Explaining Sex Differences in Motorcyclist Riding Behavior: An Application of Multi-Group Structural Equation Modeling

Savalee Uttra, Napat Laddawan, Vatanavongs Ratanavaraha and Sajjakaj Jomnonkwao *

School of Transportation Engineering, Institute of Engineering, Suranaree University of Technology, Nakhon Ratchasima 30000, Thailand; savalee.utt@gmail.com (S.U.); napat.l@g.sut.ac.th (N.L.); vatanavongs@g.sut.ac.th (V.R.)
* Correspondence: sajjakaj@g.sut.ac.th; Tel.: +66-4422-4251; Fax: +66-4422-4608

Received: 25 September 2020; Accepted: 23 November 2020; Published: 26 November 2020

Abstract: Road accidents are caused by humans, vehicles, and road environments. Human attitudes affect behavioral changes and can lead to unsafe riding behavior. The sex of an individual is a key factor that affects their riding behavior. We aimed to use structural equation modeling (SEM) by analyzing the multi-group SEM between men and women and applying the theory of planned behavior (TPB) and the locus of control (LC) theory. The data used in the research were collected from all over Thailand, consisting of 1516 motorcycle riders (903 men and 613 women) aged over 20 years. A self-administered questionnaire was designed for data collection of the riding behavior using the Motorcycle Rider Behavior Questionnaire (MRBQ), including traffic errors, control errors, stunt frequency, and safety equipment. We found that riding behaviors between men and women were significantly different in both theories. For men, TPB showed that the main factors that highly influenced motorcycle riding behavior (MRB) were the attitudes based on health motivation (AHM) and perceived behavior control (PC); for women, AHM produced a stronger effect than in men. However, for the subjective norms (SN) factor, we found no direct effect on MRB, but did find an indirect effect through the attitudes based on severity (ASE) in both sexes. Particularly for women, the indirect influence value of the SN factor was higher. For women, the LC showed that internal factors had more influence than external factors. The same was found for men, but the effect in women was significantly stronger. We found that sex significantly affected the MRB. Therefore, policies must be implemented that address each group specifically as their attitudes and behaviors are different.

Keywords: theory of planned behavior (TPB); locus of control (LC); multi-group SEM; MRBQ

1. Introduction

1.1. Background

Vehicular collisions damage property and can be harmful to the health, even causing death. The number of motor vehicle collisions in Thailand remains high. According to road collision reports from the Royal Thai Police in 2019, 99,087 incidents were confirmed, of which 36,797 involved motorcycles. Of these, 65.5% were caused by humans, while traffic signals/traffic signs, vehicles, and the environment were involved in 27.5%, 5.1%, and 1.9%, respectively [1]. These incidents resulted in 8648 deaths (6473 men and 2175 women) [1]. Accidents involving serious or minor injuries totaled 61,101 (39,231 men and 21,870 women) [1]. These incidents also caused vast damages [2], estimated at 64.8 million Baht [1].

These collisions were caused by human, vehicle, and road environment factors. Humans are the key factor leading to collisions [3,4]. Evans [5] and Shinar [4] specified that human factors are a
major cause of 95% of collisions, whereas road and vehicle factors are major causes of 28% and 8% of collisions, respectively. To understand human behavior from the perspective of vehicle collisions, Olson and Dewar [3] specified relevant human factors that cause accidents: rider perception and response when riding, individual differences, emotion, pressure, aggression, motivation, riding skill, risk behavior, social variables, rider attitude, rider sex, riding experience, fatigue, alcohol consumption, drunk riding behavior, age, and other physical characteristics. The human factor is complex due to people differing in terms of their physical and behavioral characteristics, such as their sex, age, interests, and motivations for riding behavior, which create different risks. To understand the behavioral aspect and solve problems regarding the human factors, individual attitudes must be studied to help create guidelines.

Demographics (sex and age) are considered as a basic variable of analysis. We wanted to study the same factors that affect motorcycle riding accidents as those considered in previous studies, such as Elliott and Thomson [6]. Useche, et al. [7] considered sex to study the difference of in risky bicycles cycling behavior using multi-group structural equation modeling (SEM). They found that both men and women have differences in terms of the hourly intensity of riding, psychological distress, and the level of knowledge of traffic rules. In regard to the hourly intensity of riding, women reported higher intensities than men. For psychological distress, they found that men reported higher risky behavior compared with women. The knowledge of traffic rules was better for men than for women.

In terms of age and risk perception, they found significant results only in men. When considering positive behaviors, they found that age and psychological distress had no effects on men, and that age only affected women. In conclusion, sex differences can be supported in predicting the cycling behavior of male and female bicyclists [7]. Martinussen et al. [8] constructed a car driving behavior measurement model using the driver behavior questionnaire (DBQ) [9]. The analysis also created groups structured by age, sex, and driving distance using exploratory and confirmatory factor analysis. The statistics of accidental deaths classified by gender in Thailand, as reported by the Royal Thai Police, found that more males died from accidents than females. In addition, in many past research studies based on sex differences in driving behavior, the majority found differences. Among human factors, the sex of an individual is a key factor that affects their riding behaviors, as has been stated in past studies. We focused on sex differences as the main point of this research in order to test and verify that the differences between males and females contribute to different driving behaviors. Therefore, policies must be implemented that address each group specifically as their attitudes and behaviors are different.

1.2. Literature Review

Various theories related to motivation in motor vehicle driving behavior have been widely used, such as the health belief model (HBM) [10], the theory of planned behavior (TPB) [11], and locus of control (LC) [12]. These theories are very useful in studying motivation for motorcycling behavior based on sex differences. Motorcycle driving behavior is a behavior that drivers regularly practice and become habituated to and, thus, have motivation or attitudes regarding the behavior. Therefore, the theory of TPB and LC is suitable for this study of behavior.

1.2.1. Theory of Planned Behavior (TPB)

Ajzen [11] explained the TPB as the study of the influence of attitude on behavioral change. This theory is a result of developments from the theory of reasoned action, which is social psychology developed from the theory of reasoned action by Bamberg, et al. [13]. TPB explains that human behavioral expression is generated from three kinds of belief: behavioral, normative, and control beliefs; each belief affects different variables [11].

Attitudes toward behavior enable individual assessments of behaviors that are created by relevant beliefs toward behavioral expression (behavioral beliefs), as well as assessments or judgments of negative or positive behavioral results. If an individual assessment of a result is positive, then this
individual will have a positive attitude toward the behavior that they observe, and vice versa. A subjective norm behavior is an individual perception of a social demand for a person to conduct or not conduct a certain behavior. Subjective norm behavior is generated by individual beliefs toward social demand normative actions, particularly when these actions are conducted by others that are important to that individual, e.g., family members, close friends, and partners.

Xiao [14] used TPB and SEM to study vehicle driving behavior and found that perceived behavioral control can directly and indirectly predict self-reported unsafe driving behavior. Razmara, et al. [15] used multiple regression analysis to determine that subjective norms, perceived behavioral control, and habits were the main predictors of one’s intention to drive safely. Bazargan-Hejazi, et al. [16] used multiple regression analysis to find that attitude was the strongest predictor of intention. Intention was found to mediate the relationship between willingness to text while driving (TWD) and perceived behavioral control. Li, et al. [17] used confirmatory factor analysis (CFA) and structural equation modeling (SEM) techniques and found that TPB was an accurate predictor of competitive behavior intention, and a high correlation between the dimensions of social environment and intention was observed. Differences in driver competition were also observed between sexes.

1.2.2. Locus of Control (LC)

The concept of Locus of Control (LC) was developed by Rotter [12], rooted in the concept of social learning behavior theory, consisting of four main aspects: (1) behavior potential, (2) expectancy, (3) reinforcement value, and (4) psychological situation. Control factors are divided into an internal and external locus of control. The internal locus of control can be explained by a personal attitude which accepts that the consequences of an action were subject, and can be controlled by themselves. Whereas, the outside of control was the external locus of control [12].

Therefore, Montag and Comrey [18] applied LC to studied on driving, they separated Driving Internality (DI) and Driving Externality (DE). The result from found that DI and DE had stronger relationship with safety driving. Then, Arthur and Doverspike [19] studied DI had effect to accidents rates more than DE.

In addition, LC for measuring driver locus of control, risky driving and negative outcomes was developed by Özkan and Lajunen [20]. They developed Multidimensional Traffic Locus of Control Scale (T-LOC) for drivers including: “Other Drivers”, “Self”, “Fate”, and “Vehicle and Environment”. In addition, LC and T-LOC have been developed, such as Swedish driver version [21], and Romanian driver version [22].

Măirean et al., 2017 [22] had suggested the relation between T-LOC and driving behavior is not always clear and the evidence on the relation between T-LOC, risk perception, and risky behavior is somewhat mixed. Therefore, the question about the role of LC in risky driving behavior is still open.

Moreover, LC was studied by Champahom, et al. [23], they studied vehicle riding behavior by considering helmet wearing behavior among downtown and suburban residents. Lajunen and Räsänen [24] used the LC to examine bicycle using behavior. Totkova [25] analyzed individual riding patterns activated by anger, anxiety, as well as dissociative, distress-reduction, high velocity, irrational, patient, careful, and risky styles.

