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A Study on the effect of Motorcycle Traffic Safety Workshop using Travel Speed and Vehicle Density in Phnom Penh, Cambodia

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Synopsis

In Cambodia, motorcycle use has spread rapidly in recent years, and serious accidents involving motorcycles have increased. In particular, many young motorcyclists have been involved in traffic accidents, and various issues in traffic safety are remained. To understand the current situations related to these issues in Phnom Penh, Cambodia, a video observation survey on driving situations of motorcycle users in high school and university were conducted. Based on the results, a traffic safety workshop was held to improve their risk perception ability and basic riding skills. In this study, a statistical analysis was conducted to compare travel speed with vehicle density on arterial roads before and after the workshop. The results showed that travelling speed decreased to be effects of the traffic safety workshop, and the vehicle density could be an explanatory variable to represent various driving conditions of motorcycles including psychological effects.

KEYWORDS: Motorcycles, Hazard perception, Traffic behavior, Traffic safety, Traffic education

1. Introduction

In Cambodia, motorcycle use has spread rapidly in recent years, and the proportion of accidents involving motorcycles has also increased. According to an OECD report, the number of traffic fatality in 2016 was 1852 (11.8 per 100 thousand people), and 73% of these fatalities were riders of "motorized two wheelers" [1]. Motorcycle accidents have accounted for more than 90% in the 15-24 age group, and main factors were identified as excessive speed, drink driving, and dangerous overtaking. In response to these situations, a review of driving license system for motorcycles was underway, while a mandatory helmet law for motorcycle drivers was passed when riding a motorcycle of 49cc or above in 2007, and in 2015, it was made compulsory for motorcycle passengers to wear a helmet and the law regarding traffic violations was toughened. Regarding road infrastructure, the Asian Highway Network including arterial roads in Cambodia are being improved, and traffic signals and a traffic control center are introduced in the capital city, Phnom Penh. With regard to traffic safety education, some activities are supported by NGOs, and the content of the education has been included in the compulsory education curriculum. However, judging from the current situation regarding traffic accidents occurring among young people, both the quantity and the quality of this education are considered insufficient and some advanced knowledge concerning the necessity of additional road safety education and the concrete educational effect are required.

As described above, to understand current situations about driving behaviors and related traffic safety education, the following three activities were described below were carried out. The first, an observation survey using video cameras attached to motorcycles was conducted to understand some insights from actual traffic condition. Next, based on these results, a traffic safety workshop (WS) for the participants in the behavior survey was held. The workshop consisted of two parts: a classroom portion, and a driving portion. In classroom learning, after explaining the situation of traffic accidents in Cambodia, a training aimed at improving hazard prediction ability was carried out using dangerous driving scenarios extracted from the video observation of driving behavior. In driving portion, a basic driving training was given by an instructor. Finally, a video observation of driving behavior was carried out again to examine the impact of the traffic safety workshop. In this study, with the aim of clarifying issues relating to fundamental driving behaviors that contribute to motorcycle traffic safety, such as travel speed. A comparative analysis of driving behavior before

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and after the workshop were conducted by using travel speed and vehicle density. In addition, the motorcycle in this research is an automatic scooter used in Cambodia, not including auto rickshaw.

2. Literature review

Many studies on motorcycle traffic safety examined including analysis of risk behavior in Thailand [2], and various issues have been identified such as helmet use, alcohol, training, daytime running lights, driving licenses, and risk taking behaviors [3].

With regard to driver education, there are many studies on hierarchical models for driving behavior [4), 5)] and their extension [6].

In research on motorcycle use and the effects of education, there are studies on the relationship between education and traffic safety behavior [7], educational content and license system [8], and educational methods and children's developmental stage [9]. In particular, to improve traffic safety performance among young people, dealing with risk-taking behavior [10] and the importance of move advanced driving skill training in addition to the conventional training have been identified [11].

On the other hand, in order to better understand these driving behaviors, the importance of evidence-based traffic safety measures [12] such as naturalistic driving observation studies [13], have been pointed out.

