthly motorcyclist, car driver, and bus occupant individual incomes were up to US$83 (57.8%), up to US$ 166 (34.8%) and US$84–166 (45.8%). A significant proportion of motorcyclists (49.1%) and bus occupant (55.0%) participants had monthly household incomes of US $167–416 and most car drivers (44.4%) had monthly household incomes above US$ 416. About one-third of the participants (35.4% car drivers and 38.4% bus occupants) did not have a motorcycle in the household. Around three-quarters (78.6% motorcyclists and 70.5% bus occupants) did not own a car. More than three-quarters (81.3%) of car drivers drove their own car and 19.7% of car drivers drove a company or government car.

Around half the car drivers often wore seatbelts while less than one-third of bus occupants often wore seatbelt. The low seatbelt wearing rate for the bus occupants may be because of the unavailability of seatbelts on buses as some (approximately one-third to half) of intercity buses in Myanmar did not install seatbelts until 2015. Nearly three-quarters (70.7%) of motorcyclists often wore a helmet. More than half (54.7% motorcyclists and 64.4% car drivers) the participants never drove against the traffic, and 61.8% of motorcyclists and 23.1% of car drivers never used their phone while driving. 90.6% of motorcyclists and 58.7% of car drivers never drove after drinking alcohol. The higher percentage of motorcyclists who never drove drunk may have been because of the high proportion of female participants as most Myanmar women do not drink alcohol. Around half the motorcyclists (54.5%) did not drive more than 40 kph and 62.1% of car drivers did not drive more than 70 kph. These low driving speeds may have been because most participants drove only in urban areas.

Table 5.2 Descriptive statistics of participants.

Variables	Code	Descriptions			Models		
		Car drivers	Motorcyclists	Bus occupants	Car drivers	Motorcyclists	Bus occupants
Participants		Total number of participants			385	393	404
WTP	1	≤ 1.67	≤ 3.75	≤ 2.5	30.9%	24.4%	28.0%
(US$)	2	1.68–4.16	3.76–7.5	2.6–5.0	31.9%	44.3%	38.9%
	3	> 4.16	> 7.5	> 5.0	37.1%	31.3%	33.1%
Gender	0		Female		21.3%	68.7%	79.0%
	1		Male		78.7%	31.3%	21.0%
Age (year)	1		≤ 20		2.3%	23.4%	17.3%
	2		21–30		22.1%	48.1%	43.3%
	3		31–40		40.5%	15.0%	19.6%
	4		>40		35.1%	13.5%	19.8%
Marital Status	0		Single		27.8%	74.3%	68.8%
	1		Married		72.2%	25.7%	31.2%
Education	1		≤ High-school		20.3%	17.8%	12.4%
	2		Diploma or Bachelor		49.6%	64.6%	63.4%
	3		≥ Master		30.1%	17.6%	24.2%
Occupation	1	Self-employed	Student	Student	15.3%	46.1%	28.0%
	2	Government staff	Government staff	Government staff	55.1%	44.3%	61.1%
	3	Private employee	Others	Others	11.2%	9.7%	10.9%
	4	Others			18.4%	–	–
Monthly Individual Income	1	≤ 166	≤ 83	≤ 83	34.8%	57.8%	34.2%
	2	167–250	84–166	84–166	31.7%	33.6%	45.8%
(US$)	3	>250	>166	>166	33.5%	8.7%	20.0%
Monthly Household Income	1	≤ 250	≤ 166	≤ 166	20.3%	31.6%	18.3%
	2	251–416	167–416	167–416	35.3%	49.1%	55.0%
(US$)	3	> 416	> 416	> 416	44.4%	19.3%	26.7%
Household member	1		≤ 2		19.0%	7.6%	14.1%
	2		3–4		57.1%	40.2%	49.5%
	3		> 4		23.9%	52.2%	36.4%

Table 5.2 Descriptive statistics of participants (continued).