1.2.3. Motorcycle Rider Behavior Questionnaire (MRBQ)

The MRBQ was developed by [26] from the driver behavior questionnaire (DBQ) by Reason et al. [9]. Elliott et al. [26] studied factors influencing rider behavior using principal component analysis (PCA) to divide forms of the factors, including traffic errors, control errors, speed violations, performance of stunts, and the use of safety equipment. The MRBQ has 43 questions that were used for linear modeling with age, experience, and riding distance/years. Rider behaviors were measured using five measurement factors, namely, traffic errors, control errors, speed violations, stunts, and safety equipment.
Traffic errors referred to a factor instead of making mistakes or making wrong decisions while driving. “Control errors” referred to variables of error handling behavior (slipping). “Speed violations” referred to the behavior variables involved in speed violations. “Stunts” referred to the main variables of behavior that are involved in thrilling and extreme driving. Finally, “Safety equipment” referred to the use of equipment variables that improve driving safety [26].

The MRBQ has been widely used in studies of motorcycle riding behavior, such as Özkan, et al. [27]. Uttra, et al. [28] developed the MRBQ as an assessment tool for the riding behavior of Thai people, consisting of 26 questions for four factors: traffic errors, control errors, stunts, and safety equipment. We selected these four factors to further study the motivating theory of behavioral practice in structural equation modeling.

1.2.4. Structural Equation Modeling (SEM)

We were interested in theories concerning the motivation or attitudes that resulted in a behavior with several related variables and factors. Therefore, structural equation modeling (SEM) was the most appropriate statistical equation method for this study.

Khampirat [29], in reference to Ratanavaraha, et al. [30], reported that SEM, which is also called covariance structure analysis or the LISREL model, is a model that expresses relationships between latent variables, as well as between latent variables and indicators. SEM is a result of the synthesis of important data analysis from three methods: factor, path, and parameter estimation regression analyses. The SEM consists of two sub-models: the measurement model and structural model.

Nguyen, et al. [31] applied SEM for the analysis of motorcyclists’ cellphone attention behavior based on the theory of planned behavior (TPB) in Vietnam, and the results from the SEM analysis showed good fits to the observed data. The SEM analysis also supported the utilization of an extended TPB framework in identifying the factors of mobile phone use with riding intention and behavior.

1.3. Objective, Hypothesis, and Contributions of this Research

Collisions are often due to human behaviors and attitudes, and the influence of attitude on behavioral changes can generate unsafe riding behavior. We used psychological concepts and theories relevant to behavioral influence, TPB, and LC to predict accidents so we could identify the factors that affect accident occurrence. This also involved using multiple regression analysis, CFA, and SEM. The results can be used to provide guidelines for road safety policies. No research has previously been conducted with SEM along with TPB and LC theories that divides participants by their sex, which is a key factor of individual riding behavior. Therefore, we also aimed to construct a structural equation model by analyzing multi-group SEM between men and women so we could then analyze the variance of participants by applying TPB and LC. Our hypotheses were constructed to seek answers to these questions and fill the aforementioned gap in the literature:

Hypothesis 1 (H1). There is no difference in the invariance between sexes as determined by the TPB.

Hypothesis 2 (H2). There is no difference in the variance between sexes as determined by the LC.

Hypothesis 3 (H3). Perceived behavioral control has a negative effect on rider behavior (MRBQ).

Hypothesis 4 (H4). Health motivation attitude has a negative effect on rider behavior (MRBQ).

Hypothesis 5 (H5). Attitude (severity) has a negative effect on rider behavior (MRBQ).

Hypothesis 6 (H6). Subjective norm has a negative effect on rider behavior (MRBQ).

Hypothesis 7 (H7). An external locus of control negatively affects rider behavior (MRBQ).
Hypothesis 8 (H8). An internal locus of control negatively affects rider behavior (MRBQ).

The contribution of this study was to focus on the factors influencing vehicle driving behavior at a significant level in both negative and positive signals. Particularly, the positive influence results could be used to provide guidelines for road safety policies, whereas the negative influence could be an aid in the campaign of Reducing/Abandoning/Quitting, to enhance the strategy of promoting public relations campaigns in directions consistent with different contexts.

The remainder of this paper is structured as follows: In Section 2, we describe the methods, including the participants, measures, instruments, and data analysis. In Section 3, we outline the results, including the descriptive statistics, results of factor analysis, reliability, multi-group SEM, and the model estimate. The discussion and conclusions are described in Section 4, and the limitations and future work are described in Section 5.

2. Method

2.1. Participants

The participants were gathered from all over Thailand distributed to five administrative regions, consisting of Bangkok and its vicinities, the central region, the northeast, the north, and the south. The respondents were required to be over 20 years of age, able to ride motorcycles, have experience in motorcycling, and with or without driving licenses. The total samples in this research (1516) were deemed sufficient for the analysis of structural equation models as Golob [32] stated that n should be equal to 15 times the indicator factors [33].

The sample profile (Table 1) included 903 men (59.6%) and 613 women (40.4%), with average ages of 36.4 and 33.2 years, respectively. The most common education level was a bachelor’s degree (47.40% of men and 54.81% of women). In terms of career, most of the male participants owned a private company, followed by general worker as an occupation at 40.20% and 21.37%, respectively. Female participants also most commonly owned private companies, followed by personal business/trading owner at 46.82% and 17.29%, respectively. We found that both the male and female participants commonly had motorcycle riding licenses (94.91% and 86.13%, respectively).

2.2. Measures and Instrument

The MRBQ was developed by Elliott et al. [26] as an assessment tool of the frequency of motorcycle rider behavior from the DBQ [9]. Elliott et al. [26] constructed 46 MRBQ indicators that allowing participants to complete a self-assessment, choosing one answer per question. The answers were provided on a 6-point scale (1 = never, 2 = sometimes, 3 = often, 4 = always, 5 = nearly all the time, and 6 = all the time). The five factors that measured motorcycle riding behavior were traffic errors, speed violations, stunt frequency, safety equipment, and control errors. In this study, MRBQ was specified as a dependent variable in the SEM.

Independent variable was developed to collect data regarding the attitudes that affect the MRBQ by reviewing the TPB and LC. The TPB has been developed to cover attitudes toward behavior, subjective norm, and perceived behavior control. The LC and T-LOC have been used in recent driving studies which are useful for further study and application to the context of motorcycling behavior of Thai people. Moreover, most of the factors associated with accidents are known to be caused by human factors [3–5] and behavioral approaches [11,34]. Therefore, in order to continue the development, the LC can be implemented and easy to understand. This research has developed LC indicators affecting MRBQ rider in the Thai context. The attitude that comes from Internal factor (My own decision) and External factors derived from environment related attitude (other people [35]: family and friends [36,37], accident situation or accident news, road safety campaign [38], and strictly police in traffic law [39]), which may contribute to safer driving behaviors used in this study.
Table 1. Sample profile ($n = 1516$).

| Variables                          | Men ($n=903$) | Women ($n=613$) |
|------------------------------------|---------------|-----------------|
| **Age**                            |               |                 |
| Average age                        | Average age   |                 |
| SD = 9.57                          | Average age   |                 |
| Max = 72 years                     | Max = 70 years|
| Min = 20 years                     | Min = 20 years|
| **Average income**                 |               |                 |
| 23,964 baht/month                  | 21,721 baht/month |
| **Education level**                |               |                 |
| Other                              | 1             | 0.11            |
| Primary school                     | 67            | 7.42            |
| Junior high school                 | 107           | 11.85           |
| Senior high school                 | 146           | 16.17           |
| High vocational certificate        | 118           | 13.07           |
| Bachelor’s degree                  | 428           | 47.40           |
| Master’s degree                    | 22            | 2.44            |
| Ph.D.                              | 14            | 1.55            |
| **Occupation**                     |               |                 |
| Student                            | 57            | 6.31            |
| Civil servant/state enterprise employee | 39        | 4.32            |
| Private companies                  | 363           | 40.20           |
| Personal business/trading owner    | 169           | 18.72           |
| Agriculturist                      | 79            | 8.75            |
| Contractors                        | 193           | 21.37           |
| Housewife                          | -             | -               |
| Other                              | 3             | 0.33            |
| Licensed rider                     | Yes           | 857             |
|                                   | No            | 46              |
| SD, standard deviation.            |               |                 |

The questionnaire was designed as a self-assessment, choosing one answer per question. The questions were answered on a seven-point scale in accordance with level of behavioral agreement (1 = do not agree to 7 = strongly agree). An example of a statement used in the questionnaire is: “If you get into an accident, your health and physical body will not be the same.”

These research tools were adjusted to suit Thai people’s behavior. They were tested prior to data collection using the objective congruence index (IOC) with seven measurements developed by traffic and transport, safety, and education experts who had the knowledge needed to be able to assess the research tool. Then, the experiment was run by collecting 100 sets of data and testing the data’s normal distribution [40] and calculating Cronbach’s $\alpha$, which was required to be higher than or equal to 0.7 [41]. This research was approved by the Ethics Committee for Research Involving Human Subjects, Suranaree University of Technology (Pr: EC-63-0052).

2.3. Data Analysis

2.3.1. Factor Analysis

Factor analysis was used to study the measurements of observed variables or indicators, and is a distribution technique for observed variables or indicators that can be directly measured [42] in the simple forms of exploratory factor analysis (EFA) and confirmatory factor analysis (CFA).

