Application of the Theory of Planned Behavior to the Analysis of Variations in Attitudes toward Exclusive Motorcycle Lanes

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***Abstract*—The purpose of this paper was to test the differences in attitudes influencing motorcyclists' behavioural expressions of motorcycle lane use as classified by demographic data and attitude factors from an application of the Theory of Planned Behaviour (TPB) comprised of four factors: Attitude toward use, Subjective norms, perceived behavior control, and Behaviour intention. A questionnaire study of 1,004 motorcyclists in Nakhon Ratchasima province was conducted. Independent t-tests, One-Way ANOVA were used to analyze differences between motorcyclists' demographic data and components in the Theory of Planned Behavior. The findings revealed that different age groups and income levels had significantly different effects on perceived behavior control and behavior intention to use motorcycle lanes. While there were considerable differences in indications of attitude toward use and perceived norms across educational levels. Furthermore, perceived behavior control and behavior intention differed significantly across urban and rural areas, including driver's license status. Differences in location zone subjective norms, as well as attitudes toward the use of different driver's license statuses**

***Index Terms*—Accidents, behavioral, motorcycle, motorcycle lane**

I. Introduction

According to the World Health Organization's Road Safety Situation 2018 report, the number of road fatalities worldwide increased by 100,000 cases. The number of motorcyclist fatalities from 1.25 million to 1.35 million, equaling 3,700 people per day. More than half of them were vulnerable road users (74%) [1]. In the meantime, Thailand has the highest number of road fatalities in Asia, with an average of 62 deaths per day, and is ranked ninth in the world, accounting for 32.7 per 100,000 road fatalities. The statistics of the above accidents are strongly associated with the popularity of using motorcycles in Thailand. The factors comprise convenience, speed, flexibility, quick directional control to slow down or stop quickly, and ease of access to smaller areas, in addition to fuel economy and maintenance costs being lower than other types of vehicles, as well as the reduced requirement for parking space [2-5]. The cumulative number of motorcycles registered nationwide in 2021 was 21,685,858 units or 52% of the total number of vehicles of all types registered. The ratio of motorcycles to the population in Thailand is approximately 4 people per motorcycle, and the region with the highest cumulative motorcycle registration is the Northeast region, with 5,053,010 units. Nakhon Ratchasima is the province with the highest cumulative registered motorcycles in this region with 736,809 units [6] and has a reported high motorcycle accident rate of up to 47.95% per 10,000 registered motorcycles. Thus, the increase in motorcycle quantity is also accompanied by an increasing number of accidents [7]. The high volume of motorcycles causes mixed traffic flow, resulting in highly shared conditions with other vehicle types [8]. Furthermore, due to their small sizes and shapes, motorcycles can lose balance and become unstable while driving [9]. In addition to mixed traffic conditions, human and other external factors such as driving while intoxicated, driving at a speed exceeding the legal limit, cutting in front of a car too close, and road conditions that are damaged or unsafe for driving, etc., the Health Promotion Foundation also supports that more than 90% of accidents are caused by "human behavior". It also confirms that the most important issue to stop an accident is to adjust driver behavior despite previous studies on the engineering intervention reviewing that it is best done by separating the traffic lane from the main traffic lane, or the lane for specific motorcycles [11], and it is one option to can help reduce accidents compared to running in traffic with larger vehicles. Using special lanes for motorcycles reduces accidents by approximately 39% for motorcycles [14], and potentially helps save drivers' lives and time [15]. According to previous studies, most research has studied the design of special traffic lanes for motorcycles, such as their suitable width [10, 12], [16-18], the design of special lane protection devices for motorcycles [19, 20], specific patterns of entrance and exit [21-23], and motorcycle lane markings for giving the directions [24], etc.There have also been studies on the psychological factors involved with motorcycle lanes , applying The Theory of Planned Behavior to examine the relationship between motorcyclists' psychological factors and risk behaviors in driving on traffic lanes for each vehicle type [13, 25]. Although several previous studies have wholly mentioned accident management by providing a motorcycle special lane, which is a highly effective countermeasure to achieve motorcycle safety issues [26], there are still drivers who neither strictly obey the traffic rules nor consider their safety and those of other road users; it is hard to stop an accident. This leads to the objective of this study focusing on driver behavior by applying the Theory of Planned Behavior to test the different attitudes of motorcyclists classified by personal data and attitude factors. The theory comprises four factors including attitude toward use, subjective norms, perceived behavioral control, and behavioral intention,