Variables	Code	Descriptions			Models		
		Car drivers	Motorcyclists	Bus occupants	Car drivers	Motorcyclists	Bus occupants
No of Motorcycle	1	0	1	0	36.4%	34.6%	38.4%
	2	1	2	1	43.9%	36.1%	29.5%
	3	≥ 2	≥ 3	≥ 2	19.7%	29.3%	32.2%
No of Car	1	0	0	0	18.2%	78.6%	70.5%
	2	1	1	1	62.8%	21.4%	29.5%
	3	≥ 2			19.0%	–	–
Helmet /Seatbelt Usage	0		Not often		46.8%	29.3%	70.8%
	1		Often		53.2%	70.7%	29.2%
Riding Against Traffic	0	Others		-	35.6%	45.3%	
	1	Never		-	64.4%	54.7%	
Speak Phone	0	Others		-	76.9%	38.2%	
	1	Never		-	23.1%	61.8%	
Drink Driving	0	Others		-	41.3%	9.4%	
	1	Never		-	58.7%	90.6%	
Usual Operating Speed	0	> 70kph	> 40kph	-	37.9%	45.5%	
	1	≤ 70kph	≤ 40kph	-	62.1%	54.5%	
Personal accident experience	0		No		90.6%	89.6%	90.8%
	1		Yes		9.4%	10.4%	9.2%
Close community accident experience	0		No		68.1%	70.0%	75.5%
	1		Yes		31.9%	30.0%	24.5%
Perceived risk of accident	0		Lower than average		65.2%	74.8%	52.5%
	1		Average or higher than average		34.8%	25.2%	47.5%

Around 10 % of participants (10.4% of motorcyclists, 9.4% of car drivers and 9.2% of bus occupants) had been involved in a traffic accident and less than one-third (30.0% of motorcyclists, 31.9% of car drivers and 24.5% of bus occupants) had family, friends, or relatives who had been involved in traffic accidents. More than half the participants (74.8% of motorcyclists, 65.2% of car drivers, and 52.5% of bus occupants) perceived that their accident risks were lower than the average risk. These lower risk perceptions implied that most participants believed that they were safer than others (Andersson and Lundborg, 2007).

5.4.2 WTP values, VSI and accident cost

The WTP values for the participants are shown in Table 5.3. It can be seen that 0.7% of bus occupants and 0.8% of motorcyclists had zero WTP. This very low percentage of zero WTP can be explained by the fact that most motorcyclists might have believed that the low-cost helmets available in the market did not prevent head injuries and most bus occupants might have perceived that most intercity buses in Myanmar were unsafe. However, zero WTP was nominated by 4.7% of car drivers, which was the highest percentage of all three road-user groups. The mean WTP values were MMK 7,483 (US$ 6.24) for motorcyclists, MMK 4,885 (US$ 4.07) for car drivers, and MMK 5,482 (US$ 4.57) for bus occupants. The median WTP values were MMK 7,000 (US$ 5.83) for motorcyclists, MMK 4,000 (US$ 3.33) for car drivers, and MMK 4,500 (US$ 3.75) for bus occupants. As can be seen, the car drivers' WTP was the lowest, even though they tended to come from high-income families. This may have been because the WTP questionnaire for the car drivers focused more on public safety while that of motorcyclists focused more on private safety. Similar results was found in de Baleij and Svensson, which found that the VSI from the private WTP was about 80 percent higher than the VSI derived from the public WTP (de Blaeij, Florax, Rietveld, & Verhoef, 2003; Hultkrantz, Lindberg, & Andersson, 2006) and the WTP value for private safety was three times higher than for public safety (Svensson and Vredin Johansson, 2010). The average values for the mean and median WTPs were

MMK 5,950 (US$ 4.96) and MMK 5,167 (US$ 4.30) respectively for the three road-user groups.

Table 5.3 WTP value for 50 percent risk reduction in serious injury.

Road User	Min MMK	Max MMK	Mean MMK(US$)	Median MMK(US$)	SD MMK(US$)	Skewness	SE of Skewness	Sample size	% zero WTP
1.Motorcyclist	0	25000	7483 (6.24)	7000 (5.83)	4372 (3.64)	1.204	0.123	393	0.8
2.Car Driver	0	15000	4885 (4.07)	4000 (3.33)	3399 (2.88)	0.612	0.124	385	4.7
3.Bus Occupant	0	18000	5482 (4.57)	4500 (3.75)	3441 (2.88)	0.952	0.121	404	0.7
Average (1+2+3)			5950 (4.96)	5167 (4.30)					

Note: MMK = Myanmar Kyat, US$ 1 = MMK 1200

The traffic police statistics reported that there was 14122 serious injuries during 2015 in Myanmar, which had a population of 52.449 million in 2015, resulting a serious injury rate of 26.92 in 100,000 people (Central statistical organization, 2016). Thus, the (Δρ) value for a 50% risk reduction in serious injury was 13.46 in 100,000 people. Based on the mean and median WTP value, VSI was calculated using equation 1 and the accident cost for serious injury was estimated by multiplying the VSI and the number of serious injuries due to road accident in 2015, as presented in Table 5.4. It was estimated that VSI for Myanmar road users ranged from MMK 38.387 million (US$ 31,989) to MMK 44.205 million (US$ 36,837), and the accident cost for serious injury ranged from MMK 542.113 billion (US$ 451,761 million) to MMK 624.264 billion (US$ 520.220 million).

