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Research Paper

Analysis of Factors and Cost of Motorcycle Accidents using Willingness-to-Pay Approach (Case Study: Golestan Province, Iran)

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Abstract

In this research, we employed the willingness-to-pay (WTP) approach using the contingent valuation (CV) and payment card questionnaire to estimate the cost of fatalities caused by motorcycle accidents in Golestan province, Iran. Adopting multiple linear regression analysis, we analyzed the factors influencing motorcyclists' WTP, including socio-economic characteristics, travel behavior, motorcycle riding behavior, and past accident experiences. The value of statistical life (VSL) was calculated from 20,618 million IRR[**] (US$ 187,441) to 50,966 million IRR (US$ 463,325). Therefore, the total cost of death caused by motorcycle accidents was estimated to range from 3,319 billion IRR (US$ 30.17 million) to 8,205 billion IRR (US$ 74.6 million) in 2019. The significant factors affecting the WTP for using safety measures were education, occupation, household income, and dramatic movement while riding a motorcycle, being the primary breadwinner, parents' education, and motorcycle engine, frequency of using a motorcycle, helmet usage, and perception of safety level as a motorcyclist.

Keywords: Willingness to pay; motorcyclist; accident costs; value of statistical life.

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** IRR: Iranian Rial. At the time of the study, the official US$ to IRR exchange rate was 42,200, and the unofficial was 110,000.

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1. Introduction

The statistics released by the World Health Organization (WHO) reveal that more than 1.35 million people are killed in traffic accidents annually, and approximately 50 million are injured worldwide. Traffic accidents were the 8th leading cause of mortality for all age groups and the first cause of death among children and young people aged 5 to 29. More than 90% of deaths due to traffic accidents occur in low- and middle-income countries, while these countries have only 60% of the world's registered vehicles. The traffic accident fatality rate in low-income countries is three times higher than that in high-income countries [WHO, 2018], signifying the effectiveness of road safety improvement programs in high-income countries.

According to statistics, vulnerable users such as pedestrians, cyclists, and motorcyclists account for more than half of all traffic-related fatalities globally. Unfortunately, these users remain primarily neglected in road planning, design, and operation [WHO, 2018]. For example, in 2019, the risk of a motorcyclist being killed for every mile traveled was approximately 29 times higher than that of a passenger car occupant [NHTSA, 2019]. In addition, research indicates that head injury is a significant cause of death and severe injury in motorcycle accidents [Watson et al., 1980].

Iran, similar to other developing countries, has a high rate of traffic accident fatalities. Based on data provided by the Iranian Legal Medicine Organization (ILMO) and the Statistical Center of Iran (SCI) in 2019, with a population of 83.075 million, there were 16,947 deaths and 347,307 injuries, resulting in a fatality rate of 20.4 deaths per 100,000 people [ILMO, 2019; SCI, 2019]. Vulnerable road users accounted for almost 47% of total deaths in Iran in 2018. Among them, motorcyclist casualties play a noteworthy role, contributing to 24% of all traffic accident fatalities [WHO, 2018]. This is because of the limited attention devoted to motorcyclists' needs [Fauzi et al., 2004]. A study on 4,205 hospitalized motorcyclists due to accidents revealed that 59.7% of the admitted patients and 85.4% of total death cases had a head injury [Hoseinian et al., 2019].

Consequences of traffic accidents are deaths, injuries, disabilities, financial losses, pain, grief, and suffering [Haddak et al., 2016], as well as significant economic and social negative effects on accident victims, families, friends, and society [Niroomand and Jenkins, 2016]. Traffic accidents not only can impoverish the families of victims and involve the survivors and their families in the long-term effects of the accident, including medical care, rehabilitation, burial costs, and the loss of breadwinners but also put enormous pressure on the Iranian healthcare system [Ainy et al., 2014].

Among other provinces in Iran, Golestan province has a high motorcycle accident rate, with 42.6% of all accidents attributed to motorcyclists [ILMO, 2019]. The widespread use of motorcycles can be attributed to several reasons, including the proximity of cities and villages, lower costs of motorcycles, the agricultural environment, population density, and mild weather in the province. The growing preference for motorcycles for work, leisure, and intercity travel has regrettably escalated the risk of accidents in this province. However, the lack of reliable data has precluded research on the economic impact of traffic accidents in Golestan, which can help decision-makers take appropriate strategies. Therefore, conducting this study is crucial for several reasons: (1) to determine the economic losses associated with motorcyclist' accidents; (2) to provide reliable data to facilitate the evaluation of the impact of road accidents among the targeted communities, allocating adequate funds for safety improvements; and (3) to investigate the factors influencing the WTP to aid key stakeholders in developing more effective road safety policies.

Due to the lack of accident cost analysis involving motorcyclists, as the riskiest road users in Golestan, this study aims to collect necessary data and determine the cost of motorcyclist accidents using the willingness to pay with contingent valuation (WTP-CV) approach. Then, the motorcyclist's value of statistical life (VSL) is estimated. In addition, the impact of socio-economic characteristics, travel behavior, riding behavior, and accident experience of motorcyclists on their WTP for fatality risk reduction in Golestan are evaluated. This study will enable a more comprehensive cost-benefit analysis of road safety interventions targeting motorcyclists in Golestan province by determining the cost of motorcyclist accidents using the WTP-CV approach.

The paper is structured as follows. The second section discusses the literature review and shows accident cost valuation approaches. The third section explains the research methods for collecting and analyzing cost accident data. The fourth section presents the survey results and analysis findings. The fifth section provides a comprehensive discussion, and the last section contains conclusions.

2. Literature Review

The study conducted in Thailand aimed to analyze the cost of motorcycle accidents using the WTP method. It estimated the VSL and the Value of Statistical Injury (VSI) through the CV method in two scenarios. Data were collected from 1,015 randomly selected motorcyclists in Bangkok and nearby areas. The research found that the VSL ranged from $0.17 million to $0.21 million; the VSI was estimated to be between $0.08 million and $0.10 million. Regression analysis revealed that lower-income individuals, the elderly, and males were less willing to pay, while motorcyclists who frequently used helmets and government employees were willing to pay more to reduce fatality risk. Motorcyclists who rode at high speeds were also more willing to pay for increased safety [Chaturabong et al., 2011].

Ainy et al. estimated the cost of traffic accidents using the WTP approach in Tehran, Iran. They conducted a cross-sectional survey involving 846 randomly selected individuals, including occupants, pedestrians, drivers, and motorcyclists. Given the mean WTP value of 2,612,050 IRR and 50% risk reduction, the VSL was calculated at 19,713,584,906 IRR. Furthermore, the VSI based on the annual traffic volume and average daily payment for each injury was 2,412,582,500 IRR. The study also identified several factors significantly affecting WTP, including age, gender, monthly income, daily payment for injury risk reduction, willingness to pay for travel time reduction, type of road user, and travel mileage [Ainy et al., 2014]. In another research, based on the data from previous research, motorcyclists had the lowest WTP at the rate of 888,110 IRR among other users. VSL was equal to 6,702,716,981 IRR (US$ 223,423 (1US$ = 30,000 IRR)), and the total cost of deaths based on 4,694 deaths was calculated at 31,462 billion IRR. VSI was estimated at 941,552,500 IRR. The total number of injuries was 73,325, and the injury cost was estimated at 69,039 billion IRR [Ainy et al., 2016].

