Research Journal of Applied Sciences, Engineering and Technology 5(3): 881-888, 2013
ISSN: 2040-7459; E-ISSN: 2040-7467

Submitted: June 19, 2012 Accepted: July 09, 2012 Published: January 21, 2013

Application of Technology Acceptance Model in Predicting Behavioral Intention to Use Safety Helmet Reminder System

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Abstract: Motorcycle is a common and popular mode of transportation in many developing countries. However, statistic of road accidents by the Royal Malaysian Police reveals that motorcyclists are found to be the most vulnerable road users as compared to users of other vehicles. This is due to the lack of safety protection and instability of motorcycles themselves. Despite the usefulness and effectiveness of safety helmet to prevent head injuries, majority of motorcycle users do not wear and fasten their helmet properly. This study presents a new approach in enhancing the safety of motorcycle riders through proper usage of safety helmet. The Technology Acceptance Model (TAM) was adopted in predicting the behavioral intention to use Safety Helmet Reminder (SHR) system towards a more proper helmet usage among motorcyclists. A multivariate analysis technique, known as Structural Equation Modeling (SEM) was used in modeling exercise. Results showed that the construct variables in TAM were found to be reliable and statistically significant. The evaluation of full structural model (TAM) showed the goodness-of-fit indices such as Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Comparative of Fit Index (CFI) and Tucker Lewis Index (TLI) were greater 0.9 and Root Means Square Error Approximation (RMSEA) was less than 0.08. Perceived ease of use was found as strong predictors than perceived usefulness regarding behavioral intention to use SHR. In addition, this study postulates that behavioral intention to use SHR has direct effect on the proper usage of safety helmet significantly.

Keywords: Helmet use, safety helmet reminder system, structural equation modeling, technology acceptance model

INTRODUCTION

In many developing countries, private transportation is favored and more practical compared to its' public counterpart. This is because the latter is inefficient, offers poor services and serves only to limited route. Therefore, many road users use their own vehicle to fulfill the needs and perform their daily activities that require them to travel. Such circumstances could be seen in Indonesia and Malaysia where motorcycle is a common and popular mode of transportation (Conrad *et al*., 1996; Kulanthayan *et al*., 2001). However, in spite of its popularity, motorcyclists are also known to be vulnerable road users in terms of safety-risky exposure and instability compared to other vehicles (Ambak *et al*., 2009). For instance, the Royal Malaysian Police (PDRM) recorded a total of 6282 of fatalities in road accidents in 2007. Of this figure, motorcycle users were found as the major victims and accounted for 50% (or 3197) of all road fatalities in that year (PDRM, 2009).

Many researches indicated that the major cause of death involving motorcycle users were due to head injuries (Barbara *et al*., 1995; Kulanthayan *et al*., 2000; Radin Umar *et al*., 2005; Keng, 2005; Zamani *et al*., 2009). Road accidents statistics showed that the most body part injury that led to fatality were head which was at 65% (PDRM, 2009). Therefore, one strategy that can be used is through proper usage of safety helmet. Safety helmet is the best protective equipment and most effective to protect motorcycle users' head from injuries (National Highway Traffic Safety Administration, 2009; Radin Umar *et al*., 2005). Many studies showed that the safety helmet was effective in preventing and reducing the severity of head injuries by 37 to 72% (David, 2007; Li *et al*., 2008) or deaths by 20 to 24% (Masao *et al*., 2003; Thomas, 2009).