As mentioned above, there are various research results regarding traffic safety education of motorcycle, but information about current situation of motorcycle driving behavior in young people in Cambodia is limited. In addition, there are rarely evaluated the effects of traffic safety education based on actual driving behavior. So we focused on driver behavioral changes in young people and the possibility of future introduction of more practical traffic safety education and we analyzed traffic safety education and naturalistic driving data in association with each other.

Still more, the content of traffic safety education presented in the project is to improve so-called hazard perception ability, and although there are studies relating to similar objectives [14), 15)] this study focus on analyzing whether hazard perception education training affects the development of more defensive driving behavior in young people, based on the comparative observation of actual driving behavior.

3. Methodology

3.1 Video observations of actual driving behavior

To confirm the actual situation regarding driving behaviors, video cameras were attached on the motorcycles (50 ~ 125 cc) of students who commute to high school or university within the city of Phnom Penh, and an observation survey was conducted. In the survey, the routine route between their home and school was recorded during two different periods: one from December 2015 to January 2016 and one at the end of July 2017 after the safety workshop described below. The subjects were a total of 27 people who responded to an appeal for cooperation in the survey through a local university. Four of 27 people were common samples before and after the workshop. In the analysis, driving behavior of travelling non-intersection link was compared by separating the 27 people into two groups: one is subjects who had not attended the workshop (before workshop) and another one is subjects who had attended the workshop (after workshop). Individual attributes were summarized in TABLE 1. The equipment used for video observation is the action camera GARMIN VIRB Elite with built-in GPS function. The measured viewing angle was 123°, which is roughly the same as the angle of view of a human being (120°). Using the video data, average speed were measured as driving behaviors indicating driving conditions. As a result, data of for 1014 links totaling 160.5 km was extracted (TABLE 2).

TABLE 1 Individual attributes of subjects fitted with cameras

	Before WS	After WS	Total
Date of observation	Dec. 2015-Jan. 2016	Jul. 2017	
No. of people observed	17	10	27※
Gender	8 males/ 9 females	5 males/ 5 females	13 males/ 14 females
Student category	9 high school students / 8 University students	5 high school students / 5 University students	14 high school students / 13 University students
Driving experience	Less than 1 year:5 people / more than 1 year:12 people	Less than 1 year:0 people / more than 1 year:10 people	Less than 1 year:5 people / more than 1 year:22 people
Motorcycle category	50cc : 4 people / 90-125cc : 13 people	50cc : 3 people / 90-125cc : 7 people	50cc : 7 people / 90-125cc : 20 people
Number of links	584	430	1014
Observation time period	Morning : 327 links /afternoon : 143 links / evening : 114 links	Morning : 129 links /afternoon : 184 links / evening : 117 links	Morning : 456 links /afternoon : 327 links / evening : 231 links
Weather	Clear : 429 links/Cloudy : 155 links	Clear : 192 links/Cloudy : 238 links	Clear : 621 links/Cloudy : 393 links

* Of this total, 4 people participated both before and after the WS

TABLE 2 Overview of video observation result

No. of people observed	27
Observation time	573 min(Average of 24.9 min per Person)
Travel distance (except intersections)	160.5 km (Average of 7.0 km per Person)
No. of links on arterial/non-arterial roads	594/420 (Total 1014)
Average link distance	0.160 km
Average link passage time	29.6 s

3.2 Summary of traffic safety workshop

The traffic safety workshop held at the Royal University of Phnom Penh on July 16, 2017 consisted of 2 hours of classroom learning and 2 hours of driving learning. In classroom learning, after explaining the situation of traffic accidents in Cambodia, hazard prediction training was carried out using dangerous driving scenarios that were extracted from the video observation of driving behavior. Observed cased of near-misses were used as the dangerous driving scenarios, for example, entering the blind spot of a four-wheeled vehicle when weaving between cars, another vehicle suddenly appearing from a blind spot. The training method took the form of stopping the video before the dangerous driving scenario and having the participants anticipate the potential hazards, before explaining the actual dangerous driving scenario. In driving learning, approximately two hours of basic riding skills, such as riding a figure of eight and braking was given by a motorcycle instructor.