A study conducted by Mon et al. in Myanmar estimated the economic losses of deaths due to accidents using the WTP-CV method with the payment card format. The statistical population consisted of motorcyclists, car drivers, and intercity bus passengers. Through face-to-face interviews, respondents were asked to indicate their WTP for reducing the fatality risk by 50%. Multiple regression analysis found that WTP has a positive and significant relationship with marital status, level of education, individual income, household income, accident experience, and driving under the influence of alcohol. The VSL was estimated to range from US$98,385 to US$135,712 in Myanmar [Mon et al., 2018].

Mofadal et al. analyzed the economic cost of pedestrian accidents in Sudan using the WTP-CV method with payment card format and also the impact of various factors on pedestrians' WTP for risk reduction. Data were collected from 1400 respondents selected using the two-stage clustering technique from Khartoum and Nyala. The regression analysis results showed that VSL for pedestrians is $0.019 to $0.101 million. Furthermore, the analysis demonstrated that pedestrians' WTP increased with age, household income, education, perception of safety, and average time spent on social activities with family and the community [Mofadal et al., 2015].

2.1. Accident Cost Valuation Approaches

There are at least six approaches for estimating accident costs, including human capital (HC), net output, life insurance, court award, implicit public sector valuation, and value of risk change or willingness to pay. The selection of the appropriate method depends on the objectives and priorities of the study [Hills and Jones-Lee, 1983]. One of the critical reasons for estimating road accident costs is maximizing either national production or social welfare, such as minimizing injuries or deaths caused by traffic accidents. The HC and WTP approaches appear to be directly aligned with these two aims in accident valuation methods [Aeron-Thomas et al., 2000; Silcock, 2003].

The concepts of HC and WTP approaches are different, especially on the subject of the "value of life"; therefore, each method gives distinct values. The HC approach measures human output, or productivity, to maximize a nation's wealth and is used to evaluate the value of lost production capacity due to traffic fatalities. On the other hand, the WTP approach, aiming to maximize social welfare, focuses on measuring trade-offs between wealth and risk. It is applicable for estimating the value of lost quality of life and conducting cost-benefit analysis [Elvik, 1995; Aeron-Thomas et al., 2000]. The WTP approach is the preferred method for the economic valuation of accidents, as opposed to the HC approach. This is because of the incompatibility of the HC approach with the theoretical concepts of cost-benefit analysis and its failure to quantify the amount necessary to reflect pain, grief, and suffering [Elvik, 1995; Silcock, 2003].

There are generally two methods for determining WTP: the revealed preference (RP) and the stated preference (SP) methods. RP techniques evaluate risk reduction based on actual market behavior, which reveals individual preferences, whereas SP techniques are based on the individuals' stated decisions. The SP approach creates a hypothetical market or options in which participants are asked how they will choose in a given situation or how much they would be willing to pay for a given risk reduction [Andersson, 2013; Keller et al., 2021; Schoeters et al., 2020; Svensson and Johansson, 2010]. SP approaches are the most widely used method for evaluating non-market effects in cost-benefit analysis when real market data is unavailable to predict behavior or derive reliable preferences. In other words, SP approaches are utilized when the data required for RP techniques are unavailable, as was the case in this research. [Mekonnen et al., 2022; Bateman et al., 2002]. In order to apply SP techniques, it is necessary to use either choice modeling (CM) or contingent valuation (CV) approaches.

In CM, respondents are asked to choose their preferred option from a set of alternatives (different levels of attributes) in a hypothetical setting. Nonetheless, this approach was considered inappropriate for respondents in Golestan, as they were more likely to make selections randomly without adequate consideration. The CV uses questionnaires to extract people's preferences, in monetary amounts, for changes in the quantity or quality of non-market goods or services [Bateman et al., 2002; Naznin et al., 2023]. The CV is the most common approach in the literature, as respondents can directly choose the amount of money they are willing to pay to reduce the fatality risk or injury [Haddak et al., 2016; Jomnonkwao et al., 2021; Martínez-Espiñeira and Pérez-Urdiales, 2020; Svensson and Johansson, 2010].

The three main formats for CV questions are open-ended, dichotomous choice, and payment card formats. The open-ended format simply asks the respondents for their maximum WTP to reduce the fatality risk in traffic accidents. In a dichotomous choice format, a specific price is selected, and the respondents are asked whether they are willing to pay this amount of money to reduce their fatality risk in traffic accidents or not. Since it is a dichotomous choice format, respondents can answer “yes” or “no”. They will accept if the selected price is not higher than their WTP; otherwise, they decline to pay. In the payment card format, respondents are offered a range of WTP values and are asked to pick the highest amount on the list they are willing to pay [Bateman et al., 2002; Dissanayake, 2010; Reaves et al., 1999]. In addition, respondents are free to propose their WTP values without being influenced by the prices offered. Reaves et al. stated that the payment card format has desirable characteristics compared to the other two methods; it simplifies the evaluation process for respondents with low education, and they can easily evaluate the amounts. As a result, it has a higher response rate and is an efficient data collection method [Reaves et al., 1999]. Given its benefits over other methods, the payment card format is more suitable for surveying motorcyclists unfamiliar with risk reduction valuations. Therefore, this study employed the WTP-CV payment card approach for data collection.

The primary purpose of this study is to analyze and assess the cost of motorcycle accidents and determine the factors influencing the willingness of motorcyclists to pay for fatality risk reduction in Golestan Province, Iran. This study used a WTP-CV approach with a payment card to extract motorcyclists’ WTP for fatality risk reduction. Numerous research studies on accident costs have focused on determining the VSL for road users to establish a framework for assessing road safety interventions using cost-benefit analysis. Then, the VSL of motorcyclists was estimated. Since there are few studies analyzing motorcycle accident costs and affecting factors in Iran, this study tries to validate, update, and enrich the findings in this field.

3. Materials and Methods

In this study, a WTP-CV questionnaire was used in conjunction with a roadside interview survey for sampling. The interview was conducted in several places, such as motor couriers, government offices, private companies, bazaars, and streets. The concept of WTP and risk reduction values was unfamiliar to respondents, so the interview was conducted face-to-face. The reasons for conducting the research, the importance of road safety, the fatality rate due to traffic accidents, and the consequences of accidents were explained to the respondents. The inclusion criterion was being in the age range of 18 to 65 years old. The value of reducing the risk of buying a safety product was assumed to be equal to the cost of purchasing that product. This allows the value of safety to be deduced from buying the equipment [Ainy et al., 2016; Bhattacharya et al., 2007; Chaturabong et al., 2011; Mon et al., 2018]. In addition, motorcycle traffic safety facilities, such as helmets, were used as safety equipment.

In 2019, the Golestan province, with an approximate population of 1.951 million, witnessed 378 accident deaths and 8204 injuries – resulting in a traffic fatality rate of 19.4 deaths per 100,000 people [ILMO, 2019; SCI, 2019]. Since the local number of accident deaths by road-user types was unavailable, the same national rate was considered for all road users. 50% and 20% reductions in the fatality rate were adopted based on Iran’s national road safety improvement targets. The VSL was calculated by dividing the mean and median WTP by the risk change. Finally, multiple linear regression was used to analyze the factors affecting WTP.

Table 1. Payment Card Format with a Range of WTP Values

Iranian Rial (IRR)					
0	50,000	100,000	200,000	300,000	400,000
500,000	750,000	1,000,000	1,250,000	1,500,000	2,000,000
2,500,000	3,000,000	3,500,000	4,000,000	5,000,000	6,000,000
7,000,000	8,000,000	9,000,000	10,000,000	More than 10,000,000	
Any other amount (not mentioned in card): …………..IRR					

3.1. Questionnaire Design

The questionnaire comprised five sections: (1) socio-economic and household characteristics, (2) travel behavior and riding behavior, (3) accident experience, (4) perception of risk, and (5) valuation question. A payment card was employed to extract the maximum amount of money a motorcyclist was willing to pay to reduce his fatality risk by 50% and 20% in road accidents, offering them a range of choices for their WTP values, as shown in Table 1.