SPSS 18.0 software (SPSS Inc., Chicago, IL, USA) was used in the analysis of EFA, and factor analysis was used to classify or decrease the numbers of variables in the observed variables or indicators [43]. Factor loadings $> 0.5$ were considered for further study [9]. This research consisted of 20 observed variables that were analyzed under the TPB and LC criteria.
2.3.2. Multi-Group SEM

Here, with multi-group SEM analysis, we focused on attitudes according to TPB and LC that affect motorcycle rider behavior (MRB) and the differences between men and women. We used SEM and multi-group analysis to test the hypotheses using Mplus 7.2 software [44].

For hypotheses testing, the following criteria were used: goodness-of-fit-statistics with chi-squared/degree of freedom (df) < 5 [45], root mean squared error of approximation (RMSEA) < 0.08 [46,47], standardized root mean square residual (SRMR) < 0.08 [45], comparative fit index (CFI) ≥ 0.90 [45], and the Tucker–Lewis index (TLI) ≥ 0.80 [48,49].

3. Results

3.1. Descriptive Statistics

The calculated descriptive statistics (mean, standard deviation (SD), skewness, and kurtosis; Table 2) showed that men could be classified into four latent variables (Traffic Error (TE), Control Error (CE), Stunt (ST), and Safety Equipment (SE)) for the MRBQ variables, and the mean for men was between 1.28 and 2.33. The mean for women was between 1.25 and 2.21. The SD was 0.51–0.88 and 0.48–0.79 for men and women, respectively. The skewness was between −0.805 to 1.490 in men and −0.740 to 2.081 in women. The kurtosis was −1.250 to 1.217 and −1.303 to 3.575 for men and women, respectively. From the analysis results, we concluded that the MRBQ kurtosis and skewness values were less than 3 and 10 for men and women, respectively [40].

Among the variable groups of the TPB and LC (X1–X20), we found that the means for men and women were 4.68–6.60 and 4.98–6.62, respectively. The SD in men was 0.63–1.18 and was 0.60–1.31 for women. The skewness was between −1.581 and 0.303 in men and −1.588 and 0.136 in women. The kurtosis was between −0.700 and 2.268 in men and −0.908 and 2.512 in women. We found that these results passed, which states that skewness should be less than 3.0 and kurtosis should be less than 10.0.

3.2. Factor Analysis Results

The factor analysis results dividing men and women (Table 3) was the outcome of the EFA of men according to TPB. We found four factors of EFA, including attitudes based on health motivation (AHM), attitudes based on severity (ASE), subjective norm (SN), and perceived behavior control (PC). EFA, in accordance with LC theory, identified two factors: externality (EX) and internality (IN). The EFA used PCA as the extraction method and Varimax with Kaiser normalization as the rotation method. The Kaiser–Meyer–Olkin (KMO) was 0.774, and the EFA’s factor loadings of TPB and LC theory were 0.664–0.900 and 0.746–0.880, respectively. Table 4 provides the results for women; the factor loadings using EFA from TPB and LC theory were 0.736–0.900 and 0.734–0.901, respectively.

CFA was performed before SEM to confirm both the indicators and factors. In men, the factor loading of TPB was between 0.510 and 0.981 and of LC was between 0.598 and 0.962. The CFA of MRBQ showed that the factor loading was between 0.423 and 0.843 for TPB analysis and 0.449 and 0.884 for LC analysis.

Table 4 provides the results of the EFA and CFA for female riders, with a KMO of 0.791 for TPB and 0.754 for LC. Factor loading obtained by EFA was between 0.549 and 0.866 for TPB and was between 0.542 and 0.813 for LC theory. CFA was also performed, which showed that the factor loading was between 0.489 and 0.979 for TPB and 0.579 and 0.948 for LC.

The CFA obtained by MRBQ analysis found that factor loading in TPB was 0.360–0.817. For LC, the factor loading was 0.300–0.945.
Table 2. Descriptive statistics.

| Code | Latent Variable/Questionnaire                                                                 | Men (n = 903) | Women (n = 613) |
|------|---------------------------------------------------------------------------------------------|---------------|-----------------|
|      |                                                                                             | Mean | SD   | Sk  | Ku  | Mean | SD   | Sk  | Ku  |
| TE   | Motorcycle Rider Behavior Questionnaire (MRBQ)                                              |      |      |     |     |      |      |     |     |
|      | Traffic Error                                                                               | 1.88 | 0.56 | –0.194 | 1.250 | 1.82 | 0.54 | –0.121 | –1.303 |
| CE   | Control Error                                                                               | 2.33 | 0.51 | –0.805 | 0.881 | 2.21 | 0.54 | –0.740 | 0.394  |
| ST   | Stunt frequency                                                                             | 1.38 | 0.58 | 1.490 | 1.217 | 1.25 | 0.48 | 2.081 | 3.575  |
| SE   | Safety Equipment                                                                             | 1.52 | 0.88 | 1.118 | 1.172 | 1.71 | 0.79 | 1.241 | 1.294  |
|      | Theory of planned behavior (TPB) (X1–X19) and locus of control (LC) (X12–X20)             |      |      |     |     |      |      |     |     |
| X1   | Road accidents caused by vehicle riding are the most dangerous ones.                        | 6.60 | 0.63 | –1.581 | 2.268 | 6.62 | 0.60 | –1.588 | 2.512  |
| X2   | Health and the physical body are the most important factors when riding vehicles.           | 6.43 | 0.75 | –1.027 | 0.046 | 6.46 | 0.71 | –1.033 | 0.112  |
| X3   | Proper rest is the most important thing for vehicle riding.                                 | 6.22 | 0.74 | –0.597 | –0.277 | 6.33 | 0.71 | –0.957 | 1.182  |
| X4   | You pay attention to safety when riding a vehicle.                                          | 6.29 | 0.74 | –0.677 | –0.353 | 6.41 | 0.74 | –1.033 | 0.374  |
| X5   | If you get into an accident, your health and body will not be the same.                     | 6.27 | 0.83 | –0.952 | 0.288 | 6.29 | 0.91 | –1.168 | 0.618  |
| X6   | If you do not wear a helmet, you may die if you get into an accident.                       | 4.68 | 1.17 | 0.303 | 0.193 | 4.98 | 1.31 | 0.007 | –0.465 |
| X7   | If an accident is caused by riding, it may cause death or disability, which require long-term treatment. | 5.33 | 0.93 | 0.206 | –0.347 | 5.55 | 0.98 | 0.090 | –0.908 |
| X8   | Vehicle accidents would highly affect your study/work.                                      | 5.34 | 0.87 | 0.196 | –0.140 | 5.53 | 0.95 | 0.136 | –0.826 |
| X9   | Accidents would affect your life and network, e.g., immediate family, friends, relatives.  | 5.37 | 0.90 | 0.269 | –0.618 | 5.61 | 0.97 | –0.013 | –0.940 |
| X10  | Each accident causes death, mental illness, and loss of time and money.                     | 5.50 | 0.95 | –0.018 | –0.700 | 5.69 | 0.98 | –0.239 | –0.743 |
| X11  | If you violate traffic laws, you may get fined or penalized.                                | 5.56 | 0.97 | –0.014 | –0.463 | 5.73 | 1.06 | –0.898 | 1.898  |
| X12  | Your family and friends drive carefully and follow traffic laws, so you do as well.        | 5.62 | 1.01 | –0.352 | –0.319 | 5.70 | 1.10 | –0.689 | –0.028 |
| X13  | You stay abreast of accident news, so you are afraid of accidents happening to yourself or your friends/family. | 5.92 | 0.97 | –0.565 | –0.343 | 5.89 | 1.02 | –0.548 | –0.577 |
| X14  | You often see campaigns/public relations on safe riding.                                    | 5.92 | 0.99 | –0.943 | 0.920 | 5.89 | 1.11 | –0.925 | 0.401  |
| X15  | Your organization/company pays attention to safe riding/has a safe riding campaign.         | 5.59 | 1.18 | –1.235 | 1.982 | 5.58 | 1.25 | –1.091 | 1.287  |
| X16  | You make your own decisions to follow traffic laws independent of others.                   | 6.25 | 0.84 | –0.780 | –0.419 | 6.22 | 0.80 | –0.594 | –0.690 |
| X17  | Helmet wearing is your own choice.                                                           | 6.47 | 0.68 | –0.993 | 0.103 | 6.46 | 0.66 | –1.237 | 2.357  |
| X18  | Accidents are mostly caused by road conditions and the environment, not humans.            | 6.15 | 0.83 | –0.666 | 0.018 | 6.24 | 0.78 | –0.669 | –0.333 |
| X19  | You can reduce the risk of accidents by riding safely.                                      | 6.15 | 0.81 | –0.514 | –0.562 | 6.26 | 0.73 | –0.606 | –0.373 |
| X20  | You find that polices are strict with regards to traffic discipline, so you pay attention to safe riding. | 5.58 | 1.15 | –0.323 | –0.268 | 5.62 | 1.19 | –0.435 | –0.598 |

Note: X1–X20, code for TPB and LC indicators; SD, standard deviation; Sk, Skewness; and Ku, Kurtosis.
**Table 3.** Factor analysis for Men. $N = 903$, KMO for TPB = 0.778, and KMO for LC = 0.723.