Table 5.4 VSI and accident cost of serious injury in 2015.

	WTP MMK (US$)	Δρ (x 100,000 pop)	VSI MMK x 10^6 (US$ x 10^3)	No of serious injury	Accident cost MMK x 10^9 (US$)x 10^6
Mean	5950 (4.96)	13.46	44.205 (36.837)	14122	624.264 (520.220)
Median	5167 (4.30)	13.46	38.387 (31.989)	14122	542.113 (451.761)

5.4.3 Determinants of WTP

A total of 1182 participants including motorcyclists (393), car drivers (385) and bus occupants (404) were interviewed and three separate models were developed for each road-user group. The motorcyclists, car drivers, and bus occupants' WTP values, which were the dependent variables, were categorized into three levels: low, medium, and high. As the differences in the WTP ranges (min-max) for the three road-user groups were large, the WTP values for each level were categorized separately for each group. Before the analysis, the Variance Inflation Factor (VIF) values were observed to check for multi-collinearity, from which it was found that as all VIF values were less than 3, there were no collinearity problems (Rogerson, 2001). As the dependent variables were categorical and on an ordinal scale, the ordinal regression was analyzed first, after which the chi-square values for the test of parallel lines were checked. The resulting chi-square value for the car driver model was significant at a 10 percent level. Therefore, MNL regression was used to examine the WTP determinants.

The parameter estimates (the log-odds) for the multi-nominal WTP logistic regression model for the "high WTP" reference category is shown in Table 5.5. The coefficient for the parameter estimates is explained as follows: a positive significant coefficient revealed that the willingness to pay for serious injury risk reduction was similar to the compared category (low, medium), while the negative significant coefficient indicated that a willingness to pay for serious injury risk reduction was similar to the reference category. The values for the pseudo R^2 (Negelkerke), which explained the overall goodness of fit, were respectively 0.404, 0.407 and 0.369 for the motorcyclists, car drivers, and bus occupants, which was similar to previous studies (Svensson and Vredin Johansson, 2010; Ng, Law, Wong, & Kulanthayan, 2013) and regarded as acceptable for the qualitative regression models based on the questionnaire survey data (Boumtje et al., 2005; Ng et al., 2013). The highly significant p values (< 0.001) in the log-likelihood ratio test results for all models indicated that the models explained a significant amount of the original variability (Field, 2013). It can be seen that age, education, monthly individual income, monthly household income, household members, motorcycle ownership, seatbelt wearing, personal accident experience, and accident experience in the close community were significantly related to the WTP values.

The age variable was negatively and statistically significant in the bus occupant regression model for high WTP vs low WTP. The coefficients for younger bus occupants (20–30 years old and 31–40 years old) were negative suggesting that middle-aged intercity bus occupants were more likely to pay for accident risk reduction compared to older bus occupants, which supported previous research from Sweden and Thailand (Svensson, 2009b; Chaturabong et al., 2011).

The coefficient for education up to high school level for motorcyclists was positive and statistically significant in the motorcyclist model, indicating that lower educated motorcyclists were less willing to pay for accident risk reduction compared to higher educated motorcyclists. Similar results were found in studies conducted in Sudan and China, which found that as higher educated people paid more attention to traffic safety and had a better understanding of the potential effects of traffic safety counter measures, they were more willing to pay than lower educated people (Mofadal, Kanitpong, & Jiwattanakulpaisarn, 2015; Yang, Liu, & Xu, 2016).

The coefficient for income level 1(≤US$ 83) was positive and significant in the car driver model, which implied that car drivers that had lower individual incomes were less willing to pay for accident risk reduction than drivers with higher incomes. As expected, the household income variable was positive and highly significant in all models, indicating that participants from lower income families were less willing to pay for road accident risk reduction compared to participants from higher income families. This result was consistent with economic theory and previous research (Chaturabong et al., 2011), which found that wealthier people were more likely to pay for safety compared to poorer people.