3.1.1. Socio-Economic and Household Characteristics

The first section of the questionnaire was designed to obtain socio-economic and household characteristics such as age, marital status, education, occupation, individual income, household income (grouped based on income deciles in 2019 [SCI, 2019]), household member [SCI, 2019], being the main breadwinner, location, parents' education, motorcycle ownership, motorcycle engine, and having motorcycle insurance.

3.1.2. Travel Behavior and Riding Behavior

The second section assessed travel behavior and riding behavior, such as trip purpose, having a motorcycle license, number of years of having a motorcycle license, helmet usage, usual speed (based on driving the speed limit in Iran), average daily riding distance, frequency of using a motorcycle, speaking on the phone while driving, driving in the wrong way, driving under the influence of alcohol, running red lights, riding on sidewalks, drug-impaired driving, and dramatic movement while riding.

3.1.3. Accident Experience

Seen a motorcycle accident, accident experience, accident experience of a family member or a friend, supplementary insurance, the probability that the motorcyclist has in mind that a fatal accident happens to him, and perception of safety level as a motorcyclist were subjects of the third section of the questionnaire.

3.1.4. Perception of Risk

The fourth section of the questionnaire explored whether the respondents understood the risk or not. Two different possible routes are presented with two different levels of road safety, and they are asked to choose the safer one.

3.1.5. Valuation Questions

In this section, respondents were asked to imagine that they had to buy a new helmet. The helmets appeared identical, but the prices varied according to the level of protection. Additionally, the price range of helmets in Iran was expressed from 500,000 IRR to 50,000,000 IRR (1 IRR = 110,000 US$). Helmet A was the reference helmet, which cost 1,000,000 IRR. This helmet corresponds with the probability of death due to a head injury in a motorcycle accident, with 20 deaths per 100,000 people per year. Then, two scenarios were presented as follows:

In the first scenario, Helmet B, the probability of death due to a head injury was imagined to be 10 deaths per 100,000 people per year. Therefore, as Helmet B was able to reduce the probability of head-injury death by 50%, respondents were asked: How much maximum extra amount of money are you willing to pay for Helmet B to reduce the risk of dying due to a head injury in a motorcycle accident from 20/100,000 to 10/100,000?

In the second scenario, Helmet C, the probability of death due to a head injury was imagined to be 16 deaths per 100,000 people per year. Therefore, as Helmet C was able to reduce the probability of head-injury death by 20%, respondents were asked: How much maximum extra amount of money are you willing to pay for Helmet C to reduce the risk of dying due to a head injury in a motorcycle accident from 20/100,000 to 16/100,000?

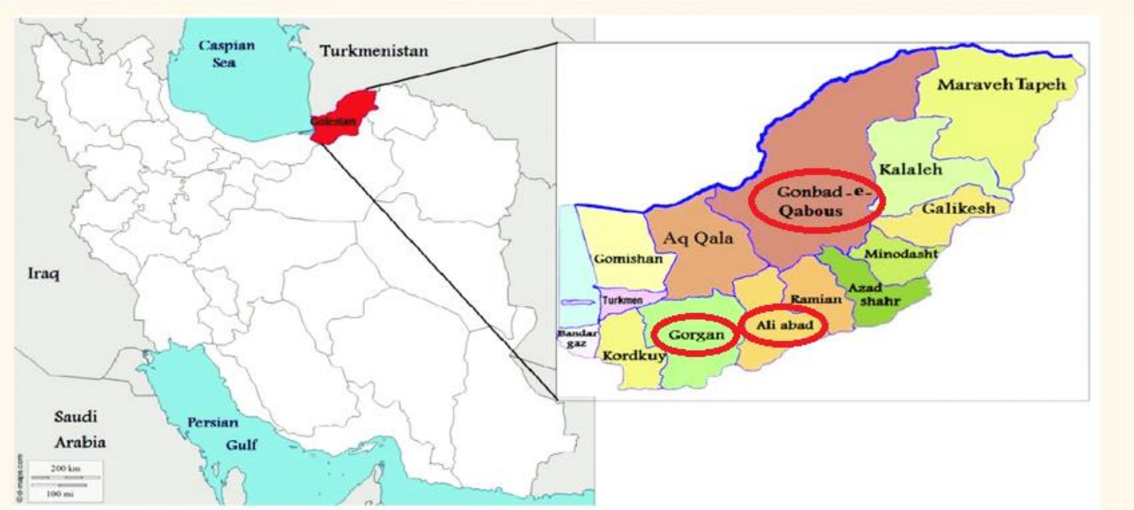

Figure 1. Geographical Location of Golestan Province

3.2. Data Collection

Pilot sampling was performed for 30 motorcyclists in September 2019 to assess the respondents' understanding of the questionnaire. In addition, its validity and reliability were examined. The concept of validity indicates how much the tool or method used can measure the desired property. The opinions of experts and specialists in the transportation and economics fields were evaluated to achieve this goal. Then, the questionnaire was edited, and its minor problems were modified. Furthermore, the study confirmed the reliability using Cronbach's alpha formula, which yielded a value of 0.659 for the questionnaire, indicating a reasonably acceptable level of reliability. The primary survey was conducted in October and November 2019.

The geographical location of Golestan province is illustrated in Figure 1. Data were collected from three cities in Golestan province: Gorgan, Gonbad, and Aliabad-e-Katul, which had the highest population and the highest accident rate in the province. According to the yearbook of Golestan province in 2019, the number of accidents in these cities was 15458, 4766, and 2361 cases, respectively. Moreover, based on the latest census in 2016, the population of these three cities stood at 480541, 348744, and 140709, respectively. Since the size of the statistical population (the total number of motorcyclists) is unknown, Cochran's formula was used for the sample size.

$$N = \frac{Z^2 pq}{d^2} \quad (1)$$

Where:

N: sample size

d: the desired level of precision (i.e., the margin of error),

p: the estimated proportion of the population that has the attribute in question,

q: 1 – p.

For this research, the value of q and confidence level were set at 0.5 and 95%, respectively, with a desired precision of at least ±5 percent. Using a 95% confidence level, which corresponds to Z-values of 1.96, the minimum required sample size was calculated to be 384. In the fourth section of the questionnaire, which aimed to explore respondents' perceptions of risk, 36 individuals provided inaccurate responses to the quiz. Consequently, they were excluded from further analysis due to the unreliability of their subsequent answers. They either did not understand the risk concept or did not take filling out the questionnaire seriously. Therefore, the total sample used in this research was 384 respondents, including 200, 150, and 70 motorcyclists in Gorgan, Gonbad, and Aliabad-e-Katul, respectively. The sample size for each city was determined based on the ratio of the population of each city to the total population of three cities.

3.3. Methodology for Accident Cost Analysis

The VSL is defined as the monetary value an individual is willing to pay to prevent the expected occurrence of their fatality. The VSL of motorcyclists was calculated as the mean or median value of the WTP divided by the change in risk (Δp) [Andersson, 2007; Chaturabong et al., 2011; Odihi et al., 2021; Persson et al., 2001; Puttawong and Chaturabong, 2020; Svensson and Johansson, 2010; Yusof et al., 2013; Mofadal et al., 2015], as shown in Eq. (2).

$$VSL = \frac{WTP_m}{\Delta p} \quad (2)$$

Where:

VSL: the value of statistical life

WTP_m: mean or median willingness to pay

Δp: change in fatality risk

In order to calculate the VSL as outlined in Eq. (2), it is necessary to obtain both the WTP values and the changes in motorcyclist fatality risk. The motorcyclist fatality risk was derived from ILMO and SCI in Golestan, while the WTP values were directly obtained through data collected from the questionnaire survey.