| Variable/Measurement Model/Cronbach's α | EFA Communalities | Loading | Loading Est./S.E. | p-Value | Error Variance | CR | AVE |
|----------------------------------------|-------------------|---------|-------------------|---------|----------------|----|-----|
| Motorcycle Rider Behavior Questionnaire (MRBQ) | Traffic Error (TE) - | 0.843 | 43.557 | <0.001 | 0.289 | 0.688 | 0.588 |
|                                           | Control Error (CE) - | 0.624 | 26.840 | <0.001 | 0.611 |          |     |
|                                           | Stunt (ST) - | 0.460 | 16.302 | <0.001 | 0.788 |          |     |
|                                           | Safety Equipment (SE) - | 0.423 | 14.084 | <0.001 | 0.821 |          |     |
| Attitudes based on Health Motivation (AHM) (Cronbach's α = 0.806) | X1 | 0.624 | 0.760 | 0.618 | 26.294 | <0.001 | 0.618 | 0.812 | 0.676 |
|                                           | X2 | 0.643 | 0.710 | 0.510 | 19.839 | <0.001 | 0.740 |          |     |
|                                           | X3 | 0.558 | 0.664 | 0.692 | 34.446 | <0.001 | 0.521 |          |     |
|                                           | X4 | 0.741 | 0.828 | 0.873 | 62.415 | <0.001 | 0.237 |          |     |
|                                           | X5 | 0.615 | 0.701 | 0.687 | 34.524 | <0.001 | 0.528 |          |     |
| Attitudes based on Severity (ASE) (Cronbach's α = 0.927) | X6 | 0.744 | 0.804 | 0.838 | 79.116 | <0.001 | 0.298 | 0.930 | 0.827 |
|                                           | X7 | 0.722 | 0.841 | 0.793 | 59.012 | <0.001 | 0.371 |          |     |
|                                           | X8 | 0.759 | 0.830 | 0.902 | 86.089 | <0.001 | 0.186 |          |     |
|                                           | X9 | 0.779 | 0.850 | 0.906 | 98.840 | <0.001 | 0.178 |          |     |
|                                           | X10 | 0.843 | 0.900 | 0.874 | 89.500 | <0.001 | 0.237 |          |     |
|                                           | X11 | 0.672 | 0.802 | 0.649 | 32.806 | <0.001 | 0.578 |          |     |
| Subjective Norm (SN) (Cronbach's α = 0.856) | X12 | 0.643 | 0.791 | 0.640 | 36.335 | <0.001 | 0.590 | 0.883 | 0.803 |
|                                           | X13 | 0.702 | 0.769 | 0.981 | 111.048 | <0.001 | 0.039 |          |     |
|                                           | X14 | 0.751 | 0.829 | 0.797 | 95.630 | <0.001 | 0.365 |          |     |
|                                           | X15 | 0.685 | 0.816 | 0.793 | 59.077 | <0.001 | 0.371 |          |     |
| Perceived Behavior Control (PC) (Cronbach's α = 0.864) | X16 | 0.756 | 0.856 | 0.674 | 34.408 | <0.001 | 0.545 | 0.862 | 0.775 |
|                                           | X17 | 0.614 | 0.769 | 0.624 | 25.119 | <0.001 | 0.611 |          |     |
|                                           | X18 | 0.755 | 0.854 | 0.862 | 71.956 | <0.001 | 0.257 |          |     |
|                                           | X19 | 0.744 | 0.827 | 0.938 | 90.679 | <0.001 | 0.120 |          |     |
| Motorcycle Rider Behavior Questionnaire (MRBQ) | TE - | 0.884 | 27.720 | <0.001 | 0.219 | 0.697 | 0.595 |
|                                           | CE - | 0.588 | 20.720 | <0.001 | 0.654 |          |     |
|                                           | ST - | 0.449 | 14.149 | <0.001 | 0.798 |          |     |
|                                           | SE - | 0.458 | 11.864 | <0.001 | 0.790 |          |     |
### Table 3. Cont.

| Variable/Measurement Model/Cronbach's α | EFA | CFA |
|----------------------------------------|-----|-----|
|                                        | EFA | CFA |
|                                        | Communalities | Loading | Loading | Est/S.E. | p-Value | Error Variance | CR | AVE |
| Externality (EX) (Cronbach's α = 0.889) |     |     |     |           |         |               |    |    |
| X12                                    | 0.560 | 0.746 | 0.621 | 31.755 | <0.001 | 0.614 | 0.913 | 0.818 |
| X13                                    | 0.716 | 0.840 | 0.962 | 69.801 | <0.001 | 0.074 |       |    |
| X14                                    | 0.774 | 0.880 | 0.797 | 61.343 | <0.001 | 0.364 |       |    |
| X15                                    | 0.712 | 0.843 | 0.871 | 71.119 | <0.001 | 0.241 |       |    |
| X20                                    | 0.741 | 0.851 | 0.841 | 64.396 | <0.001 | 0.293 |       |    |
| Internality (IN) (Cronbach's α = 0.864) |     |     |     |           |         |               |    |    |
| X16                                    | 0.744 | 0.853 | 0.671 | 33.708 | <0.001 | 0.550 | 0.859 | 0.769 |
| X17                                    | 0.603 | 0.768 | 0.598 | 23.304 | <0.001 | 0.643 |       |    |
| X18                                    | 0.764 | 0.874 | 0.866 | 67.972 | <0.001 | 0.250 |       |    |
| X19                                    | 0.751 | 0.866 | 0.942 | 81.001 | <0.001 | 0.112 |       |    |

Note: Extraction method: principal component analysis, Rotation method: Varimax with Kaiser Normalization. KMO, Kaiser–Meyer–Olkin; CFA, confirmatory factor analysis; CR, composite reliability; AVE, average variance extracted.

### Table 4. Factor analysis for women. N = 613, KMO for TPB = 0.791, KMO for LC = 0.754.

| Variable/Measurement Model/Cronbach's α | EFA | CFA |
|----------------------------------------|-----|-----|
|                                        | EFA | CFA |
|                                        | Communalities | Loading | Loading | Est/S.E. | p-Value | Error Variance | CR | AVE |
| Motorcycle Rider Behavior Questionnaire (MRBQ) |     |     |     |           |         |               |    |    |
| TE                                     | -   | -   | 0.817 | 37.225 | <0.001 | 0.332 | 0.699 | 0.529 |
| CE                                     | -   | -   | 0.787 | 32.988 | <0.001 | 0.380 |       |    |
| ST                                     | -   | -   | 0.405 | 11.557 | <0.001 | 0.836 |       |    |
| SE                                     | -   | -   | 0.360 | 10.865 | <0.001 | 0.870 |       |    |
| Attitudes based on Health Motivation (AHM) (Cronbach's α = 0.805) |     |     |     |           |         |               |    |    |
| X1                                     | 0.605 | 0.741 | 0.683 | 25.21  | <0.001 | 0.533 | 0.814 | 0.678 |
| X2                                     | 0.615 | 0.736 | 0.489 | 14.726 | <0.001 | 0.761 |       |    |
| X3                                     | 0.673 | 0.746 | 0.726 | 33.042 | <0.001 | 0.473 |       |    |
| X4                                     | 0.731 | 0.824 | 0.839 | 47.331 | <0.001 | 0.296 |       |    |
| X5                                     | 0.549 | 0.602 | 0.654 | 24.739 | <0.001 | 0.573 |       |    |
| Attitudes based on Severity (ASE) (Cronbach's α = 0.932) |     |     |     |           |         |               |    |    |
| X6                                     | 0.780 | 0.796 | 0.865 | 79.142 | <0.001 | 0.251 | 0.940 | 0.847 |
| X7                                     | 0.702 | 0.807 | 0.797 | 52.144 | <0.001 | 0.365 |       |    |
Table 4. Cont.

| Variable/Measurement Model/Cronbach’s α | EFA | CFA |
|----------------------------------------|-----|-----|
|                                        | Communalities | Loading | Loading Est./S.E. | p-Value | Error Variance | CR | AVE |
| X8                                     | 0.794 | 0.813 | 0.916 | 87.650 | <0.001 | 0.161 |
| X9                                     | 0.832 | 0.881 | 0.932 | 113.294 | <0.001 | 0.131 |
| X10                                    | 0.866 | 0.900 | 0.903 | 102.439 | <0.001 | 0.184 |
| X11                                    | 0.652 | 0.794 | 0.666 | 31.065 | <0.001 | 0.556 |
| Subjective Norm (SN) (Cronbach’s α = 0.900) | | | | | | |
| X12                                    | 0.744 | 0.836 | 0.693 | 34.595 | <0.001 | 0.520 | 0.917 | 0.852 |
| X13                                    | 0.738 | 0.814 | 0.979 | 91.171 | <0.001 | 0.131 |
| X14                                    | 0.807 | 0.872 | 0.832 | 63.628 | <0.001 | 0.308 |
| X15                                    | 0.770 | 0.847 | 0.904 | 59.781 | <0.001 | 0.183 |
| Perceived Behavior Control (PC) (Cronbach’s α = 0.842) | | | | | | |
| X16                                    | 0.733 | 0.834 | 0.671 | 26.24 | <0.001 | 0.549 | 0.847 | 0.756 |
| X17                                    | 0.551 | 0.738 | 0.596 | 17.964 | <0.001 | 0.645 |
| X18                                    | 0.767 | 0.865 | 0.857 | 50.731 | <0.001 | 0.266 |
| X19                                    | 0.711 | 0.801 | 0.900 | 61.327 | <0.001 | 0.190 |
| Motorcycle Rider Behavior Questionnaire (MRBQ) | | | | | | |
| TE                                     | - | - | 0.945 | 25.861 | <0.001 | 0.107 | 0.671 | 0.562 |
| CE                                     | - | - | 0.651 | 20.518 | <0.001 | 0.576 |
| ST                                     | - | - | 0.300 | 7.895 | <0.001 | 0.91 |
| SE                                     | - | - | 0.350 | 7.506 | <0.001 | 0.878 |
| Externality (EX) (Cronbach’s α = 0.921) | | | | | | |
| X12                                    | 0.708 | 0.841 | 0.739 | 41.011 | <0.001 | 0.453 | 0.936 | 0.860 |
| X13                                    | 0.747 | 0.861 | 0.948 | 80.874 | <0.001 | 0.101 |
| X14                                    | 0.813 | 0.901 | 0.857 | 76.796 | <0.001 | 0.266 |
| X15                                    | 0.782 | 0.881 | 0.911 | 87.171 | <0.001 | 0.169 |
| X20                                    | 0.780 | 0.875 | 0.845 | 61.173 | <0.001 | 0.285 |
| Internality (IN) (Cronbach’s α = 0.842) | | | | | | |
| X16                                    | 0.724 | 0.836 | 0.672 | 27.481 | <0.001 | 0.548 | 0.843 | 0.751 |
| X17                                    | 0.542 | 0.734 | 0.579 | 17.398 | <0.001 | 0.665 |
| X18                                    | 0.769 | 0.875 | 0.857 | 49.589 | <0.001 | 0.265 |
| X19                                    | 0.710 | 0.842 | 0.896 | 53.640 | <0.001 | 0.197 |