In comparison to families with five or more household members, up to two household members in the bus occupant model and three or four household members in the motorcyclist model were found to be negatively significant, which suggested that bus occupant and motorcyclist participants from smaller households were more willing to pay for accident risk reduction than those from larger households. A similar result was found in Anderson and Lindberg (2009), which found that the WTP decreased with the increase in the number of adults in the household (Andersson and Lindberg, 2009). However, Bhattacharya (2007) also found that the WTP declined with an increase in the number of dependents for main wage earners (Bhattacharya et al. 2007).

The motorcycle ownership estimated coefficient was positive and statistically significant in the motorcyclist model. It was found that motorcyclists who had only one motorcycle at home were less likely to pay for accident risk reduction than motorcyclists who had two or more motorcycles. However, a higher motorcycle ownership might be related with higher household income. A similar result was found in Elias, Benjamin, & Shiftan (2015), which found that higher income individuals were more likely to own cars (Elias et al., 2015).

Table 5.5 Multi-nominal logistic regression predicting odds of car drivers, motorcyclists and bus occupants.

Independent Variable	Motorcyclist		Car Driver		Bus occupants	
	High WTP vs low WTP	High WTP vs medium WTP	High WTP vs low WTP	High WTP vs medium WTP	High WTP vs low WTP	High WTP vs medium WTP
Intercept	−6.501***	−1.622*	−3.137***	−1.858*	−5.021***	−2.963**
Female (relative to male)	0.503	0.463	−0.444	−0.355	0.119	0.512
Age (years) (relative to age >40)						
≤ 20	−0.470	0.809	−1.058	−0.081	−1.245	0.382
20 – 30	−0.419	−0.032	−0.115	0.481	−1.245**	−0. 226
30 – 40	0.008	−0.281	0.112	0.394	−0.938*	−0.297
Single (relative to married)	−0.157	−0.474	−0.100	−0.362	0.21	0.573
Education (relative to master and above)						
Up to high school	1.759**	0.200	0.799	−0.263	0.768	0.745
Diploma or bachelor	0.227	−0.151	0.665	0.113	0.886	0.270
Employment (relatives to others)						
Student / (Self-employed)	−0.401	−0.325	−0.187	0.646	0.838	−0.653
Government staff	0.600	0.678	0.053	0.659	0.674	0.293
Company staff	–	–	−0.094	0.903	–	–
Monthly individual income (US$) (relatives to > 166)						

Table 5.5 Multi-nominal logistic regression predicting odds of car drivers, motorcyclists and bus occupants (Continues).

Independent Variable	Motorcyclist		Car Driver		Bus occupants	
	High WTP vs low WTP	High WTP vs medium WTP	High WTP vs low WTP	High WTP vs medium WTP	High WTP vs low WTP	High WTP vs medium WTP
≤ 83	0.765	0.359	0.656	1.247**	−0.509	−0.046
84 – 166	0.289	−0.200	−0.407	0.400	−0.149	−0.283
Monthly household income (US$) (relatives to > 416)						
≤ 166	3.861***	2.050***	2.808***	1.662***	3.744***	2.611***
167 – 416	1.120*	0.404	2.129***	1.605***	1.635***	1.663***
Household member						
(relatives to > 4)						
≤ 2	−0.525	−0.345	0.406	0.643	−1.464**	−0.186
3 – 4	−1.097**	−0.707**	0.382	0.022	−0.54	0.026
Motorcycle ownership (relative to ≥ 2)						
0	0.456	0.542	0.079	−0.205	0.739	0.142
1	0.734	0.750**	−0.406	−0.675	0.453	−0.333
Had no car (relative to had car)	0.403	0.400	1.179	0.813	0.442	0.386
2			−0.205	−0.181		
Helmet/Seatbelt use (relative to often)						
Not often	0.558	0.028	0.702**	0.454	0.212	0.329
Against traffic (relative to never)						
Others (Sometimes)	0.584	0.294	−0.001	0.005		
Phone use (relative to never)						
Others (Sometimes)	0.452	0.395	−0.233	−0.321		
Drunk driving (relative to never)						
Others (Sometimes)	0.583	−0.323	0.040	0.116		
Speeding (relative to speed ≤ 70kph)						
Speed > 70 kph	−1.007	−0.007	0.394	−0.048		

Table 5.5 Multi-nominal logistic regression predicting odds of car drivers, motorcyclists and bus occupants (Continues).