3.4. Analyzing the Determinants of WTP

One of the objectives of this study was to analyze the factors influencing the willingness of motorcyclists to pay for fatality risk reduction. Multiple linear regression was applied to determine the factors influencing the WTP of respondents. Table 2 shows the definition of the independent variables considered in the regression analysis. The scenarios were analyzed using the Social Package for Statistical Science (SPSS) software.

Table 2. Definition of the Independent Variables Considered in the Regression Analysis

Variable	Definition	Category
AGE	Age	Continuous
MARST	Marital status	1 if married, 0 otherwise
EDU	Education	1 if with university education, 0 otherwise
OCCUP	Occupation	1 if self-employed, 0 otherwise
INDIN	Individual income	1 if ≥ US$ 100, 0 otherwise
HHIN1	Household income level 1	1 if ≥ US$ 281, 0 otherwise
HHIN2	Household income level 2	1 if ≥ US$ 456, 0 otherwise
HHMEMB	household member	Continuous
BREAD	Being the main breadwinner	1 if yes, 0 otherwise
LOC	Location	1 if village, 0 otherwise
PARENTEDU	Parents' education	1 if both/one of them have a university education, 0 otherwise
OWNER	Motorcycle ownership	1 if yes, 0 otherwise
ENGINE	Motorcycle engine	1 if ≤ 150 c.c., 0 otherwise
MOTORINSUR	Having motorcycle insurance	1 if yes, 0 otherwise
PURPOSE	Trip purpose	1 if working, 0 otherwise

Variable	Definition	Category
LICENSE	Having motorcycle license	1 if yes, 0 otherwise
YEARLICENSE	No. of years of having motorcycle license	Continuous
HELMET	Helmet usage	1 if frequently/sometimes, 0 otherwise
SPEED	Usual driving speed	1 if ≥ 60 km/h, 0 otherwise
RIDEFREQ	Frequency of using a motorcycle	1 if weekly use almost every day & daily use>50 km, 0 otherwise
DRAMATIC	Dramatic movement while riding	1 if frequently/sometimes, 0 otherwise
SEEN	Seen a motorcycle accident	1 if yes, 0 otherwise
ACCEXP	Accident experience	1 if yes, 0 otherwise
SUPPINSU	Supplementary insurance	1 if yes, 0 otherwise
SAFEPER	Safety perception as a motorcyclist	1 if not safe/low safety, 0 otherwise

Table 3. Socio-Economic Characteristics

Socio-economic characteristics	Frequency	Percentage
Age		
≤ 20	31	8.1
21-30	180	46.9
31-40	119	31
>40	54	14.1
Marital status		
Single	155	40.4
Married	229	59.6
Education		
Non-university degree	292	76
University degree	92	24
Occupation		
Government employee	11	2.9
Farmer	9	2.3
Motor courier	107	27.9
Student	19	4.9
Unemployed	20	5.2
Self-employment	201	52.3
Labor	17	4.4
Individual income (USD$)		
≤ 45	43	11.2
46-99	92	24
100-140	105	27.3
141-181	63	16.4
> 182	81	21.1
Household income (USD$)		
≤ 99	83	21.6
100-190	139	36.2
191-280	63	16.4
281-370	41	10.7
371-455	27	7
> 456	31	8.1
Household member		
< 4	189	49.2
≥ 4	195	50.8
Being the main breadwinner		
Yes	317	82.6
No	67	17.4
Location		
City	300	78.1
Village	84	21.9
Parents' education		
Both non-university degree	328	85.4
Both university degree	14	3.6
Just one university degree	42	10.9
Motorcycle ownership		
Yes	320	83.3
No	64	16.7
Motorcycle engine c.c.		
125	241	62.8
150	98	25.5
200	31	8.1
≥ 250	14	3.6
Motorcycle insurance		
Yes	220	57.3
No	164	42.7

In the context of our study, we followed best practices in statistical modeling, considering both theoretical foundations and empirical evidence in choosing the variables included in the analysis. Each variable was included based on its relevance and significance in explaining motorcycle accidents and associated costs in Golestan province. While a model with fewer variables may appear more straightforward, it might overlook critical factors that significantly impact accident rates and associated costs, and our goal was to provide a holistic understanding of the issue, which necessitated considering a range of variables.

4. Results

4.1. Descriptive Statistics of Respondents

The socio-economic characteristics, travel behavior, riding behavior, and accident experience of 384 respondents who participated in the survey are presented in Tables 3-5.

4.2. Mean and Median WTP Values for 50% and 20% Fatality Risk Reduction

The mean and median values of WTP for 50% and 20% fatality risk reduction are shown in Table 6. It is important to note that a portion of the respondents, 6% in the first scenario and 7% in the second scenario, indicated a zero WTP. The mean values for WTPs were 3,369,557 IRR (US$ 30.63) and 1,977,474 IRR (US$ 17.98) for the first and second scenarios, respectively. The median WTP values were 2,000,000 IRR (US$ 18.19) and 1,500,000 IRR (US$ 13.63) for the first and second scenarios, respectively.

Table 4. Travel Behavior and Riding Behavior

Travel / Riding behavior	Frequency	Percentage
Trip purpose		
Work	305	79.2
Recreation	51	13.2
Education	3	0.8
Business	5	1.3
No purpose	20	5.2
Having motorcycle driving license		
Yes	164	42.7
No	220	57.3
Number of years of having motorcycle license		
0 (No license)	216	56.3
1 < N ≤ 4	58	15.1
> 4	110	28.6
Helmet usage		
Frequently	122	31.8
Sometimes	90	23.4
Rarely	35	9.1
Never	137	35.7
Usual speed		
< 60 km/h	328	85.4
≥ 60 km/h	56	14.6
Average daily riding distance		
> 50[2] km	104	27.1
≤ 50 km	280	72.9
Frequency of using a motorcycle in a week		
A few hours per day	19	4.9
1-2 days	38	9.9
Almost everyday	141	36.7
Everyday	186	48.4
Speaking on the phone while driving		
Frequently/ Sometimes	191	49.8
Rarely	86	22.4
Never	107	27.9
Wrong-way driving		
Frequently/ Sometimes	95	24.7

[2] The MEAN of daily riding distance was 48.17km.

Travel / Riding behavior	Frequency	Percentage
Rarely	101	26.3
Never	188	49
Driving under the influence (Alcohol)		
Frequently/ Sometimes	40	10.4
Rarely	40	10.4
Never	304	79.2
Running red lights		
Frequently/ Sometimes	114	29.7
Rarely	71	18.5
Never	199	51.8
Driving on sidewalks		
Frequently/ Sometimes	111	28.9
Rarely	122	31.8
Never	151	39.3
Drug-impaired driving		
Frequently/ Sometimes	28	7.3
Rarely	19	4.9
Never	337	87.8
Dramatic movement while driving		
Frequently/ Sometimes	38	9.9
Rarely	36	9.4
Never	310	80.7

4.3. VSL and Motorcyclists' Accident Cost Analysis

Based on the ILMO, in 2019, there were 378 deaths, 8204 injuries, and a traffic fatality rate of 19.4 deaths per 100,000 people in Golestan province. The values of Δp for 50% and 20% fatality risk reduction were 9.7 and 3.88 people per 100,000 people, respectively. Based on the average values of the mean and median WTP presented in Table 6, the VSL was calculated using Eq. (2). Then, accident costs were estimated by multiplying the VSL by the total number of traffic deaths due to motorcycle accidents, as shown in Table 7. The estimated VSL for Golestan motorcyclists ranges from 20,618 million IRR (US$187.441) to 50,966 million IRR (US$463.325). The total accident cost was calculated by multiplying the VSL by the total number of traffic deaths due to motorcycle accidents, ranging from 3,319 billion IRR (US$ 30.17 million) to 8,205 billion IRR (US$ 74.6 million).