Note: Extraction method: principal component analysis, Rotation method: Varimax with Kaiser normalization.
3.3. Reliability

The accuracy of indicators was indicated by Cronbach’s $\alpha$ values of 0.7 or higher [41]. The TPB analysis consisted of four variables: AHM, ASE, SN, and PC. In men, the Cronbach’s $\alpha$ values were 0.806, 0.927, 0.856, and 0.864, respectively. LC theory analysis produced two variables: EX and IN. For men, the Cronbach’s $\alpha$ values were 0.889 and 0.864, respectively (Table 3). For women (Table 4), the Cronbach’s $\alpha$ values were 0.805–0.932 for the TPB analysis and 0.842–0.921 for the LC analysis.

The composite reliability (CR) and average variance extracted (AVE) were respectively calculated using Equations (1) and (2):

$$CR = \frac{\left(\sum_{i=1}^{n} L_i\right)^2}{\left(\sum_{i=1}^{n} L_i\right)^2 + \left(\sum_{i=1}^{n} e_i\right)}$$

$$AVE = \frac{\sum_{i=1}^{n} L_i}{n}$$

where $L_i$ is the standardized factor loadings obtained by CFA, $i$ is the number of observed variables in each variable factor, and $e_i$ is the error variance terms of each group of measurement models under the condition $CR \geq 0.7$ [42]. The CR was 0.812–0.930 for TPB and 0.859–0.913 for LC analysis with $AVE \geq 0.5$ [42]. The analysis of men was 0.678–0.827 for TPB and 0.768–0.818 for LC (Table 4). For women (Table 4), the CR was 0.814–0.940 with TPB and 0.936–0.843 for LC. The AVE was between 0.678–0.852 for TPB and 0.860 and 0.751 for LC.

We tested for correlation to investigate the relationships between MRBQ (TE, CE, ST, and SE), TPB (AHM, ASE, SN, and PC), and LC (EX, IN) using a Pearson table at the 99% significance level. We found that men were between $-0.479$ and $-0.066$ and women were between $-0.550$ and $-0.099$ (Table 5).

3.4. Multi-Group Analysis

Multi-group SEM was used to test the invariance in the between-group model for men and women (Hypotheses 1 and 2) using TPB and LC theory. According to the results in Table 6, we found that the TPB measurements of invariance with factor loading hypothesis, intercepts, and structural paths were equal between the groups (model 3; Chi-square = 1420.039, df = 330, Chi-square/df = 4.69 (<5) [45], RMSEA = 0.070 (0.066–0.073) [46,47], CFI = 0.954 [45], TLI = 0.924 [48,49], and SRMR = 0.068 < 0.08 [45]). For model 4, the factor loading, intercept, and structural path were equal between the groups (Chi-square = 1529.940, df = 336, Chi-square/df = 4.55, RMSEA = 0.068 (0.065–0.072), CFI = 0.951, TLI = 0.926, and SRMR = 0.077). The analysis result of both models (models 3 and 4) showed the goodness of fit and met the criteria in accordance with specified values. The testing result of the difference between model 3 and model 4 produced a Chi-square of 109.901 with df = 33 at $p < 0.01$. In conclusion, we rejected the hypothesis 1 that the TPB’s SEM of motorcycle riding behaviors of men and women are different.

The LC measurement invariance (model 7) had a Chi-square of 213.265, a df of 67, and a Chi-square/df of 3.18, which is <5 [45] (RMSEA = 0.054 (0.046–0.062) [46,47], CFI = 0.987 [45], TLI = 0.970 [48,49], and SRMR = 0.042 < 0.08 [45]). Model 8 had a Chi-square of 277.877, a df of 84, and a Chi-square/df of 3.18 (RMSEA = 0.055 (0.048–0.062), CFI = 0.983, TLI = 0.968, and SRMR = 0.056). The analysis results of both models (models 7 and 8) had good fits and met the criteria. The testing result of the difference between the models was Chi-square = 64.612 with df = 17 at $p < 0.01$. In conclusion, we rejected the hypothesis that the LC’s structural equation model of motorcycle riding behavior of the samples of men and women are different.
Table 5. Correlation analysis results.

| Code (Men) | TE    | CE    | ST    | SE    | AHM   | ASE   | SN    | PC    | EX    | IN    |
|-----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| TE        | 1.00  |       |       |       |       |       |       |       |       |       |
| CE        | 0.508 ** | 1.00 |       |       |       |       |       |       |       |       |
| ST        | 0.401 ** | 0.396 ** | 1.00 |       |       |       |       |       |       |       |
| SE        | 0.336 ** | 0.259 ** | 0.505 ** | 1.00 |       |       |       |       |       |       |
| AHM       | −0.341 ** | −0.351 ** | −0.295 ** | −0.334 ** | 1.00 |       |       |       |       |       |
| ASE       | −0.323 ** | −0.340 ** | −0.132 ** | −0.017 | 0.224 ** | 1.00 |       |       |       |       |
| SN        | 0.061 | −0.191 ** | 0.051 | −0.049 | 0.224 ** | 0.388 ** | 1.00 |       |       |       |
| PC        | −0.479 ** | −0.356 ** | −0.208 ** | −0.267 ** | 0.312 ** | 0.196 ** | 0.104 ** | 1.00 |       |       |
| EX        | 0.055 | −0.205 ** | 0.032 | −0.066 | 0.245 ** | 0.414 ** | 0.986 ** | 0.128 ** | 1.00 |       |
| IN        | −0.479 ** | −0.356 ** | −0.208 ** | −0.267 ** | 0.312 ** | 0.196 ** | 0.104 ** | 1.00 |       |       |

| Code (Women) | TE    | CE    | ST    | SE    | AHM   | ASE   | SN    | PC    | EX    | IN    |
|--------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| TE          | 1.00  |       |       |       |       |       |       |       |       |       |
| CE          | 0.592 ** | 1.00 |       |       |       |       |       |       |       |       |
| ST          | 0.291 ** | 0.318 ** | 1.00 |       |       |       |       |       |       |       |
| SE          | 0.224 ** | 0.239 ** | 0.403 ** | 1.00 |       |       |       |       |       |       |
| AHM         | −0.387 ** | −0.350 ** | −0.292 ** | −0.385 ** | 1.00 |       |       |       |       |       |
| ASE         | −0.384 ** | −0.477 ** | −0.269 ** | −0.099 | 0.366 ** | 1.00 |       |       |       |       |
| SN          | 0.009 | −0.267 ** | −0.009 | −0.122 ** | 0.240 ** | 0.467 ** | 1.00 |       |       |       |
| PC          | −0.550 ** | −0.371 ** | −0.161 ** | −0.172 ** | 0.295 ** | 0.182 ** | 0.046 | 1.00 |       |       |
| EX          | 0.000 | −0.303 ** | −0.025 | −0.116 ** | 0.258 ** | 0.505 ** | 0.990 ** | 0.072 | 1.00 |       |
| IN          | −0.550 ** | −0.371 ** | −0.161 ** | −0.172 ** | 0.295 ** | 0.182 ** | 0.046 | 1.00 |       |       |

Note: ** p-value < 0.05.