Independent Variable	Motorcyclist		Car Driver		Bus occupants	
	High WTP vs low WTP	High WTP vs medium WTP	High WTP vs low WTP	High WTP vs medium WTP	High WTP vs low WTP	High WTP vs medium WTP
Personal accident experience (relative to Yes)						
No	1.971*		−0.522		0.137	
Accident of close community (relative to Yes)						
No	0.774*		0.914**		0.875**	
Perceived risk (relative to average or higher)						
Lower than average	0.068		0.366		0.108	
	−2 Log likelihood = 661.113		−2 Log likelihood = 666.838		−2 Log likelihood = 699.112	
	χ^2_{52} = 173.253***		χ^2_{56} = 172.973***		χ^2_{44} = 160.329***	
Pseudo R^2 (Nagelkerke)	0.404		0.407		0.369	

Note: *, **, *** Statistically significant at 0.10, 0.05, 0.01 level

In the car driver model, the not often seatbelt wearing variable was positive and statistically significant suggesting that car drivers who did not wear seatbelts often were less willing to pay for accident risk reduction than car drivers who often wore a seatbelt. Therefore, it could be surmised that drivers who worried about road safety or who followed traffic rules were more willing to pay for accident risk reduction. This result supported Moen, (2007), which found that drivers with lower worry or who were less anxious were less willing to pay for risk reduction (Moen, 2007).

The parameter estimate for the personal accident experience variable was positive and statistically significant in the motorcyclist and bus occupant models, which indicated that motorcyclists and bus occupants who had not been involved in a traffic accident were less willing to pay for accident risk reduction than participants who had been involved in traffic accidents. This result was consistent with Andersson and Lindberg (2009) and Haddak et al. (2016), which reported that the WTP was higher in participants who had had an accident experience.

The coefficient for the close community accident variable was positive and statistically significant in the motorcyclist and car driver models, from which it was surmised that motorcyclists and car drivers who had not had a family, friend, or relative involved in a traffic accident were less likely to pay for accident risk reduction than those who had had close family involved in an accident. A similar result was found in Haddak et al. (2016), who found that participants who had been involved in a road accident or whose close community had had a road accident were more willing to pay for road accident risk reduction.

5.5 Conclusions

This study explored the economic losses associated with serious road traffic injuries in Myanmar using a WTP-CV approach with a modified payment card format. The road users' characteristics such as socio-economic status, driving behavior, accident experience, and risk perception on WTP were assessed using MNL regression analyses. The data collection was carried out in seven major regions of Myanmar using face-to-face interview with 385 car drivers, 393 motorcyclists, and 404 bus occupants. In this study, traffic safety facilities such as road safety improvements for toll roads, helmets, and buses with better drivers were used as different scenarios for the three road-user groups.

Based on the median and mean WTP values, the Myanmar road users' VSIs was estimated to range from MMK 38.387 million (US$ 31,989) to MMK 44.205 million (US$ 36,837), with the total costs of serious traffic injuries for 2015 ranging from MMK 542.113 billion (US$ 451.761 million) to MMK 624.264 billion (US$ 520.220 million). In this study, age, education, number of household members, income, household income, motorcycle ownership, seatbelt usage, and direct and indirect accident experience were found to have a significant effect on serious injury risk reduction WTP, of which household income was found to have the strongest influence.

This study estimated figures for the costs of road traffic serious injuries in 2015 and examined the behavior and attitudes of Myanmar road users toward traffic accident risk. These findings are helpful for stakeholders and policy makers to assess the impact of the traffic accidents and to make decisions about road safety improvement funding and policies in Myanmar.

5.6 Acknowledgement

The researchers would like to express their gratitude towards Enago (www.enago.com) for the English language review.