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contributing to the use of special motorcycle lanes to help reduce motorcycle accidents**.**

A. Theory of Planned Behavior

The Theory of Planned Behavior (TPB) was initially a psychological theory developed from the Theory of Reasoned Action (TRA) [27] by adding an element called "Perceived Behavioral Control" by Ajzen [28], explaining that human behavior is influenced by behavioral intention and by what influences behavioral intention, comprising three components: 1) attitude, 2) subjective norms, and 3) perceived behavioral control. All these three components are based on behavior, rules, and control beliefs, respectively [29]. Attitude is an overall assessment of the individual's expression of target behavior [30] and is considered an accessible belief about the consequences of behavior expression. At the same time, beliefs according to subjective norms are beliefs related to factors supporting or hindering behaviors determined by them (e.g., family, friends, spouse, etc.). The mentioned beliefs result from social pressure and are absolutely perceived to participate in those behaviors [31, 32]. Under the mentioned pressure, they lead to perceived behavioral control, which is a control belief in each issue by interacting with the perceived power of the factors facilitating or hindering behavior expression. The three components of attitude toward behavior expressions, subjective norms, and perceived behavioral control can result in behavioral intention [31]. The Theory of the Planned Behavior Model is shown in Fig. 1.

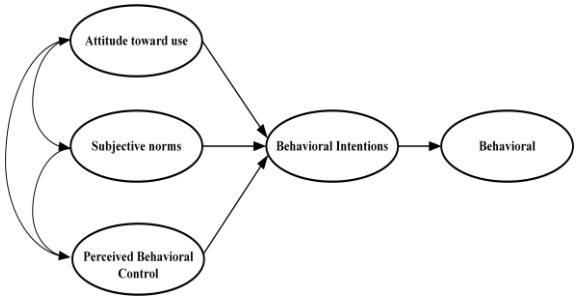

Fig. 1. The theory of planned behavior model (TPB) [28].

II. Method

Data collection was conducted in Nakhon Ratchasima Province by interviewing a total of 1,004 samples using questionnaires. The questionnaire consisted of 3 parts: 1) demographic data of respondents; 2) physical characteristics affecting the use of special lanes for motorcycles, and 3) attitudes toward the use of special lanes for motorcycles. Attitude variables used in this study were derived from the Theory of Planned Behavior, namely: attitude toward use, subjective norms, perceived behavioral control, and behavioral intention on the use of special motorcycles lanes. The questionnaire style in this study was designed as a 5-point Likert scale, ranging from strongly disagree to strongly agree (1 = strongly disagree, 2 = disagree, 3 = not sure, 4 = agree, 5 = strongly agree). The questionnaire quality and content validity were examined by five experts, with Item Objective Congruence (IOC) with the value of each question item being between 0.6 and 1 [33], and Cronbach's alpha coefficient values ranged from 0.6 to 0.819 [34], passing the criteria, so the data could be further analyzed. The statistics used to analyze the significance of differences between demographic data and the Theory of Planned Behavior were the T-test and One-Way ANOVA. The demographic data, which are independent variables in this analysis, included gender, age, educational level, income, residential area (urban-rural, driving license status, accident record, motorcycle travel frequency, and driving speed. The hypotheses for analyzing the results are established as follows:

Hypothesis 1: Motorcyclist groups living in urban and rural areas have different opinions on attitudes toward the Theory of Planned Behavior regarding motorcycle lanes.

Hypothesis 2: Motorcyclist groups possessing different driving license statuses have different opinions on attitudes toward the Theory of Planned Behavior regarding motorcycle lanes.

Hypothesis 3: Motorcyclist groups with different genders have different opinions on attitudes toward the Theory of Planned Behavior regarding motorcycle lanes.

Hypothesis 4: Motorcyclist groups having different accident records have different opinions on attitudes toward the Theory of Planned Behavior regarding motorcycle lanes.

Hypothesis 5*:* Motorcyclist groups of different ages have different opinions on attitudes toward the Theory of Planned Behavior regarding motorcycle lanes.

Hypothesis 6*:* Motorcyclist groups having different incomes have different opinions on attitudes toward the Theory of Planned Behavior regarding motorcycle lanes.

Hypothesis 7: Motorcyclist groups with different educational levels have different opinions on attitudes toward the Theory of Planned Behavior regarding motorcycle lanes.