Table 6. Model of fit and statistical and multi-group analyses.

| Theory of Planned Behavior (TPB) | χ² | df | χ²/df | RMSEA | CFI | TLI | SRMR | Delta-χ² | Delta-df | p  |
|--------------------------------|----|----|------|-------|-----|-----|------|----------|----------|----|
| Theory of planned behavior (TPB) |    |    |      |       |     |     |      |          |          |    |
| Model 1: Men (n = 900)         | 766.104 | 163 | 4.70 | 0.064 (0.059–0.069) | 0.957 | 0.933 | 0.065 |          |          |    |
| Model 2: Women (n = 613)       | 699.652 | 147 | 4.76 | 0.075 (0.073–0.084) | 0.947 | 0.909 | 0.066 |          |          |    |
| TPB Measurement Invariance     |    |    |      |       |     |     |      |          |          |    |
| Model 3: Simultaneous          | 1420.039 | 303 | 4.69 | 0.070 (0.066–0.073) | 0.954 | 0.924 | 0.068 |          |          |    |
| Model 4: Factor loading, intercept, and structural path held equal groups | 1529.940 | 336 | 4.55 | 0.068 (0.063–0.072) | 0.951 | 0.926 | 0.077 | 199.901 | 33 | 0.0000 |
| Locus of Control (LC)          |    |    |      |       |     |     |      |          |          |    |
| Model 5: Men (n = 900)         | 92.597 | 31 | 2.99 | 0.047 (0.036–0.058) | 0.991 | 0.976 | 0.038 |          |          |    |
| Model 6: Women (n = 613)       | 90.664 | 31 | 2.92 | 0.056 (0.043–0.070) | 0.987 | 0.969 | 0.037 |          |          |    |
| LC Measurement invariance      |    |    |      |       |     |     |      |          |          |    |
| Model 7: Simultaneous          | 213.265 | 67 | 3.18 | 0.054 (0.046–0.062) | 0.987 | 0.970 | 0.042 |          |          |    |
| Model 8: Factor loading, intercept, and structural path held equal groups | 277.877 | 84 | 3.31 | 0.055 (0.048–0.062) | 0.983 | 0.968 | 0.056 | 64.612 | 17 | 0.0000 |

The root mean squared error of approximation (RMSEA), standardized root mean square residual (SRMR), comparative fit index (CFI), and the Tucker–Lewis index (TLI).

3.5. Model Estimate

The analysis results of the SEMs for TPB and LC, which affect the MRB, could explain and express the factor loading of each indicator, as shown in Tables 7 and 8.

3.5.1. TPB Model Estimate for Men

The SEM for the TPB (Figure 1) in men showed that H3 (perceived behavior control has a negative effect on rider behavior) was supported (β = −0.411, p < 0.05). H4 (attitude (health motivation) has a negative effect on rider behavior) was also supported (β = −0.458, p < 0.05). H4 and H5 (attitude (health motivation) and attitude (severity) have a negative effect on rider behavior, respectively) were supported (β = −0.458 and −0.215, respectively; p < 0.05). H6 (subjective norm) had no effect on the MRB. AHM, ASE, and SN were found to indirectly affect the MRB, as presented in Figure 1 and Table 9.
Table 7. Theory of planned measurement model parameters.

| Variable | Men | | | | | | | Women | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Standardized Estimate | S.E. | Est./S.E. | p-Value | R² | Standardized Estimate | S.E. | Est./S.E. | p-Value | R² |
| Rider behavior use MRBQ by TE | 0.841 | 0.019 | 43.260 | <0.001 | 0.708 | 0.814 | 0.022 | 36.876 | <0.001 | 0.663 |
| CE | 0.621 | 0.023 | 26.990 | <0.001 | 0.386 | 0.785 | 0.024 | 32.918 | <0.001 | 0.617 |
| ST | 0.458 | 0.028 | 16.307 | <0.001 | 0.210 | 0.402 | 0.035 | 11.529 | <0.001 | 0.162 |
| SE | 0.418 | 0.030 | 14.028 | <0.001 | 0.175 | 0.363 | 0.033 | 11.028 | <0.001 | 0.132 |
| Attitudes based on Health Motivation (AHM) by X1 | 0.618 | 0.023 | 26.295 | <0.001 | 0.382 | 0.684 | 0.027 | 25.277 | <0.001 | 0.468 |
| X2 | 0.508 | 0.026 | 19.751 | <0.001 | 0.258 | 0.488 | 0.033 | 14.672 | <0.001 | 0.239 |
| X3 | 0.688 | 0.020 | 34.404 | <0.001 | 0.473 | 0.733 | 0.021 | 34.521 | <0.001 | 0.537 |
| X4 | 0.870 | 0.014 | 61.765 | <0.001 | 0.756 | 0.840 | 0.018 | 47.879 | <0.001 | 0.705 |
| X5 | 0.682 | 0.020 | 34.264 | <0.001 | 0.466 | 0.665 | 0.025 | 26.862 | <0.001 | 0.442 |
| Attitudes based on Severity (ASE) by X6 | 0.838 | 0.011 | 79.202 | <0.001 | 0.703 | 0.865 | 0.011 | 79.094 | <0.001 | 0.748 |
| X7 | 0.794 | 0.013 | 59.357 | <0.001 | 0.631 | 0.797 | 0.015 | 52.117 | <0.001 | 0.635 |
| X8 | 0.902 | 0.010 | 86.630 | <0.001 | 0.814 | 0.916 | 0.010 | 87.518 | <0.001 | 0.839 |
| X9 | 0.904 | 0.009 | 97.035 | <0.001 | 0.818 | 0.932 | 0.009 | 112.354 | <0.001 | 0.868 |
| X10 | 0.871 | 0.010 | 88.353 | <0.001 | 0.759 | 0.903 | 0.008 | 101.576 | <0.001 | 0.815 |
| X11 | 0.649 | 0.020 | 32.868 | <0.001 | 0.422 | 0.665 | 0.022 | 30.911 | <0.001 | 0.442 |
| Subjective Norm (SN) by X12 | 0.636 | 0.018 | 36.069 | <0.001 | 0.405 | 0.696 | 0.020 | 35.504 | <0.001 | 0.485 |
| X13 | 0.980 | 0.009 | 109.981 | <0.001 | 0.960 | 0.980 | 0.011 | 92.916 | <0.001 | 0.961 |
| X14 | 0.794 | 0.008 | 96.966 | <0.001 | 0.631 | 0.834 | 0.013 | 64.417 | <0.001 | 0.695 |
| X15 | 0.792 | 0.013 | 58.866 | <0.001 | 0.628 | 0.906 | 0.015 | 61.312 | <0.001 | 0.821 |
| Perceived Behavior Control (PC) by X16 | 0.672 | 0.020 | 34.183 | <0.001 | 0.451 | 0.669 | 0.026 | 26.019 | <0.001 | 0.447 |
| X17 | 0.617 | 0.025 | 24.816 | <0.001 | 0.381 | 0.594 | 0.033 | 17.914 | <0.001 | 0.352 |
| X18 | 0.862 | 0.012 | 71.733 | <0.001 | 0.744 | 0.859 | 0.017 | 51.543 | <0.001 | 0.738 |
| X19 | 0.936 | 0.010 | 89.163 | <0.001 | 0.876 | 0.897 | 0.020 | 61.319 | <0.001 | 0.805 |
Table 8. Locus of control measurement model parameters.

| Variable                          | Men                                                                 | Women                                                                 |
|-----------------------------------|----------------------------------------------------------------------|----------------------------------------------------------------------|
|                                   | Standardized Estimate | S.E. | Est./S.E. | p-Value | R² | Standardized Estimate | S.E. | Est./S.E. | p-Value | R² |
| Rider behavior use MRBQ by        |                                                                     |      |           |          |    |                                                                     |      |           |          |    |
| TE                                | 0.884                  | 0.032 | 27.719    | <0.001   | 0.781 | 0.945                  | 0.037 | 25.862    | <0.001   | 0.893 |
| CE                                | 0.588                  | 0.028 | 20.720    | <0.001   | 0.346 | 0.561                  | 0.032 | 20.518    | <0.001   | 0.424 |
| ST                                | 0.449                  | 0.032 | 14.149    | <0.001   | 0.202 | 0.300                  | 0.038 | 7.895     | <0.001   | 0.090 |
| SE                                | 0.458                  | 0.039 | 11.864    | <0.001   | 0.210 | 0.350                  | 0.047 | 7.506     | <0.001   | 0.122 |
| Externality (EX) by               |                                                                     |      |           |          |    |                                                                     |      |           |          |    |
| X12                               | 0.621                  | 0.020 | 31.756    | <0.001   | 0.386 | 0.739                  | 0.018 | 41.011    | <0.001   | 0.547 |
| X13                               | 0.962                  | 0.014 | 69.801    | <0.001   | 0.926 | 0.948                  | 0.012 | 80.874    | <0.001   | 0.899 |
| X14                               | 0.797                  | 0.013 | 61.343    | <0.001   | 0.636 | 0.857                  | 0.011 | 76.796    | <0.001   | 0.734 |
| X15                               | 0.871                  | 0.012 | 71.118    | <0.001   | 0.759 | 0.911                  | 0.010 | 87.172    | <0.001   | 0.831 |
| X20                               | 0.841                  | 0.013 | 64.395    | <0.001   | 0.707 | 0.845                  | 0.014 | 61.173    | <0.001   | 0.715 |
| Internality (IN) by               |                                                                     |      |           |          |    |                                                                     |      |           |          |    |
| X16                               | 0.671                  | 0.020 | 33.708    | <0.001   | 0.450 | 0.672                  | 0.024 | 27.481    | <0.001   | 0.452 |
| X17                               | 0.598                  | 0.026 | 23.304    | <0.001   | 0.357 | 0.579                  | 0.033 | 17.398    | <0.001   | 0.335 |
| X18                               | 0.866                  | 0.013 | 67.971    | <0.001   | 0.750 | 0.857                  | 0.017 | 49.589    | <0.001   | 0.735 |
| X19                               | 0.942                  | 0.012 | 81.001    | <0.001   | 0.888 | 0.896                  | 0.017 | 53.640    | <0.001   | 0.803 |
### Table 9. Results of the hypothesis testing.