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CHAPTER VI

CONCLUSION AND RECOMMENATIONS

This research estimated the economic losses due to road traffic accident death and serious injury in Myanmar using a WTP with a CV approach. The impact of the road users' characteristics such as socioeconomic status, travel behavior, driving behavior, accident experience, and risk perception; on WTP for accident risk reductions were then analyzed. The data collection was conducted in seven major regions; Nay Pyi Taw, Yangon, Mandalay, Magway, Sagaing, Bago, and Ayeyawady, of Myanmar using face-to-face interviews with 1222 respondents for fatality, 1182 respondents for serious injury risk reduction of motorcyclists, car drivers, and bus passengers. In this study, traffic safety facilities such as helmets, speed controlled devices, toll fee for road safety improvement and safer buses with well-trained drivers were applied as different scenarios for the three types of road users. A modified payment card was employed to determine the WTP value. The factors influencing WTP were examined using multiple regression analyses and Structural equation modeling for fatality risk reduction, and multi-nominal logistic regression analyses for serious injury risk reduction. The summary of this study is categorized into five parts as follows; (1) The discussion on resulted values of WTP, VSL, VSI and accident costs for fatality and serious injury risk reduction, and comparison of the resulted values in this study with those values in other developed and developing countries, (2) checking for scope insensitivity of WTP values, (3) examining the factors influencing the WTP in regression analyses and SEM, (4) recommendations and future research, and (5) limitation.

6.1 The resulted values of WTP, VSL, VSI and accident costs for fatality and serious injury risk reduction

Mean (median) value of WTP for 50% road accident fatality risk reduction was found to be US$ 6.51 (US$ 5.83), US$ 7.83 (US$ 4.17) and US$ 5.21 (US$ 4.17) for motorcyclists, car drivers and bus passengers as shown in Table 6.1. It was found that car drivers gave the highest WTP and bus passenger gave the lowest WTP which was positively related with their income as car drivers came from higher income families. Average WTP values for three road user group ranged from US$ 4.72 to US$ 6.56 and the value of statistical life (VSL) ranged from US$ 98,385 to US$ 135,712 which was significantly lower than developed countries and comparable with other developing countries (US$ 0.36–0.45 million in Malaysia, US$ 0.15 million in India and US$ 0.17–0.21 million in Thailand. Robinson, Hammitt, & O'keeffe (2017) stated that the difference in VSL not only depends on the income variation but also depends on differences in life expectancy, health, economic and social support, religion, and culture across individuals.

The resulted values of VSL and VSI were described in Table 6.2 and it was found that the ratio of VSL per GNI per capita was 85.62 to 118.11, these values seem high for developing countries. The study of Robinson et al. (2017) stated that VSL to GNI per capita ratio was 155 to 172 for the US estimates and a ratio of 98 for OECD estimate. Robinson et al. (2017) indicated that VSL to GNI per capita ratio was smaller among lower income than in higher income populations. This seemed reasonable given that lower-income individuals must devote a larger share of their incomes to more necessary or urgent expenses (Robinson et al., 2017). The high VSL per GNI per capita ratio in Myanmar may be due to the fact that the income and education levels of the respondents in this study were higher than the average of the country.

Table 6.1 WTP value, VSL and VSI for 50 percent risk reduction in fatality and serious injury.

Road User	WTP for Fatality Mean MMK(US$)	WTP for Fatality Median MMK(US$)	WTP for Serious Injury Mean MMK(US$)	WTP for Serious Injury Median MMK(US$)
1.Motorcyclist	7809 (6.51)	7000 (5.83)	7483 (6.24)	7000 (5.83)
2.Car Driver	9397 (7.83)	5000 (4.17)	4885 (4.07)	4000 (3.33)
3.Bus Passenger	6246 (5.21)	5000 (4.17)	5482 (4.57)	4500 (3.75)
Average WTP (1+2+3)	7817 (6.56)	5667 (4.72)	5950 (4.96)	5167 (4.30)

Table 6.2 VSL, VSI and accident cost for fatality and serious injury in 2015.

	Fatality		Serious Injury		Total	VSI/VSL	VSL/ GNI per capita
Based WTP	VSL US$ x 10^3	Accident cost US$ x 10^6	VSI US$ x 10^3	Accident cost US$ x 10^6	Accident cost (Fatal + Serious injury) US$ x 10^6	(%)	
Mean	135.712	683.580	36.837	520.220	1203.800 (2.0% GDP)	27.14	114
Median	98.385	495.567	31.989	451.761	947.328 (1.6% GDP)	32.51	83
	GNI per capita = US$ 1190				GDP = US$ 59.687 billion		

Regarding the 50% serious injury risk reduction, mean (median) value of WTP was found to be US$ 6.24 (US$ 5.83), US$ 4.07 (US$ 3.33) and US$ 4.57 (US$ 3.75) for motorcyclists, car drivers and bus passengers as shown in Table 6.1. It was noticed that car drivers' WTP was significantly lower than that of motorcyclists and bus passengers even though car drivers' individual- and household-income was the highest among 3 road users. This was due to the payment mechanism used in the questionnaire, as toll fee for car drivers was public safety nature and helmet was private safety nature.