Hypothesis 8*:* Motorcyclist groups having different travel frequencies have different opinions on attitudes toward the Theory of Planned Behavior regarding motorcycle lanes.

Hypothesis 9*:* Motorcyclist groups using different driving speeds have different opinions on attitudes toward the Theory of Planned Behavior regarding motorcycle lanes.

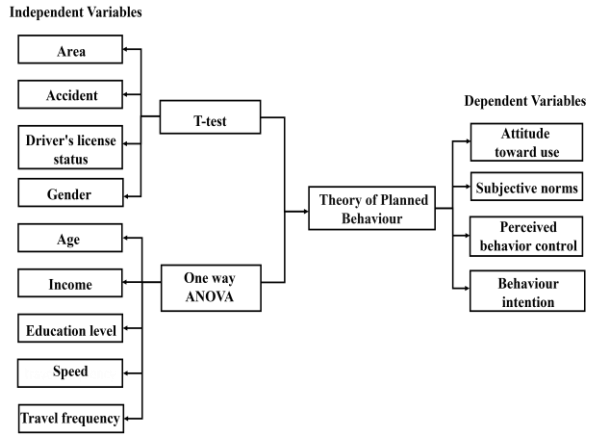

Fig. 2. Conceptual framework of attitudes toward Exclusive Motorcycle Lanes.

III. Result

A. Sample Demographics

From the data collection, the majority of respondents were female (53.9%). If divided by age, most were 21–30 years old

(42.6%) and lived in urban areas (50.2%). Most used motorcycles in their daily travel (53.6%), and the driving speed mostly used was 60-80 km/h (61.3%).

TABLE I: DESCRIPTIVE STATISTICS OF MOTORCYCLIST

characteristics	Frequency (n=1,004)	Percentage
Gender		
Male	463	46.1
Female	541	53.9
Area		
Urban	504	50.2
Rural	500	49.8
Age		
15-20 Year	130	12.9
21-30 Year	428	42.6
31-45 Year	286	28.5
46-60 Year	106	10.6
> 60 year	54	5.4
Frequency of motorcycle use		
Every day in a week	538	53.6
1-2 time within a week	208	20.7
3-5 time within a week	538	25.7
Speed (km/hr)		
Less than 60	189	18.8
60-80	615	61.3
80-100	181	18
More than 100	19	1.9

B. Results of Theory of Planned Behavior

The hypothesis testing results were analyzed by an independent sample t-test and a one-way ANOVA with dependent variables from the Theory of Planned Behavior including all 4 factors: 1) attitude toward use; 2) subjective norms; 3) perceived behavior control; and 4) behavioral intention and independent variables such as gender, age, educational level, income, residential area (urban or rural), driving license status, accident record, motorcycle travel frequency, and driving speed. The results of each factor analysis are shown as follows:

1) Attitude toward use

For the significant differences in driving license possession and educational level, as shown in Tables 4 and 5, the opinions of group of motorcyclists possessing a driving license (M = 3.987, SD = 0.95), and the group without a driving license (M = 4.106, SD = 0.532) were statistically significant at 0.05 (t = 2.321, p = 0.020), as well as their educational levels (f = 4.075, p = 0.017).

2) Subjective norms

The mean subjective norms of the motorcyclists in urban areas (M = 3.693, SD = 0.400) was significantly different from that of those in rural areas (M = 4.030, SD = 0.820), (t = -8.287)., p = 0.00) as shown in Table III. In addition, males (M = 3.907, SD = 0.684) had different opinions on attitudes from females (M = 3.824, SD = 0. 0.650) significantly at 0.05 (t = 1.968, p = 0.049) as shown in Table II. Similarly, motorcyclists of different educational levels had significantly different opinions on attitudes toward subjective norms (F = 5.232, p = 0.005), as in Table V.