| Hypothesis | Standardized Estimates | t-Value | Result | Standardized Estimates | t-Value | Result |
|------------|------------------------|---------|--------|------------------------|---------|--------|
| Theory of planned (TPB) | | | | | | |
| H3: PC → MRB | -0.411 | -13.825 ** | Supported | -0.323 | -7.744 ** | Supported |
| H4: AHM → MRB | -0.458 | -11.732 ** | Supported | -0.751 | -3.906 ** | Supported |
| H5: ASE → MRB | -0.215 | -5.835 ** | Supported | -0.168 | -3.023 ** | Supported |
| H6: SN → MRB | 0.000 | -0.012 | - | -0.002 | -0.069 | - |
| Locus of control (LC) | | | | | | |
| H7: EX → MRB | -0.227 | -5.169 ** | Supported | -0.382 | -7.245 ** | Supported |
| H8: IN → MRB | -0.586 | -19.342 ** | Supported | -0.607 | -7.015 ** | Supported |
| Indirect effect | | | | | | |
| AHM → PC | 0.310 | 9.613 ** | - | 0.288 | 7.027 ** | - |
| ASE → AHM | 0.320 | 10.129 ** | - | 0.411 | 11.492 ** | - |
| SN → ASE | 0.418 | 15.494 ** | - | 0.455 | 14.891 ** | - |

Note: **p-value < 0.05.

### 3.5.2. TPB Model Estimate for Women

The SEM for TPB (Figure 1) in women showed that H3–H5 were supported ($\beta = -0.323, -0.751, -0.168$, respectively; $p < 0.05$). H6 (subjective norm) had a negative effect on MRB. AHM indirectly affected the MRB through PC, ASE indirectly affected the MRB through AHM, and SN had no direct effect on the MRB but indirectly had an effect through ASE as shown in Figure 2 and Table 9.
3.5.3. LC Model Estimate for Men

The SEM for the LC (Figure 3) in men showed that H7 (internality (IN)) most affected the MRB ($\beta = -0.586; p < 0.05$). H8 (externality (EX)) had a $\beta$ of $-0.227 (p < 0.05)$; thus, H7 and H8 were supported. The analysis results are presented in Tables 8 and 9.

**Figure 2.** The theory of planned behavior model for women.

**Figure 3.** The locus of control model for men.
3.5.4. LC Model Estimate for Women

The SEM for the LC (Figure 4) in women found that H7 (IN affects the MRB) had a $\beta$ value of $-0.607$. H8 (EX affects the MRB) had a $\beta$ of $-0.382$ ($p < 0.05$); thus, H7 and H8 were supported. The analysis results are presented in Tables 8 and 9.

![Figure 4. The locus of control model for women.](image_url)

4. Discussion and Conclusions

In this research, we developed a structural equation model by analyzing multi-group SEM between men and women through applying the theory of planned behavior (TPB) [11] and the locus of control (LC) theory [12]. From the developed SEM, we found that the leading attitudes of men and women toward riding behavior from both theories were significantly different, which is a finding in accordance those reported by Useche et al. [7], who studied sex differences in risky bicycle riding behavior. Martinussen et al. [8] found that the criteria for a good fit between men and women were significantly different. Our findings also agreed with those of Li et al. [17], who observed sex differences in driver competition.

4.1. Discussion of the TPB

Using multi-group SEM analysis with TPB, Ajzen [11] reported that the TPB led to the actual behavior. We found that in men, the attitude (health motivation) factor most strongly affected the riding behavior. This finding is supported by Bazargan-Hejazi et al. [16] and Nguyen et al. [31], who found that attitude had the greatest effect on riding behavior. The next most influential factor was perceived behavior control, in agreement with Xiao [14], Razmara et al. [15] and Bazargan-Hejazi et al. [16], who both reported the direct and indirect effects of this factor on the theory of planned behavior (TPB). Although we only found a direct influence, attitude (severity) was also found to influence riding as was also reported by Bazargan-Hejazi et al. [16].

For the women’s study results, we found that the attitude (health motivation) factor most affected the riding behavior, as reported by Bazargan-Hejazi et al. [11,16]. In comparison to men, we found that this factor received almost double the loading. The perceived behavior control factor finding also agrees with Razmara et al. [15] and Xiao [14]. Attitude (severity) also influenced riding as reported by Bazargan-Hejazi et al. [16].
A difference was found in the subjective norm (SN). Both Thai men and women showed no direct influence on the attitude toward behavior, which contrasts the findings of Razmara et al. [15]. However, we found that SN also indirectly affected the MRB through ASE, AHM, and PC.

The research results obtained by applying the TPB can provide a guideline for policy construction on road safety. Through SN analysis, we found no direct influence of this factor on either men or women. Therefore, encouraging riders to imitate the desired behavior or to follow referral groups or family may not affect their behavior. Government sectors or relevant organizations have to consider attitudes based on health motivation, perceived behavior control, and attitudes based on severity as the main issues affecting riding behavior, especially for women’s motorcycle riding behavior. Riders can be encouraged to have a behavior-influencing attitude through their health motivation by helping them to perceive the severity of motor vehicle accidents. Perceived behavior control could help riders to change their behavior. The greater the perception and realization of the danger of vehicular collisions, the safer the motorcycle riding behavior would become.

4.2. Discussion of LC

Multi-group SEM analysis using the locus of control (LC) showed that both internality and externality were behavior-influencing factors [31], in accordance with Rotter [12]. Factor analysis also supported behavioral-leading attitudes, in agreement with Champahom et al. [23], Lajunen and Räsänen [24], and Totkova [25]. The indicator other people [35], family or friend refer to Externality (EX) significantly following Transport Scotland [36] and Gicquel et al. [37], while accident news, public campaign on safe riding have also been involved in reducing unsafe driving behavior [38], as well as policy and law enforcement [39].

We found that internality (IN) influenced both men’s and women’s motorcycle riding behaviors. The effect was higher in women. Externality (EX) produced an influence similar to IN, where women were more highly influenced [16], which is a finding that agrees with that reported by Champahom et al. [23]. Considering IN, both men and women had a stronger influence than with EX. This result agrees with Champahom et al.’s [23] findings, which reported that IN had a stronger influence compared with EX and Arthur and Doverspike [19], that finding driving internality was related to accident rates rather than externality.

In terms of the conceptual and behavior-influencing attitudes based on sex classification, we found a significant difference in behavior. Therefore, policies should be constructed that can respond in different ways to the problem solving, support, and suggestions for each group according to context as attitudes and behaviors have different effects for men and for women.

5. Limitations and Future Work

The research limitations are that data from teenage self-reported riding behavior groups under 20 years of age were not collected, and we considered only the sex differences groups.

The research can be further developed by considering the indicators that most strongly affect the behavior of motorcycle riding in more detail, providing specific suggestions for safe riding policy specifications, helping public officials to reduce, avoid, and stop risky riding behavior, and helping the media to educate riders regarding the importance of riding safely.

Author Contributions: Conceptualization, S.J.; data curation, S.J. and S.U.; formal analysis, S.J. and S.U.; funding acquisition, S.J.; methodology, S.J., S.U. and N.L.; supervision, V.R. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Suranaree University of Technology Research and Development Fund, grant number RU7-706-59-03, and the APC was funded by Suranaree University of Technology.

Acknowledgments: The authors would like to thank the Suranaree University of Technology Research and Development Fund.