6.2 Scope sensitivity

It was observed that the mean WTP values for fatality risk reduction was slightly higher than that of serious injury risk reduction in motorcyclist and bus passenger samples (except car drivers). Moreover, the average of WTP values for fatality risk reduction was higher than that value for serious injury risk reduction. Therefore, it can be concluded that there was scope sensitivity for fatality risk reduction and serious injury risk reduction. The value of VSI ranged from US$ 31,989 to US$ 36,837 as shown in Table 6.2. The resulted value of VSI/VSL ranged from 0.271 to 0.325, which were comparable with the report of Dawson (2008) with a range of 20% to 30%.

6.3 Factors affecting WTP

6.3.1 Results of multiple regression analyses for fatality risk reduction

Multiple regression analyses were conducted to observe the factors influencing the WTP for 50% fatality risk reduction of motorcyclists, car drivers and bus passengers. Regarding the socio-economic characteristic of the respondents, motorcyclists with more than 40 years old and students (motorcyclists and bus passengers) were negatively influenced on the WTP for their accident risk reduction whereas family status (married), education, individual income and household income were positively influenced on the WTP for fatality risk reduction in motorcyclist and bus passenger models. It was also found that individual income and household income were positive and significantly related with the WTP in car driver model.

In respect to travel and driving behavior, and risk perception, main bus passengers were less willing to pay while car drivers with higher risk perception and never drunk driving were more willing to pay for accident risk reduction.

6.3.2 Results of SEM for motorcyclists

From the results of SEM for motorcyclists, it was reasonable to surmise that older, lower educated people were less willing to pay for accident risk reduction compared to younger, higher educated people. Respondents from higher income family were found to be more willing to pay for traffic accident risk reduction compared to respondents from lower income families. In addition, motorcyclists who followed traffic rules and regulations were more likely to pay for fatality risk reduction compared to motorcyclists who tended to violate traffic rules. The male motorcyclists were more likely to violate the traffic rules and less willing to pay for accident risk reduction compared to females. However, government staffs were more likely to obey the traffic rules and were more willing to pay for accident risk reduction than other road users. Moreover, the motorcyclists who had been involved in a traffic accident (compared to motorcyclists who had had no traffic accident experiences) and who perceived their road accident risk to be average or higher than average (compared to motorcyclists who believed their risk was lower than average) were more likely to pay for traffic accident risk reduction. Overall, good driving behavior factor was found to have the highest influence on the WTP.

6.3.3 Results of SEM for car drivers

From car drivers SEM results, it was found that drivers with a higher education, higher household income, a higher number of household members, and car ownership were more willing to pay for fatality risk reduction compared to drivers that had a lower education, lower household income, and a lower number of household members. Older drivers were less willing to pay for road accident fatality risk reduction. Moreover, the male drivers were more likely to violate traffic rules and regulations and were less willing to pay for traffic accident fatality risk reduction compared to females. In addition, drivers who obeyed traffic rules and regulations were more willing to pay for fatality risk reduction than respondents with risky behaviors were.

Drivers who believed that their accident risk was average or higher than average were more willing to pay for road safety than respondents who believed their accident risk to be lower than average. Further, drivers whose family or close friends had had an accident in the previous 2 years were more willing to pay for accident risk reduction. Overall, the risk perception factor had the strongest influence on the WTP.

6.3.4 Results of MNL for serious injury risk reduction

In the multi-nominal logistic (MNL) regression analyses for serious injury risk reduction models, age, education, monthly individual income, monthly household income, household member, motorcycle ownership, seatbelt wearing, personal accident experience and accident experience on close community were significantly related to WTP values. It was found that middle-aged (20−40 years) intercity bus occupants were more likely to pay for their accident risk reduction compared to older bus occupants whereas lower educated motorcyclists were less willing to use their money for accident risk reduction compared to higher educated motorcyclists. Regarding income, car drivers with lower individual income were less willing to pay for their accident risk reduction compared to high income drivers. The respondents from lower income family were less likely to pay for their road accident risk reduction compared to respondents from higher income family in all models. In regard to household member, respondents of bus occupants and motorcyclists from small household were more willing to pay for their accident risk reduction compared to respondents from large household. The motorcyclists who had only one motorcycle in their home were less likely to pay for their accident risk reduction compared to motorcyclists who had two or more motorcycles.