Despite the usefulness of safety helmet, majority motorcycle users did not wear or fasten properly. Several studies in developing countries found that the percentage of proper usage of helmet among

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motorcycle users was considered low (Conrad *et al*., 1996; Ichikawa *et al*., 2003; Hung *et al*., 2006; Li-Ping *et al*., 2008; Kulanthayan *et al*., 2000; Zamani *et al*., 2009; Ambak *et al*., 2011). However, Radin Umar *et al*. (2005) highlighted that the Malaysian government has taken many steps in ensuring proper helmet usage issue by implementing series of initiatives since early seventies. The first was through the introduction of Motorcycle Safety Helmet Standard MS1: 1969. This was followed by the implementation of Helmet Law in 1973, safety helmet campaign which has been going on since 1997 and the latest is the Community Based Program which started in 2007. Furthermore, the effectiveness of the initiatives has been evaluated through a few studies. Radin Umar *et al*. (2005) reported that since 1995, 1998 and 2000, the rates of proper usage of safety helmet have increased by 33, 41 and 54%, respectively. Though it seems to have positively improved, the percentage rate was saturated at 66%. Furthermore, this is an average figure representing both urban and rural areas. Unfortunately, the compliance rate in rural area was still low which only 33% (Kulanthayan *et al*., 2001). Thus, extra effort needs to be done to ensure safety in helmet usage. Li *et al*. (2008) suggested that there is a need to implement new interventions to increase proper helmet use. Therefore, the aim of this study is to apply a behavioral sciences theory and a technology called Safety Helmet Reminder (SHR) system in predicting behavioral intention toward proper usage of safety helmet.

Behavioral sciences theories and models have the potential to enhance efforts to reduce unintentional injuries (Trifiletti *et al*., 2005). The behavioral sciences theories such as Theory of Planned Behavior (TPB) by Ajzen (1991), Health Belief Model (HBM) by Rosenstock (1966) and Technology Acceptance Model (TAM) by Davis (1989) provide a potentially fruitful framework to understand in prediction of behavioral intention. Chun-Der *et al*. (2007) used TAM and TPB models to understand critical antecedents of motorists' intention toward Electronic Toll Collection (ETC) service adoption. Thus, theories in behavioral sciences can be seen as an integral part of a comprehensive injury prevention strategy and to understand the effectiveness of behavioral interventions change health behavior (Gielen and Sleet, 2003). Therefore, the main of objective of this study is to develop a Structural Equation Model (SEM) using TAM in order to predict behavioral intention to use proper usage of safety helmet.

THEORY AND APPROACH

Technology Acceptance Model (TAM): The Technology Acceptance Model (TAM) is grounded in both Theory of Reasoned Action (TRA) and Theory of Planned Behavior (TPB) (Davis, 1989; Davis *et al*., 1989), Fig. 1. The TAM is perhaps the most widely applied user acceptance model. It's most notable application is in the prediction and explanation of end-user reactions to health IT (Holden and Karsh, 2010; Yi *et al*., 2006). TAM is specifically tailored for modeling user acceptance of an information system with the aim of explaining the behavioral intention to use the system (Chun-Der *et al*., 2007). The model's Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) are considered as two predecessors affecting *attitude* toward a technology, which affects behavioral intention to use that technology. TAM states that an individual's system usage is determined by his behavioral intention which in turn is dictated by two beliefs:

- **Perceived usefulness**: The extent to which a person believes that using the system will improve his or her job performance.
- **Perceived ease of use:** The extent to which a person believes that using the system will be free of effort (Yi *et al*., 2006).

TAM has been tested by many researchers with different populations of users and IT innovations (Polančič *et al*., 2010). Besides this, Hong *et al*. (2006) concluded that TAM is the simplest and most generic model that can be used to study both initial and continuous IT adoption.

Hypotheses of the research: Chun-Der *et al*. (2007) highlighted that research embracing TAM consistently showed that a positive relationship between PU and PEOU with acceptance of Information Technology (IT). In addition, Polančič *et al*. (2010) reported that a previous extensive research provided evidence of the significant effect of perceived ease of use on user behavior, either directly or mediated by perceived usefulness. Thus, based on the research problem and theoretical foundations, the following research questions are constructed:

- Is TAM valid in predicting behavioral intention to use SHR?
- Can TAM constructs be used for anticipating the acceptance of SHR toward proper usage of safety helmet?

Based on the questions, the followings research hypotheses are built:

H1: Perceived usefulness of SHR has a positive effect toward behavioral intention to use SHR.
H2: Perceived ease of use of SHR has a positive effect toward behavioral intention to use SHR.