3.3 Introduction of average vehicle density around a subject

Although driving behavior on non-intersection links of arterial roads is thought to be influenced by surrounding traffic conditions, measuring the traffic conditions which could be an important factor to describe driver's psychological situations, for each road in different time thought to be difficult. So the observable relationship between average link speed and average vehicle density was employed in this study instead of the relationship between speed and density for each road in traffic flow theory.

First, to define the unit distance of motorcycle use on roads, non-intersection links were defined between intersections. The boundary of intersection was set as the extension of a straight line from the end of the corner cut-off at the intersection. The width and length of the links were measured using Google Earth. Measurement errors may occur in the passage times because the link start and end positions were reliant on visual estimates. As a rough guide, assuming that the error in average link passage time is ±1 s for both intersections, the error in average link speed will be approximately -1.23 to 1.41 (km/h).

Next, with regard to vehicle density, average vehicle density around the observed vehicle was used. To calculate this, a range with road width in front of the motorcycle was defined using traffic lane markings, and the number of vehicles in the range was counted according to the type of vehicle as shown in FIGURE 1. Area parameters shown in TABLE 3 for each type of vehicle were used to convert the number of vehicles into the total vehicle area in the range. Using Equation (1), the instantaneous vehicle density for every five seconds was averaged over the number of observations within the same link. The coefficients used were a, b, c: number of motorcycles, four-wheeled vehicles, auto rickshaws and others; α, β, γ: area parameters; A: area by which the total vehicle area is divided; n: number of observations within link.

$$(\sum_{K=1}^{n} (\alpha a_{mn}+\beta b_{mn}+\gamma c_{mn}))/An \qquad (1)$$

Excluding 136 links for which it was not possible to accurately count all of the vehicles inside the angle of view owing to the effect of camera shaking and road congestion, etc., data for a total of 878 links was obtained from the video analysis. The number of observations of instantaneous vehicle density found every five seconds averaged 4.86 per link, with a standard deviation of ±4.42.

Using the calculated results, when correlation coefficients of average link speed and average link vehicle density according to road conditions were compared, excluding the small number of one-way links, correlation was highest for "links with median strip, and 2 or more lanes in each direction" (TABLE 4), and the scatter diagram of vehicle density and speed confirmed that, as average link vehicle density increases, average link speed decreases (FIGURES 2, 3). Reasons for different correlation coefficients depending on road conditions include the fact that, in addition to road conditions such as road surface, the situation concerning crossing the centerline, reckless right/left turning, driving in the wrong direction on the road shoulder, etc. also varies according to road conditions. The conditions on "links with median strip, and 2 or more lanes in each direction" are such that driving behavior is less affected by the road and other people, and a detailed analysis of the 542 "links with median strip, and 2 or more lanes in each direction" was conducted.

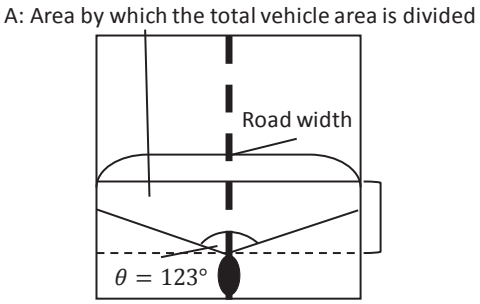

FIGURE 1 Defined range in front of motorcycle

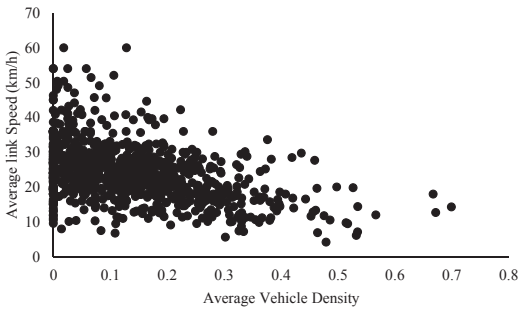

FIGURE 2 Relationship between average vehicle density and average link speed (all links)