4.4. Determinants of Motorcyclists WTP

Table 8 presents the linear regression analysis results for the two scenarios. It should be mentioned that some variables are grouped based on their effects on the best model (with the highest R^2). According to the correlation coefficients listed in Appendix Table 1, the independent variables of the model do not have a high correlation with each other, so the problem of multi-collinearity cannot be so acute. In addition, each model has been selected so that no two correlated variables increase the probability of multi-collinearity in one model. The Variance Inflation Factor (VIF) values for all the variables in the regression are below three, indicating no significant issues with multi-collinearity, as is shown in Appendix Table 2. Also, the 95% confidence interval for each coefficient is represented in the last columns.

The results of regression analysis show that the variables including education (EDU), occupation (OCCUP), household income (HHIN), dramatic movement while riding (DRAMATIC), being the main breadwinner (BREAD), parents' education (PARENTEDU), motorcycle engine (ENGINE), frequency of using motorcycle (RIDEFREQ), helmet usage (HELMET), and perception of safety level as a motorcyclist (SAFEPER) have a significant influence on the WTP of motorcyclists in risk fatality reduction.

Table 5. Accident Experience

Accident experience and history	Frequency	Percentage
Seen a motorcycle accident		
Yes	292	76
No	92	24
Accident experience		
Yes	243	63.3
No	141	36.7
Accident experience of a family member or a friend		
Yes	184	47.9
No	200	52.1
Supplementary insurance		
Yes	69	18
No	315	82
The probability that the motorcyclist has in mind that a fatal accident happens for him		
Unthinkable probability	70	18.2
Low probability	131	34.1
Average probability	102	26.6
High probability	81	21.1
Perception of safety level as a motorcyclist		
Not safe	201	52.3
Low safety level	133	34.6
Medium/high safety level	50	13

5. Discussion

Initially, we discussed variables that were significant in both scenarios and then considered others that were significant in only one scenario.

Education is a significant and positive variable for reducing fatality risk in both models. The positive coefficients associated with education suggest that motorcyclists with a university education have a higher WTP to reduce their fatal accident risk than motorcyclists with high school diplomas or lower educational levels. This result is consistent with the findings from previous research, which indicated that respondents with higher education levels exhibited a greater willingness to pay for risk reduction measures than those with lower education levels [Bhattacharya et al., 2007; Dissanayake, 2010; Mofadal et al., 2015; Mon et al., 2018; Puttawong and Chaturabong, 2020].

The positive sign of the occupation variable suggests that self-employed respondents are more likely to pay for risk reduction measures than those in other occupations. This is somewhat different from the findings of a previous study, which indicated that public-sector employees, private-sector employees, and private business participants were willing to pay more [Mofadal et al., 2015]. In addition, government officers were found to be willing to pay more than students for fatality risk reduction measures [Chaturabong et al., 2011]. Yang et al., 2016 found that private-sector employers are more likely to pay for risk avoidance than other occupation classes [Yang et al., 2016]. An alternative result found that private business respondents are more willing to pay for fatality risk reduction measures [Puttawong & Chaturabong, 2020]. Also, another study concluded that various employment sectors influenced the VSL in various ways [Yusof et al., 2013].

The positive sign of the household income variable suggests that respondents from high-income families tend to be more willing to pay for their risk reduction measures. The same findings can be observed in previous studies [Andersson, 2007; Balakrishnan and Karuppanagounder, 2020; Bharti et al., 2022; Chaturabong et al., 2011; Kriswardhana et al., 2020; Liu and Zhao, 2011; Mofadal et al., 2015; Mon et al., 2019, 2018; Persson et al., 2001].

Such a result was expected because low-income families have financial constraints on buying safety measures.

Table 6. WTP Values for Risk Reduction

Scenario	Mean IRR(USD)	Median IRR(USD)	SD IRR(USD)	Skewness	Sample size	No(%) zero WTP
First scenario	3,369,557(30.63)	2,000,000(18.19)	3,251,559(29.56)	1.609	384	23 (6)
Second scenario	1,977,474(17.98)	1,500,000(13.63)	2,151,429(19.59)	2.319	384	27 (7)

Table 7. VSL and Accident Cost of Motorcyclists in 2019

Scenario	WTP IRR(USD)		Δp	VSL IRR x 10^6 (USD x 10^3)	No of motorcyclists' fatalities	Accident cost IRR x 10^9 (USD x 10^6)
First Scenario	Mean	3,369,557	9.7	34,738(315.797)	161	5,593(50.84)
	Median	2,000,000		20,618(187.441)		3,319(30.17)
Second Scenario	Mean	1,977,474	3.88	50,966(463.325)		8,205(74.6)
	Median	1,500,000		38,660(351.452)		6,224(56.59)

Table 8. Results of Linear Regression Analysis

Independent variable	First scenario: 50% risk reduction			Second scenario: 20% risk reduction		
	b	β	t	b	β	t
AGE	-772.043	−0.022	−0.331	-996.954	−0.043	−0.699
FAMST	17049.252	0.026	0.414	20485.673	0.047	0.715
EDU	138483.860	0.182***	3.568	48748.994	0.097*	1.751
OCCUP	84337.880	0.130**	2.349	70129.331	0.163***	2.812
INDIN	-43248.649	−0.064	−1.256	-37012.410	−0.082	−1.520
HHIN1				64141.260	0.131**	2.196
HHIN2	256585.632	0.215***	4.170			
HHMEMB	13005.226	0.056	1.086	10620.315	0.069	1.268
BREAD	105062.749	0.123**	2.181	53380.040	0.094	1.582
LOC	-23533.173	−0.030	−0.597	−17726.202	−0.034	−0.645
PARENTEDU	-104834.471	−0.114**	−2.181	-34259.046	−0.056	−1.037
OWNER	-40341.811	−0.046	−0.897	-13383.335	−0.023	−0.429
ENGINE	-148632.446	−0.147***	−2.919	-54346.531	−0.081	−1.535
MOTORINSUR	48557.457	0.074	1.398	15252.624	0.035	0.631
PURPOSE	33686.733	0.041	0.749	22696.025	0.042	0.733
LICENSE	71641.687	0.109	1.605	24876.998	0.057	1.002
YEARLICENSE	-3712.557	−0.075	−1.038			
HELMET	32383.582	0.050	0.972	38252.366	0.089*	1.652
SPEED	782.593	0.001	0.017	−7612.316	−0.013	−0.236
RIDEFREQ	-70736.761	−0.096*	−1.691	-38249.590	−0.078	−1.320
DRAMATIC	210948.061	0.194***	3.726	101371.953	0.141***	2.581
SEEN	57270.122	0.075	1.521	23398.889	0.046	0.902
ACCEXP	11649.526	0.017	0.350	10873.936	0.024	0.471
SUPPINSU	4024.270	0.005	0.096	-12656.948	−0.023	−0.437
SAFEPER	41946.325	0.043	0.904	62222.739	0.097*	1.934
Constant	146589.079		1.120	21995.585		0.245
R^2	0.22			0.13		