With respect to travel and driving behavior, car drivers who did not wear seatbelt often were less likely to pay for their accident risk reduction compared to often seatbelt wearing car drivers. Regarding accident experience, motorcyclists and bus occupants who had not involved in the traffic accident were less willing to pay for accident risk reduction compared to respondents who had involved in traffic accidents. Concerning the family or friend's accident experience, motorcyclists and car drivers who did not have family, friend or relative involved in a traffic accidents were less likely to pay for their accident risk reduction compared to those having close community accident.

This study provided the VSL and the figures for the cost of road traffic deaths for 2015 and examined the behavior and attitudes of Myanmar's road users toward traffic accident risk. The VSL can be used as an input in benefit cost analysis to compare the benefit of preventing loss of life with the cost of road safety measures in the decision-making process of allocating scare resources. This can aid in the creation of effective methods for road safety improvement at the national level and allow for an equivalent benefit from the prevention of road injuries and other national investments such as healthcare systems. Myanmar road authorities can increase the budget allocation for road safety by perceiving the amount of economic loss due to road traffic death from this research. These findings are helpful for stakeholders and policy makers when assessing the impact of the traffic accidents and when making decisions about budget allocations and policies to improve road safety in Myanmar.

It was noticed that the number of significant variables and significant levels were higher in SEM than that of multiple regression analyses. It was due to the fact that measurement errors are neglected in multiple regression analysis whereas measurement errors which cannot be explained by latent variable are considered in SEM. Thus, more accurate causal relationship between constructs can be observed in SEM (Jeon, 2015).

Overall, income was positively related with the WTP whilst male was negatively associated with good driving behavior in all models. Household member was positively associated with the WTP in car drivers' SEM model and negatively associated with motorcyclists and bus occupants' MNL regression models. Further in depth research is needed for conclusion for household member. This research is helpful for policy formulation for road safety improvement and decision making for resource allocation of road safety related projects.

6.4 Recommendations and future research

To increase WTP for road accident risk reduction, road safety authorities need to educate more and implement more road safety campaign to increase awareness and risk perception on road safety by specifying specific target group of road users based on the research such as male, students. In the road planning stage, economic benefit of installing road safety features such as lighting, traffic calming, rumble strip, shoulder widening, grade separated pedestrian crossing should be considered. Accident cost should be included as part of road user cost in road project planning.

In future studies, the risk value should be based on road user categories when the accident rate for each category is available. The questionnaire should include various risk reduction levels to determine scale insensitivity or certainty. Other road user groups such as pedestrian, bicyclist and drivers of public vehicles should be conducted in future research.

As this study is an initial estimation of accident cost in Myanmar using WTP method, choice modeling (CM) approach should be used for future research to compare with the estimated cost from CV approach. The accident costs resulting from HC approach conducted in 2003 should be updated and should be compared with the costs resulting from WTP method.

6.5 Limitations

This study used the reported numbers of traffic death and serious injury, and did not make adjustments for the underreported accident deaths and injuries. As the majority of respondents in this study were educated and lived in urban areas, their behavior and attitude toward road safety might differ from illiterate people (who had difficulty in understanding the WTP questionnaire) living in rural areas.

6.6 References

Dawson, J. (2008). **The true cost of road crashes: Valuing life and the cost of a serious injury.** 12p.

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APPENDIX I

LIST OF PUBLICATIONS

List of Publications

Mon, E.E., Jomnonkwao, S., Khampirat, B., & Ratanavaraha, V. (2018). Myanmar motorbike riders' willingness to pay for fatality risk reduction. **Suranaree Journal of Science and Technology.**

Mon, E.E., Jomnonkwao, S., Khampirat, B., Ratanavaraha, V., & Satiennam W. (2018). Willingness to pay for mortality risk reduction for traffic accidents in Myanmar. **Accident Analysis and Prevention.** (In press).

BIOGRAPHY

Ms. Ei Ei Mon was born on the thirteenth of May, 1975 at Magway Region, in Myanmar. She got her Bachelor degree in Civil Engineering at Mandalay Technological University in Myanmar in 2002. After her graduation, she has been working for the Ministry of Construction in Myanmar. She got a Thailand Government’s scholarship for Master of Transportation Engineering at Kasetsart University in Bangkok, Thailand in 2009. She graduated Master degree in 2011.

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