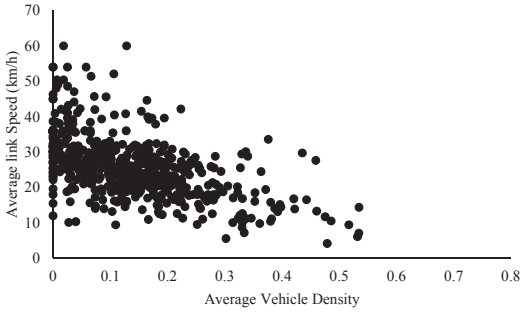

FIGURE 3 Relationship between average vehicle density and average link speed (links with median strip, and 2 or more lanes in each direction)

TABLE 3 Area parameters

	Sample size	**Average vehicle area (m^2)**	**Standard deviation (m^2)**
Motorcycle	6	1.22	0.14
Four-wheeler	6	8.51	0.51
Auto rickshaw	10	4.59	0.17

TABLE 4 Correlation between average link speed and average vehicle density for each traffic lane scenario

Traffic lane scenario	**No. of links**	**Correlation coefficient, R**
Link without median strip, and 1 or 1.5 lanes in both direction	165	-0.27
Link without median strip, and 2 or more lanes in both direction	126	-0.37
Link with median strip, and 1 or 1.5 lanes in each direction	33	-0.48
Link with median strip, and 2 or more lanes in each direction	542	-0.54
One-way link	12	-0.65
All links	878	-0.43

4. Results

Simple Comparison before/after WS showed that an average traveling speed decreased from 26.67 km/h (267links) to 25.44 km/h (275links). Also, to confirm the effect of the workshop on the travel speed, a multiple regression analysis of the average link speed was carried out using a workshop dummy variable, average link vehicle density, female dummy variable, university student dummy variable, lane line (white line) is drawn dummy variable, right / left turn intersection at the end of link dummy variable, the frequency of passing a motorcycle and being passed by a motorcycle as explanatory variables.

The results (TABLE 5) show that the average link speed decreased approximately 2km/h after participating in the workshop. In term of the overall analysis, the average vehicle density has the greatest influence on the speed reduction and the traffic condition is the dominant factor of the traveling speed. Among individual attributes, the average interval speed is higher in case of male and university student. Furthermore, when lane line (white line) is drawn, average link speed would increase. This result shows excessive speed with overconfidence may become a more serious problem in Cambodia if road surface were improved in the future.

TABLE 5 Multiple regression analysis with the average link speed as the objective variable

	Coeficient	t-value	
Constant term	32.15	45.20	**
Average vehicle density	-39.76	-15.69	**
Female dummy	-3.79	-6.22	**
University student dummy	1.48	2.54	*
WS dummy	-2.16	-3.90	**
Lane line (white line) dummy	1.73	2.98	**
Intersection right / left turn Dummy	-2.70	-3.36	**
Passing a motorcycle / km	0.18	6.86	**
Being passed by a motorcycle / km	-0.10	-5.17	**
Coefficient of determination	0.49		
Number of links	542		

*p < 0.05, **p < 0.01

5. Conclusion

A Study on the effect of Motorcycle Traffic Safety Workshop was conducted based on the video observations of actual driving behavior. Comparing driving behavior on arterial roads before and after the traffic safety workshop which included practical skills and classroom learning aimed at improving hazard prediction ability and acquiring basic driving skills, showed that an average travel speed decreased significantly after the workshop. In the analysis, the variable of average vehicle density had a negative and statistically significant impact on average link speed. This result implied that vehicle density could be an explanatory variable to represent various driving conditions of motorcycles with psychological effects. Furthermore, this result showed that even though average vehicle density was high, some students got average link speed more than the legal limit speed of 30 km/h. These results suggested that many young motorcyclists didn't have sufficient risk awareness and hazard perception skills and the current motorcycle use among young people is not safe due to insufficient educational opportunities. More practical and advanced driver education, such as hazard prediction and knowledge for driving safety can be expected to improve safety performance through motorcycle driving behavior. Hereafter, to clearly demonstrate the relationship between the content of this kind of traffic safety workshop and driving confidence, it is necessary to refine the experimental design, as in a panel study. Regarding the contents of the safety workshop, the development of a traffic safety workshop program that includes advanced driving skills training, such as speed awareness or hazard anticipation would be required for practical implementation.

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