N	384	384

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

Among the riding behavior factors, only the dramatic movement variable affected WTP significantly. The positive sign of this coefficient indicates that motorcyclists who sometimes or frequently perform dramatic movements while riding a motorcycle are willing to pay more to save their lives in accidents. This is probably because they believe the accident probability due to their risky behavior is higher for them. These results were inconsistent with other studies on riding behavior. The study conducted in Thailand found that motorcyclists who rode under the influence of alcohol tended to be less willing to pay for measures to reduce injury risk [Chaturabong et al., 2011]. Moreover, car drivers who had never been under the influence of alcohol while driving tended to pay more to reduce their risk [Mon et al., 2018]. Furthermore, in China, individuals who run red lights were found to have a lower likelihood of being willing to pay for safety measures. This suggests that running red lights indicates the extent of risk aversion among individuals. Essentially, if someone demonstrates a disregard for the associated risks, it is useless to pay more to reduce the risk [Liu and Zhao, 2011]. Also, another research showed that respondents who followed traffic laws and regulations were more likely to pay for fatality risk reduction measures than those who engaged in risky behaviors [Mon et al., 2019].

Being the primary breadwinner significantly and positively affects a motorcyclist’s WTP, reducing fatality risk in the first scenario. Motorcyclists, the main breadwinners, tend to pay more to reduce fatality risk, likely because they feel a greater responsibility towards their families. Therefore, it is essential for them to take care of their health daily. This could be because if something happens to them, it would significantly impact their family. A similar parameter was discussed by Bhattacharya et al., who showed that respondents were less inclined to pay for accident risk reduction measures as the number of their dependents increased [Bhattacharya et al., 2007]. Interestingly, this variable was insignificant for the second scenario, possibly because a 20% reduction in death risk may not seem valuable or sufficient to the main breadwinners. This lesser reduction may not instill enough confidence in their protection from daily hazards, making this variable significant for a 50% reduction in mortality risk but not for a 20% reduction.

Parents’ education is another significant factor affecting WTP values in the first scenario. The negative sign indicates that respondents with at least one parent or both who have a university degree are less willing to pay to reduce their fatal accident risk than respondents whose parents hold high school diplomas or lower educational levels. This is an interesting finding, and there is a possible interpretation; individuals with university-educated parents may have greater knowledge about safety and risks associated with motorcycle riding and, therefore, may have already adopted more safety measures, which they feel are sufficient and do not require additional expenses for further reduction in the risk of death. The variable was insignificant for the second scenario because individuals with university-educated parents might feel that a 20% reduction in the risk of death is relatively small and, therefore, may seem insignificant to justify the additional costs. This difference in valuation may be why this variable is insignificant in the second scenario.

The significant negative coefficient of a motorcycle engine in the first scenario indicates that respondents who have motorcycles with an engine of 150 c.c. or less are willing to pay less to reduce their fatality risk in accidents. This is probably because people who own motorcycles with smaller engines may perceive themselves at a lower risk of fatal accidents than those with larger ones. The result was in contrast to a study in Malaysia, in which those riding a motorcycle with an engine more than 150 c.c. were less likely to pay [Fauzi et al., 2004]. In addition, this variable was not significant for the second scenario. To explain this result, one could argue that motorcyclists with more powerful engines (e.g., 200 or 250 cc) are naturally exposed to greater risks because they have higher speeds and probably move more on busy and dangerous roads. Therefore, for these individuals, a 50% reduction in mortality risk may be much more valuable, and they are willing to pay more for a helmet that reduces their mortality risk by 50%. However, a 20% reduction in mortality risk may seem less attractive to these individuals; therefore, they are less willing to pay more.

Among the travel behavior factors, the frequency of using a motorcycle (which reflects one's riding proficiency and experience) is also one of the factors affecting the WTP in the first scenario. The negative sign of this coefficient implies that respondents who use motorcycles almost daily and travel an average of more than 50 km per day are willing to pay less to reduce their fatality risk in traffic accidents. This is probably because these individuals are more experienced and professional at riding. They believe that life-threatening situations can be avoided by themselves, so they tend to pay less to reduce the risk. This result was the same as in a previous study in Thailand [Chaturabong et al., 2011]; motorcyclists who used motorcycles more often were willing to pay less. In addition, a similar result was observed in Chinese and Iranian studies; those who traveled short distances were willing to pay more [Ainy et al., 2016; Liu and Zhao, 2011]. In the second scenario, the frequency of motorcycle use was not a significant factor affecting WTP. Experienced motorcyclists probably feel they can avoid life-threatening situations themselves, which might give them the confidence that there is no need to incur additional costs to reduce risk. Therefore, in a scenario where the risk reduction is only 20%, these individuals might feel that it is not significant enough to justify the additional costs, especially if they already believe that the risk of death is low. Hence, this variable does not become significant in this scenario because its impact on individuals' willingness to pay is low and is probably controlled by other factors such as confidence and experience.

The association between helmet usage and WTP was positive and significant in the second scenario, indicating that motorcyclists who use helmets either sometimes or frequently are likely more aware of safety on the road and, hence, have a better perception of risk. Therefore, they are willing to pay more to reduce the fatality risk. This observation aligns with findings from studies conducted in Thailand and Iran [Ainy et al., 2016; Chaturabong et al., 2011]. Interestingly, the helmet usage variable was not significant in the first scenario. In the first scenario, the proposed reduction in fatality risk is 50%, a significant decrease. Individuals who already use helmets might think they have already achieved a significant level of protection, making the additional 50% reduction in fatality risk less valuable compared to the protection already provided by regular helmet usage. Conversely, in the second scenario, the proposed reduction in fatality risk is only 20%, a decrease that might seem less noticeable to individuals. In this context, individuals who sometimes or frequently wear helmets might perceive the additional reduction in fatality risk, when combined with their regular helmet usage, as justifying the extra costs.

The positive sign of the perception of the safety level variable in the second scenario suggests that the respondents who perceive the motorcycle's safety level as low are more willing to pay to reduce their risk compared to those who perceive it as medium or high. In other words, respondents with a high perception of safety are willing to pay more to reduce their risk than respondents with a low perception of safety. This finding is consistent with the results of a previous study in Sudan [Mofadal et al., 2015]. In the first scenario, where there is a 50% reduction in the risk of death, individuals with a high perception of safety may feel that this significant reduction in risk does not warrant any additional cost. For example, someone who already perceives motorcycles as very dangerous (i.e., they perceive low safety) may consider a 50% reduction in the risk of death so significant that it does not require any additional payment. Therefore, this variable may not be significant in this scenario.

6. Summary and Conclusion

This study aimed to estimate the VSL of motorcyclists in Golestan province, Iran, using the WTP-CV approach. The impact of motorcyclists' socio-economic characteristics, travel behavior, riding behavior, and accident experience on the WTP of motorcyclists for accident risk reduction was analyzed. Data was collected from three cities in the Golestan province via a questionnaire survey, yielding 384 valid responses out of 420.

The study employed a hypothetical scenario involving helmet usage as a motorcyclist traffic safety measure, considering two effect scenarios: a 20% and a 50% reduction in fatality risk. The payment card method was used for respondents to express their WTP values. The VSL was estimated from 20,618 million IRR (US$ 187.441) to 50,965 million IRR (US$ 463.325) based on the WTP median and mean values for the two scenarios. The total cost of traffic fatalities ranged from 3,319 billion IRR (US$ 30.17 million) to 8,205 billion IRR (US$ 74.6 million) in 2019. In this study, the Golestan motorcyclists' WTP was significantly associated with education, occupation, household income, dramatic movement while riding, being the main breadwinner, parents' education, motorcycle engine, frequency of using a motorcycle, helmet usage, and perception of safety level as a motorcyclist.