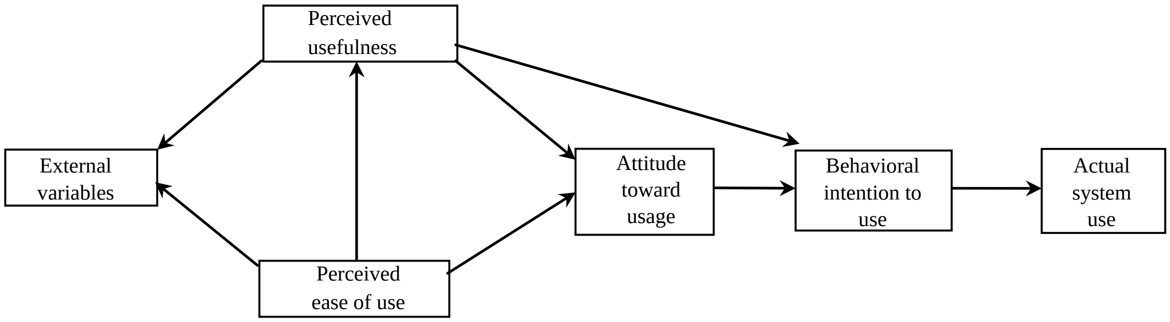

Fig. 1: Original technology acceptance model (Davis *et al*., 1989)

H3: Perceived ease of use of SHR has a positive effect on perceived usefulness of SHR.

H4: Behavioral intention to use SHR has a positive effect toward proper usage of safety helmet.

Safety Helmet Reminder system (SHR): Radin Umar (2006) stated that one of the main reasons for motorcycle users' vulnerability is due to the exposed body regions and little protection offered by motorcycle safety devices during a collision. Thus, Ambak *et al*. (2009) suggested that to reduce the severity of motorcyclist injuries and enhancing the motorcycle safety, it is important to introduce a technology called Intelligent Transport System (ITS) in motorcycles themselves. Intelligent Transport Systems (ITS) have significant potential to enhance traffic safety (Regan *et al*., 2001). While any technology that improves the safety of other road users can reasonably also be assumed to have indirectly improved the safety of other vulnerable road users, little has been done to directly implement ITS in motorcycles (Hsu *et al*., 2000; Regan *et al*., 2001). Ambak *et al*. (2009) suggested a possibility to adapt and apply a seat belt reminder system into motorcycle as helmet reminder system. Williams *et al*. (2002) examined the effectiveness of the seat belt reminder system equipped to several Ford vehicles in increasing seat belt wearing rates. The finding indicated that the seat belt wearing rates were significantly higher for drivers of vehicles with the seat belt reminder system (76%) than for those driving vehicles not equipped with a reminder system (71%). Regan *et al*. (2006) stated that it appeared that the seat-belt reminder and interlock systems were generally effective in increasing the seat belt wearing rates among vehicles occupants.

Due to similarity of the functions between seat belt and safety helmet in reducing severity of injuries, this study proposed a conceptual design of Safety Helmet Reminder system (SHR) as part of intervention toward motorcycle riders' head injury prevention. The development of SHR will not be discussed in details as it is still under patent registration and henceforth strictly confidential. However, the specific information regarding the SHR has been designed into a questionnaire. Preliminary evaluation of the SHR was carried out through respondents' survey.

Structural Equation Modeling (SEM): Structural Equation Modeling (SEM) is a family of statistical techniques permitting researchers to test such models and as a hybrid of factor analysis and path analysis that researchers can test hypothesized relationships between constructs (Weston and Gore, 2006). The development of Structural Equation Modeling (SEM) methods and software has proceeded rapidly since the 1970s (Maccallum and Austin, 2000). An SEM is an extremely flexible linear-in-parameters multivariate statistical modeling technique and it has been used in modeling travel behavior and values since about 1980s (Golob, 2003). Also, SEM is a technique used for specifying and estimating models of linear relationships among variables. Variables in a model may include both measured variables and latent variables. The latent variables are hypothetical constructs that cannot be directly measured (Maccallum and Austin, 2000). An SEM is a relatively new method and applied in many areas such as in psychology, sociology, the biological sciences, educational research, political science, market research and travel behavior (Golob, 2003).