TABLE II: INDEPENDENT SAMPLES T-TEST: MALE VS. FEMALE

Variables	Gender	Mean	*S.D*	*t*	p-value
AT	Male	4.076	0.578	-0.723	0.470
	Female	4.101	0.543		
SN	Male	3.907	0.684	1.968	0.049*
	Female	3.824	0.651		
PBC	Male	4.342	0.573	-1.156	0.248
	Female	4.383	0.556		
BI	Male	4.363	0.551	-1.125	0.261
	Female	4.402	0.538		

Note: **p < 0.01, *p < 0.05, AT= Attitude toward use, SN = Subjective norms, PBC= Perceived behaviour control, BI= Behaviour intenrion

TABLE III: INDEPENDENT SAMPLES T-TEST: RURAL VS. URBAN

Variables	Area	Mean	*S.D*	*t*	p-value
AT	urban	4.073	0.383	-0.925	0.355
	rural	4.106	0.691		
SN	urban	3.693	0.400	-8.287	0.000**
	rural	4.030	0.820		
PBC	urban	4.499	0.407	7.784	0.000**
	rural	4.230	0.658		
BI	urban	4.486	0.411	6.040	0.000**
	rural	4.282	0.633		

Note: **p < 0.01, *p < 0.05, AT= Attitude toward use, SN = Subjective norms, PBC= Perceived behaviour control, BI= Behaviour intenrion

TABLE IV: INDEPENDENT SAMPLES T-TEST: DRIVING LICENSE

Variables	status	Mean	S.D	*t*	p-value
AT	Yes	3.987	0.698	-2.321	0.020*
	No	4.106	0.532		
SN	Yes	3.933	0.771	1.345	0.179
	No	3.851	0.649		
PBC	Yes	4.048	0.753	-7.307	0.000**
	No	4.415	0.510		
BI	Yes	4.207	0.665	-4.165	0.000**
	No	4.412	0.517		

Note: **p < 0.01, *p < 0.05, AT= Attitude toward use, SN = Subjective norms, PBC= Perceived behaviour control, BI= Behaviour intenrion

TABLE V: ONE WAY ANOVA TEST

Dependent Variable	Inpendent Variable	Mean Square		F	Sig
		Between Group	Within Group		
AT	Age	0.312	0.313	0.988	0.408
	Income	0.676	0.312	2.17	0.090
	Education	1.266	0.311	4.075	0.017*
	RF	0.020	0.313	0.065	0.937
	Speed	0.143	0.313	0.456	0.713
SN	Age	0.292	0.446	0.655	0.623
	Income	0.518	0.445	1.166	0.322
	Education	2.309	0.441	5.232	0.005*
	RF	0.057	0.446	0.129	0.879
	Speed	0.157	0.446	0.353	0.787
PBC	Age	2.514	0.309	8.13	0.000**
	Income	5.150	0.303	16.971	0.000**
	Education	0.099	0.318	0.311	0.733
	RF	0.005	0.319	0.016	0.984
	Speed	0.348	0.318	1.094	0.350
BN	Age	2.678	0.286	9.359	0.000**
	Income	5.562	0.280	19.869	0.000**
	Education	0.609	0.295	2.064	0.127
	RF	0.125	0.296	0.423	0.656
	Speed	0.304	0.296	1.027	0.380

Note: **p < 0.01, *p < 0.05, AT= Attitude toward use, SN = Subjective norms, PBC= Perceived behaviour control, BI= Behaviour intenrion RF= Riding frequency.

3) Perceived behavioral control

From Tables III-V, the mean opinions on attitudes of perceived behavioral control showed significant differences in residential areas (urban and rural), driving license status, age, and income. The mean opinions of motorcyclists living in urban areas (M = 4.499, SD = 0.407) were significantly different from those in rural areas (M = 4.230, SD = 0.658) (t = 7.784, p = 0.00). Similarly, the motorcyclists possessing a driving license (M = 4.048, SD = 0.753) had different opinions on attitudes toward the Theory of Planned Behavior from those who did not have a driving license (M = 4.415, SD = 0.510) (t = -7.307, p = 0.00). In addition, motorcyclists with

different ages (f = 8.130, p = 0.001) and incomes (f = 16.971, p = 0.00) had significantly different opinions on attitudes toward perceived behavioral control at 0.01.

4) Behavioral intention

For behavioral intention, the mean of opinions on motorcyclists' demographic data, consisting of residential areas (urban and rural), driving license status, age, and income, showed significant differences like those of perceived behavior control. The opinions of motorcyclists living in urban areas (M = 4.486, SD = 0.411) were statistically different from those in rural ones (M = 4.282, SD = 0.633) (t = 6.040, p = 0.00). Likewise, the opinions of motorists possessing a driving license (M = 4.207, SD = 0.517) were different from those without a driving license (M = 4.412, SD = 0.517) (t = -4.165, p = 0.00). Considering age (f = 9.359, p = 0.00) and income (f = 19.869, p = 0.00), their different opinions on attitudes toward the Theory of Planned Behavior were statistically significant at 0.00, as shown in Tables III-V.