These findings are valuable for government planners, policymakers, community representatives, and stakeholders in the road transport sector. They offer invaluable insights for formulating and executing road transport policies to enhance motorcyclist safety, a critical and vulnerable demographic among road users. For example, policymakers could consider implementing educational campaigns or financial incentives to increase helmet usage among motorcyclists. Additionally, the VSL determined in this study can be employed as a critical factor in benefit-cost analysis, enabling a comprehensive assessment of the advantages of averting fatalities against the expenses incurred for implementing road safety measures.

However, this study has several limitations. Due to time and distance constraints, the research focused on the three cities with the highest population and accident rates in Golestan province in 2019, as indicated by the Golestan province yearbook. Also, it is essential to note that the study exclusively included male respondents, as women are not permitted to obtain motorcycle licenses in Iran.

Future research should investigate the WTP and the VSL to reduce the risk of fatalities among various road user groups, including car drivers, pedestrians, and bicyclists. Such research can assess the difference in the VSL of other road users compared to motorcycle users and ascertain whether motorcyclists are more prone to risks. Moreover, predictive models can be developed based on the collected data to forecast potential motorcycle accidents and associated costs. Such models could assist policymakers and authorities in implementing proactive safety measures.

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Appendices

Appendix Table 1: Pearson Correlation Coefficients (PCC)

	AGE	FAMST	EDU	OCCUP	INDIN	HHIN1	HHIN2	HHMEMB	BREAD	LOC	PARENTEDU	OWNER	ENGINE	MOTORINSUR	PURPOSE	LICENSE	YEARLICENSE	HELMET	SPEED	RIDEFREQ	DRAMATIC	SEEN	ACCEXP	SUPPINSU	SAFERPER	WTP20PER	WTP50PER
AGE	1.00	0.46	-0.06	-0.03	0.21	-0.16	-0.11	-0.14	0.27	-0.09	-0.17	0.14	0.13	0.14	0.16	0.32	0.57	0.12	-0.23	0.03	-0.28	0.02	-0.07	-0.02	0.00	-0.05	-0.08
FAMST	0.46	1.00	-0.11	0.04	0.13	-0.16	-0.09	-0.34	0.50	0.04	-0.07	0.09	0.18	0.06	0.25	0.14	0.23	0.09	-0.20	0.03	-0.23	0.04	0.01	-0.03	0.03	0.01	-0.03
EDU	-0.06	-0.11	1.00	0.01	0.11	0.34	0.17	-0.08	-0.14	-0.13	0.23	0.10	-0.19	0.07	-0.11	0.10	0.04	0.03	0.04	-0.04	-0.06	0.04	-0.08	0.04	0.05	0.12	0.20
OCCUP	-0.03	0.04	0.01	1.00	0.12	0.10	0.11	0.00	0.07	0.03	0.08	-0.05	-0.02	-0.06	0.03	-0.10	-0.04	-0.03	-0.12	-0.47	0.07	-0.05	-0.10	-0.06	-0.03	0.21	0.19
INDIN	0.21	0.13	0.11	0.12	1.00	0.20	0.12	-0.08	0.11	-0.16	0.06	0.14	0.00	0.08	0.11	0.15	0.14	0.01	-0.10	0.04	-0.12	0.05	0.08	0.05	0.01	-0.03	-0.01
HHIN1	-0.16	-0.16	0.34	0.10	0.20	1.00	0.50	0.10	-0.25	-0.14	0.30	0.02	-0.16	-0.12	-0.25	-0.06	-0.08	-0.18	0.09	-0.15	0.02	0.02	-0.03	0.13	0.00	0.12	0.13
HHIN2	-0.11	-0.09	0.17	0.11	0.12	0.50	1.00	0.01	-0.14	-0.06	0.28	0.00	-0.13	0.00	-0.24	0.00	-0.02	-0.06	0.01	-0.11	0.00	0.03	-0.05	0.04	-0.03	0.15	0.22
HHMEMB	-0.14	-0.34	-0.08	0.00	-0.08	0.10	0.01	1.00	-0.21	0.11	-0.01	-0.16	-0.08	-0.10	-0.05	-0.08	-0.07	-0.03	0.04	-0.13	0.12	-0.10	-0.04	0.03	-0.04	0.06	0.04
BREAD	0.27	0.50	-0.14	0.07	0.11	-0.25	-0.14	-0.21	1.00	0.13	-0.06	0.13	0.15	0.03	0.24	0.11	0.12	0.10	-0.14	0.07	-0.10	0.03	0.05	-0.07	0.01	0.04	0.04
LOC	-0.09	0.04	-0.13	0.03	-0.16	-0.14	-0.06	0.11	0.13	1.00	-0.09	-0.10	0.06	-0.10	0.02	-0.04	-0.06	0.07	0.08	-0.06	0.06	-0.09	0.04	-0.05	0.05	0.00	-0.01
PARENTEDU	-0.17	-0.07	0.23	0.08	0.06	0.30	0.28	-0.01	-0.06	-0.09	1.00	0.05	-0.15	-0.02	-0.09	-0.01	-0.08	-0.04	0.06	-0.06	0.09	0.04	0.01	0.23	0.01	0.03	0.04
OWNER	0.14	0.09	0.10	-0.05	0.14	0.02	0.00	-0.16	0.13	-0.10	0.05	1.00	-0.01	0.08	0.15	0.24	0.12	0.12	-0.05	0.11	-0.09	0.21	0.09	0.08	0.08	0.00	-0.01
ENGINE	0.13	0.18	-0.19	-0.02	0.00	-0.16	-0.13	-0.08	0.15	0.06	-0.15	-0.01	1.00	-0.02	0.25	-0.03	0.01	0.01	-0.17	0.12	-0.15	0.00	0.02	-0.06	0.03	-0.12	-0.22
MOTORINSUR	0.14	0.06	0.07	-0.06	0.08	-0.12	0.00	-0.10	0.03	-0.10	-0.02	0.08	-0.02	1.00	0.12	0.34	0.17	0.29	-0.08	0.03	-0.14	-0.05	-0.04	0.07	0.01	0.03	0.08
PURPOSE	0.16	0.25	-0.11	0.03	0.11	-0.25	-0.24	-0.05	0.24	0.02	-0.09	0.15	0.25	0.12	1.00	0.08	0.03	0.12	-0.21	0.17	-0.28	0.02	-0.02	-0.03	-0.05	-0.03	-0.09
LICENSE	0.32	0.14	0.10	-0.10	0.15	-0.06	0.00	-0.08	0.11	-0.04	-0.01	0.24	-0.03	0.34	0.08	1.00	0.64	0.18	-0.10	0.11	-0.16	0.02	-0.04	-0.05	-0.03	0.02	0.05