Conflicts of Interest: The authors declare no conflict of interest.
References

1. Royal Thai Police. Traffic Accident on National Highways in 2020. Available online: https://www.m-society.go.th/ewt_news.php?nid=19593 (accessed on 11 September 2020).
2. Tainio, M.K. Burden of disease caused by local transport in Warsaw, Poland. J. Transp. Health 2015, 2, 423–433. [CrossRef] [PubMed]
3. Olson, P.L.; Dewar, R.E. Human Factors in Traffic Safety; Lawyers & Judges Pub.: Tucson, AZ, USA, 2002.
4. Shinar, D. Traffic Safety and Human Behavior; Emerald Group Publishing Limited: Bingley, UK, 2007.
5. Evans, L. Human Behavior and Traffic Safety; Springer: New York, NY, USA, 2012.
6. Elliott, M.A.; Thomson, J.A. The social cognitive determinants of offending drivers’ speeding behaviour. Accid. Anal. Prev. 2010, 42, 1595–1605. [CrossRef] [PubMed]
7. Usecu, S.A.; Montoro, L.; Alonso, F.; Gil, F.T. Does gender really matter? A structural equation model to explain risky and positive cycling behaviors. Accid. Anal. Prev. 2018, 118, 86–95. [CrossRef] [PubMed]
8. Martinussen, L.M.; Hakamies-Blomqvist, L.; Møller, M.; Özkan, T.; Lajunen, T. Age, gender, mileage and the DBQ: The validity of the Driver Behavior Questionnaire in different driver groups. Accid. Anal. Prev. 2013, 52, 228–236. [CrossRef]
9. Reason, J.; Mansstead, A.; Stradling, S.; Baxter, J.; Campbell, K. Errors and violations on the roads: A real distinction? Ergonomics 1990, 33, 1315–1332. [CrossRef]
10. Rosenstock, I.M. Historical Origins of the Health Belief Model. Heal. Educ. Monogr. 1974, 2, 328–335. [CrossRef]
11. Ajzen, I. The theory of planned behavior. Organ. Behav. Hum. Decis. Process. 1991, 50, 179–211. [CrossRef]
12. Rotter, J.B. Generalized expectancies for internal versus external control of reinforcement. Psychol. Monogr. Gen. Appl. 1966, 80, 1–28. [CrossRef]
13. Bamberg, S.; Ajzen, I.; Schmidt, P. Choice of Travel Mode in the Theory of Planned Behavior: The Roles of Past Behavior, Habit, and Reasoned Action. Basic Appl. Soc. Psychol. 2003, 25, 175–187. [CrossRef]
14. Xiao, Y. Analysis of the influencing factors of the unsafe driving behaviors of online car-hailing drivers in china. PLoS ONE 2020, 15, e0231175. [CrossRef]
15. Razmara, A.; Aghamolaei, T.; Madani, A.; Hosseini, Z.; Zare, S. Prediction of taxi drivers’ safe-driving behaviors based on the theory of planned behavior: The role of habit. J. Educ. Heal. Promot. 2018, 7, 139.
16. Bazargan-Hejazi, S.; Teruya, S.; Pan, D.; Lin, J.; Gordon, D.; Krochalk, P.C.; Bazargan, M. The theory of planned behavior (TPB) and texting while driving behavior in college students. Traffic Inj. Prev. 2017, 18, 56–62. [CrossRef]
17. Li, P.; Shi, J.; Liu, X.; Wang, H. The Theory of Planned Behavior and Competitive Driving in China. Procedia Eng. 2016, 137, 362–371. [CrossRef]
18. Montag, I.; Comrey, A.L. Internality and externality as correlates of involvement in fatal driving accidents. J. Appl. Psychol. 1987, 72, 339–343. [CrossRef] [PubMed]
19. Arthur, W.; Doverspike, D. Locus of control and auditory selective attention as predictors of driving accident involvement: A comparative longitudinal investigation. J. Saf. Res. 1992, 23, 73–80. [CrossRef]
20. Özkan, T.; Lajunen, T. Multidimensional Traffic Locus of Control Scale (T-LOC): Factor structure and relationship to risky driving. Pers. Individ. Differ. 2005, 38, 533–545. [CrossRef]
21. Warner, H.W.; Özkan, T.; Lajunen, T. Can the traffic locus of control (T-LOC) scale be successfully used to predict Swedish drivers’ speeding behaviour? Accid. Anal. Prev. 2010, 42, 1113–1117. [CrossRef]
22. Mäirean, C.; Havârneanu, G.M.; Popușoi, S.A.; Havârneanu, C.-E. Traffic locus of control scale—Romanian version: Psychometric properties and relations to the driver’s personality, risk perception, and driving behavior. Transp. Res. Part F Traffic Psychol. Behav. 2017, 45, 131–146. [CrossRef]
23. Champahom, T.; Jommonkwao, S.; Satiennam, T.; Suesat, N.; Ratanavaraha, V. Modeling of safety helmet use intention among students in urban and rural Thailand based on the theory of planned behavior and Locus of Control. Soc. Sci. J. 2020, 1, 1–22. [CrossRef]
24. Lajunen, T.; Räsänen, M. Can social psychological models be used to promote bicycle helmet use among teenagers? A comparison of the Health Belief Model, Theory of Planned Behavior and the Locus of Control. J. Saf. Res. 2004, 35, 115–123. [CrossRef]
25. Totkova, Z. Interconnection Between Driving Style, Traffic Locus of Control, and Impulsivity in Bulgarian Drivers. *Behav. Sci.* **2020**, *10*, 58. [CrossRef] [PubMed]

26. Elliott, M.A.; Baughan, C.J.; Sexton, B.F. Errors and violations in relation to motorcyclists’ crash risk. *Accid. Anal. Prev.* **2007**, *39*, 491–499. [CrossRef]

27. Özkan, T.; Lajunen, T.; Dogruyol, B.; Yıldırım, Z.; Çoymak, A. Motorcycle accidents, rider behaviour, and psychological models. *Accid. Anal. Prev.* **2012**, *49*, 124–132. [CrossRef] [PubMed]

28. Ulba, S.; Jomnonkwao, S.; Watthanaklang, D.; Ratanavaraha, V. Development of Self-Assessment Indicators for Motorcycle Riders in Thailand: Application of the Motorcycle Rider Behavior Questionnaire (MRBQ). *Sustainability* **2020**, *12*, 2785. [CrossRef]

29. Khampirat, B. *Structural Equation Modeling*; Institute of Social Technology (IST), Suranaree University of Technology: Nakorn Ratchasima, Thailand, 2012.

30. Ratanavaraha, V.; Jomnonkwao, S.; Watthanaklang, D.; Chonsalasin, D. *Factors Affecting Motorcycle Helmet Use: Using Structural Equation Modeling (SEM) for the Theory of the Health Belief Model in Urban and Rural Area*; Institute of Engineering, Suranaree University of Technology: Nakhon Ratchasima, Thailand, 2014.

31. Nguyen, D.V.; Ross, V.; Vu, A.T.; Brijs, T.; Wets, G.; Brijs, K. Exploring psychological factors of mobile phone use while riding among motorcyclists in Vietnam. *Tran. Res. Part F Traffic Psychol. Behav.* **2020**, *73*, 292–306. [CrossRef]

32. Golob, T.F. Structural equation modeling for travel behavior research. *Trans. Res. Part B Methodol.* **2003**, *37*, 1–25. [CrossRef]

33. Stevens, J. *Applied Multivariate Statistics for the Social Sciences*; Lawrence Erlbaum Associates: Mahwah, NJ, USA, 1996.

34. Dekker, H.; Dijkstra, B.; Meijerink, F. Behaviour and attitude. Effect of attitude on behavioural desire with respect to foreign countries and peoples and Germany and Germans in particular. In *Culture and Conflict*; Aksant Academic: Amsterdam, The Netherlands, 2007; pp. 197–215.

35. Wilkinson, W.W. The structure of the Levenson locus of control scale in young adults: Comparing item and parcel indicator models. *Pers. Individ. Differ.* **2007**, *43*, 1416–1425. [CrossRef]

36. Transport Scotland. Prolific Illegal Driving Behaviour: A Qualitative Study. Available online: https://www.transport.gov.scot/media/30468/j267570.pdf (accessed on 21 November 2020).

37. Gicquel, L.; Ordonneau, P.; Blot, E.; Toillon, C.; Ingrand, P.; Romo, L. Description of Various Factors Contributing to Traffic Accidents in Youth and Measures Proposed to Alleviate Recurrence. *Front. Psychiatry* **2017**, *8*. [CrossRef]

38. Ali, E.; El-Badawy, S.; Shawaly, E.-S. Young Drivers Behavior and Its Influence on Traffic Accidents. *J. Traffic Logist. Eng.* **2014**, *2*, 45–51. [CrossRef]

39. Pino, O.; Pelosi, A.; Baldari, F. Drivers’ behaviour. Risk factors for road accidents and safety implications. A study of 1489 cases in the province of Parma. *Psicoterapia Cognitiva e Comportamentale* **2013**, *19*, 141–156.

40. Kline, R.B. *Principles and Practice of Structural Equation Modeling*; Guilford Press: New York, NY, USA, 2011.

41. Nunally, J.C. *Psychometric Theory*; McGraw-Hill: New York, NY, USA, 1978.

42. Hair, J.F.; Black, W.C.; Babin, B.J. *Multivariate Data Analysis: A Global Perspective*; Prentice Hall: Upper Saddle River, NJ, USA, 2010.

43. Muthén, L.K.; Muthén, B.O. *Mplus User’s Guide: Statistical Analysis with Latent Variables: User’s Guide*; Muthén & Muthén: Los Angeles, CA, USA, 2010.

44. Linda, K.; Muthén, B.O.M. *Mplus User’s Guide*, 7th ed.; Muthén & Muthén: Los Angeles, CA, USA, 2012.

45. Hu, L.T.; Bentler, P.M. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Struct. Equ. Model. A Multidiscip.* **1999**, *6*, 1–55. [CrossRef]

46. Deb, S.; Ali Ahmed, M. Determining the service quality of the city bus service based on users’ perceptions and expectations. *Travel Behav. Soc.* **2018**, *12*, 1–10. [CrossRef]

47. Lai, W.-T.; Chen, C.-F. Behavioral intentions of public transit passengers—the roles of service quality, perceived value, satisfaction and involvement. *Trans. Policy* **2011**, *18*, 318–325. [CrossRef]

48. Daire Hooper, J.C.; Mullen, M. *Structural Equation Modelling: Guidelines for Determining Model Fit*. *Electron. J. Bus. Res. Methods* **2008**, *6*, 53–61.
49. Jomnonkwao, S.; Sangphong, O.; Khampirat, B.; Siridhara, S.; Ratanavaraha, V. Public transport promotion policy on campus: Evidence from Suranaree University in Thailand. *Public Transp.* **2016**, *8*, 185–203. [CrossRef]

**Publisher’s Note:** MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

© 2020 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (http://creativecommons.org/licenses/by/4.0/).