However, the analysis results showed that the opinions on the accident record, travel frequency, and driving speed of motorists were insignificantly different in each aspect of the variables based on the four factors of the Theory of Planned Behavior

IV. Discussion and Conclusion

This research examined the differences in the mean opinions on motorcyclists' attitudes toward the use of motorcycle lanes. The Theory of Planned Behavior (TPB) was applied to analyze the demographic data using an independent samples t-test and a one-way ANOVA. The study found that the mean opinions on motorcyclists' demographic data consisting of gender, age, income, education level, driving license status, and different areas were statistically significant with factors in the Theory of Planned Behavior.

Motorcyclists with different educational levels and driving license statuses had statistically significantly different mean opinions on attitude toward use. Contrary to Siddiqui et al. [35], their different driving license statuses and educational levels were not. They identified that different opinions on attitudes depended on perceived usefulness, perceived barriers, etc. In addition, gender, educational level, and the mean opinions on the residential areas between urban and rural zones of the motorcyclists were statistically significant differences in subjective noms. These findings were supported by Uttra et al. [36], stating that females and males had different opinions on attitudes toward subjective norms; females were more affected by the mentioned factors than males. The different opinions on attitudes between motorcyclists in urban and rural societies were consistent with Brijs et al. [37] and Lajunen and Räsänen [29], mutually affirming that subjective norms had no impact on the increase in behavioral intention in urban motorcyclists, in contrast to the motorcyclists' motivation to act in rural zones. Those with different educational levels possibly had different mean opinions on subjective norms. In other words, motorcyclists with educational levels lower than a bachelor's degree are more amenable to subjective norms they respect (e. g., family, friends, relatives) as these groups have the influence to induce them to do various things easily. Moreover, the study also showed that the age, income, area, and driving license status of motorcyclists had statistically significant differences in their mean opinions on attitudes toward perceived behavioral control and behavioral intention. These findings are consistent with Moan [38] and Özkan et al. [39], who asserted that older people were more aware than younger people. This is associated with the number of accident occurrences. Contrary to Moan [38], regarding driving license possession status, on which the opinions were not different. O'Callaghan and Nausbaum [40] and Brijs et al., [37] supported the differences between motorists living in urban and rural societies, where the attitudes of motorists in rural areas are more likely to be affected by perceived behavioral control, leading to their behavioral intentions, unlike those in urban settings. Contrary to Champahom et al. [41], they indicated that there was no difference in their perceived behavioral control in the two areas. Motorcyclists with higher incomes possibly had more perceived behavioral control and behavioral intentions than those with lower incomes, causing different mean opinions on their attitudes. As the limited analytic methods of an independent sample t-test and a one-way ANOVA barely distinguished the independent and dependent variables, to conduct further studies, the examination of causality and the weight of influence between demographic data and the structural diagram of the Theory of Planned Behavior is required. They will be employed to promote the use of special motorcycle lanes policies in order to reduce the number of accidents and eliminate the problem of undesirable driver behavior in the future 4.

V. Recommendation

Doing this intensive research can be help the planner to understand their own characteristic which has different in several countries. This research can be observed the perspective of motorcycle users which are mainly impact on exclusive motorcycle lane. The application of exclusive motorcycle lane expects to decrease road crash causing from mixed traffic. One of the key achievements is to promote the usefulness to the road users. There are three activities that the planner can do: 1) Creating advertisements to present the overview concepts. 2) Making campaign to encourage rider shifting their path. 3) Educating road user about benefit and caution of using. According to the previous application in the real world, the restriction rule and management also need to consider. There was the case that passenger cars would like to access along the road then, they park a part of motorcycle lane. Moreover, there were the shop build adjacent a part of motorcycle lane area. Therefore, the regulation rules and management should be clearly set. The application of a motorcycle lane depends on the area. Motorcycle lanes should be designed to suit the context of the area and traffic volume. including measures to increase safety for drivers at intersections with high conflicts, such as separating traffic directions clearly at intersections by road median. In addition, the traffic signs and lane marking should be emphasized following engineering standard. Those must be clearly and easy to understand and visibly for all road users. It should be

brightly illuminated at night and suitable for both size and perception distance.

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