	AGE	FAMST	EDU	OCCUP	INDIN	HHIN1	HHIN2	HHMEMB	BREAD	LOC	PARENTEDU	OWNER	ENGINE	MOTORINSUR	PURPOSE	LICENSE	YEARLICENSE	HELMET	SPEED	RIDEFREQ	DRAMATIC	SEEN	ACCEXP	SUPPINSU	SAFERPER	WTP20PER	WTP50PER
YEARLICENSE	0.57	0.23	0.04	-0.04	0.14	-0.08	-0.02	-0.07	0.12	-0.06	-0.08	0.12	0.01	0.17	0.03	0.64	1.00	0.05	-0.12	-0.02	-0.16	0.09	-0.04	-0.03	-0.04	-0.01	-0.02
HELMET	0.12	0.09	0.03	-0.03	0.01	-0.18	-0.06	-0.03	0.10	0.07	-0.04	0.12	0.01	0.29	0.12	0.18	0.05	1.00	-0.13	0.07	-0.02	-0.03	-0.03	0.00	-0.10	0.07	0.07
SPEED	-0.23	-0.20	0.04	-0.12	-0.10	0.09	0.01	0.04	-0.14	0.08	0.06	-0.05	-0.17	-0.08	-0.21	-0.10	-0.12	-0.13	1.00	0.07	0.16	0.04	0.05	0.00	0.01	-0.02	0.01
RIDEFREQ	0.03	0.03	-0.04	-0.47	0.04	-0.15	-0.11	-0.13	0.07	-0.06	-0.06	0.11	0.12	0.03	0.17	0.11	-0.02	0.07	0.07	1.00	-0.12	0.07	0.17	-0.03	0.02	-0.18	-0.19
DRAMATIC	-0.28	-0.23	-0.06	0.07	-0.12	0.02	0.00	0.12	-0.10	0.06	0.09	-0.09	-0.15	-0.14	-0.28	-0.16	-0.16	-0.02	0.16	-0.12	1.00	0.04	0.07	-0.02	-0.03	0.15	0.19
SEEN	0.02	0.04	0.04	-0.05	0.05	0.02	0.03	-0.10	0.03	-0.09	0.04	0.21	0.00	-0.05	0.02	0.02	0.09	-0.03	0.04	0.07	0.04	1.00	0.17	0.07	0.09	0.04	0.07
ACCEXP	-0.07	0.01	-0.08	-0.10	0.08	-0.03	-0.05	-0.04	0.05	0.04	0.01	0.09	0.02	-0.04	-0.02	-0.04	-0.04	-0.03	0.05	0.17	0.07	0.17	1.00	-0.05	0.09	-0.01	-0.02
SUPPINSU	-0.02	-0.03	0.04	-0.06	0.05	0.13	0.04	0.03	-0.07	-0.05	0.23	0.08	-0.06	0.07	-0.03	-0.05	-0.03	0.00	0.00	-0.03	-0.02	0.07	-0.05	1.00	-0.04	-0.03	-0.01
SAFERPER	0.00	0.03	0.05	-0.03	0.01	0.00	-0.03	-0.04	0.01	0.05	0.01	0.08	0.03	0.01	-0.05	-0.03	-0.04	-0.10	0.01	0.02	-0.03	0.09	0.09	-0.04	1.00	0.08	0.03
WTP20PER	-0.05	0.01	0.12	0.21	-0.03	0.12	0.15	0.06	0.04	0.00	0.03	0.00	-0.12	0.03	-0.03	0.02	-0.01	0.07	-0.02	-0.18	0.15	0.04	-0.01	-0.03	0.08	1.00	0.83
WTP50PER	-0.08	-0.03	0.20	0.19	-0.01	0.13	0.22	0.04	0.04	-0.01	0.04	-0.01	-0.22	0.08	-0.09	0.05	-0.02	0.07	0.01	-0.19	0.19	0.07	-0.02	-0.01	0.03	0.83	1.00

Appendix Table 2. Linear Regression Coefficient

Independent variable	First scenario: 50% risk reduction				95% CI		Second scenario: 20% risk reduction				95% CI	
	b	β	t	VIF	Lower Bound	Upper Bound	b	β	t	VIF	Lower Bound	Upper Bound
AGE	-772.04	−0.022	−0.331	2.02	-5352.3	3808.2	-996.95	−0.043	−0.699	1.57	-3803.3	1809.4
MARST	17049.25	0.026	0.414	1.78	-63919.7	98018.2	20485.67	0.047	0.715	1.78	-35872.4	76843.7
EDU	138483.86	0.182***	3.568	1.20	62154.4	214813.3	48748.99	0.097*	1.751	1.27	-5995.8	103493.8
OCCUP	84337.88	0.130**	2.349	1.40	13716.1	154959.6	70129.33	0.163***	2.812	1.40	21086.4	119172.2
INDIN	-43248.64	−0.064	−1.256	1.18	-110951.6	24454.3	-37012.41	−0.082	−1.520	1.22	-84905.6	10880.7
HHIN1							64141.26	0.131**	2.196	1.47	6692.2	121590.3

Independent variable	First scenario: 50% risk reduction				95% CI		Second scenario: 20% risk reduction				95% CI	
	b	β	t	VIF	Lower Bound	Upper Bound	b	β	t	VIF	Lower Bound	Upper Bound
HHIN2	256585.63	0.215***	4.17	1.23	135574.1	377597.1						
HHMEMB	13005.22	0.056	1.086	1.24	-10554.0	36564.4	10620.31	0.069	1.268	1.25	-5847.8	27088.4
BREAD	105062.74	0.123**	2.181	1.46	10322.0	199803.5	53380.04	0.094	1.582	1.48	-12963.1	119723.1
LOC	-23533.17	−0.030	−0.597	1.16	-101073.2	54006.8	−17726.20	−0.034	−0.645	1.16	-71740.6	36288.2
PARENTEDU	-104834.4	−0.114**	−2.181	1.26	-199375.3	-10293.7	-34259.04	−0.056	−1.037	1.23	-99237.2	30719.1
OWNER	-40341.81	−0.046	−0.897	1.23	-128786.8	48103.1	-13383.33	−0.023	−0.429	1.22	-74765.4	47998.8
ENGINE	-148632.4	−0.147***	−2.919	1.17	-248770.3	-48494.6	-54346.53	−0.081	−1.535	1.17	-123965.7	15272.7
MOTORINSUR	48557.45	0.074	1.398	1.29	-19729.6	116844.5	15252.62	0.035	0.631	1.29	-32311.6	62816.8
PURPOSE	33686.73	0.041	0.749	1.39	-54730.1	122103.6	22696.02	0.042	0.733	1.36	-38200.3	83592.4
LICENSE	71641.68	0.109	1.605	2.13	-16128.9	159412.3	24876.99	0.057	1.002	1.36	-23970.9	73724.9
YEARLICENSE	-3712.55	−0.075	−1.038	2.43	-10743.0	3317.9						
HELMET	32383.58	0.05	0.972	1.20	-33145.7	97912.8	38252.36	0.089*	1.652	1.20	-7291.0	83795.7
SPEED	782.593	0.001	0.017	1.17	-90627.5	92192.6	−7612.31	−0.013	−0.236	1.17	-71143.9	55919.3
RIDEFREQ	-70736.76	−0.096*	−1.691	1.47	-153012.6	11539.1	-38249.59	−0.078	−1.320	1.46	-95230.4	18731.2
DRAMATIC	210948.06	0.194***	3.726	1.25	99595.9	322300.2	101371.95	0.141***	2.581	1.24	24125.8	178618.1
SEEN	57270.12	0.075	1.521	1.13	-16795.7	131335.9	23398.88	0.046	0.902	1.11	-27642.2	74440.0
ACCEXP	11649.52	0.017	0.35	1.12	-53801.4	77100.4	10873.93	0.024	0.471	1.12	-34553.6	56301.4
SUPPINSU	4024.27	0.005	0.096	1.12	-78000.5	86049.0	-12656.94	−0.023	−0.437	1.12	-69692.7	44378.8
SAFEPER	41946.32	0.043	0.904	1.06	-49255.5	133148.1	62222.73	0.097*	1.934	1.06	-1058.3	125503.8
Constant	146589.07		1.12				21995.58		0.245			