An SEM has two primary components: the measurement model and the structural model. The measurement model describes the relationships between observed variables (e.g., instruments) and the construct or latent variables are hypothesized to measure. In contrast, the structural model describes interrelationships among constructs. When the measurement model and the structural model are

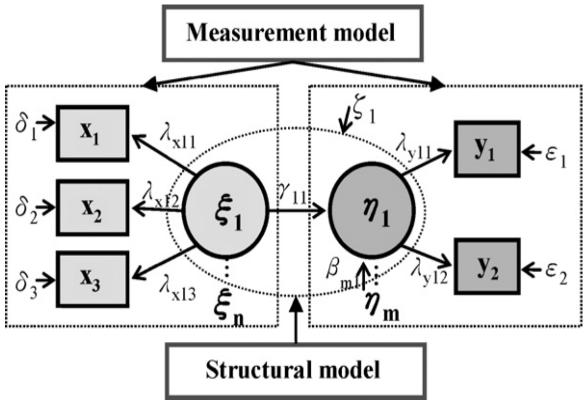

Fig. 2: A basic example of SEM component (Lee *et al*., 2008)

considered together, the model may be called the composite or full structural model (Weston and Gore, 2006). Figure 2 shows a basic example of component in structural equation model.

The measurement model is expressed as:

$$X_{1,\ldots,n} = \lambda_{x_1,\ldots,x_n}\,\xi_{1,\ldots,n} + \delta_{1,\ldots,n}$$

$$Y_{1,\ldots,n} = \lambda_{y_1,\ldots,y_n}\,\eta_{1,\ldots,n} + \varepsilon_{1,\ldots,n}$$

The structural model is expressed as:

$$\eta_{1,\ldots,n} = \gamma_{y_1,\ldots,y_n}\,\xi_{1,\ldots,n} + \zeta_{1,\ldots,n}$$

where,

X = Vector of observed exogenous variables
Y = Vector of observed endogenous variables
ξ = Vector of latent exogenous variables
η = Vector of latent observed endogenous variables
δ = Vector of measurement error terms for observed variables X
ε = Vector of measurement error terms for observed variables Y
λ = Coefficients of observed variables
ζ = Vector of the error terms in structural model
β = Coefficient of expected changes after a unit increases in η or ξ

METHODOLOGY

The collections of data were carried out within outside-town centre including country sides, housing estates and residential areas. The state of Selangor was chosen as the location of the study due to its' highest occurrence of road accidents as recorded in a statistical report (PDRM, 2009). Specifically, Bangi area in Selangor was selected to represent typical suburban of the state.

Data collection: In the data collection, face-to-face interviews were carried out with motorcyclists. Each one of them was asked to fill-up a self-administered questionnaire form. If a motorcyclist refused to cooperate, another respondent was approached and prior to giving the questionnaire, the way they were

Table 1: Measurements for TAM

Constructs	Scale
Perceived usefulness	
PU1: Using the SHR system would alerts me to wear a safety helmet properly.	1 = Strongly disagree 7 = Strongly agree
PU2: Using the SHR system make me concern about to think safety firstly.	1 = Strongly disagree 7 = Strongly agree
PU3: Using the SHR system would avoid my forgetfulness from wearing a safety helmet properly.	1 = Strongly disagree 7 = Strongly agree
Perceived ease of use	
PEOU1: I find the SHR system easy to use without any skilful requirement.	1 = Strongly disagree 7 = Strongly agree
PEOU2: With the SHR system easy for me to ensure that I am always wearing a safety helmet properly.	1 = Strongly disagree 7 = Strongly agree
Behavioral intention to use SHR	
INTOSA1: I intend to use the SHR system if it is provided free.	1 = Strongly disagree 7 = Strongly agree
INTOSA2: I will use the SHR system if it is already installed (built-in) in a motorcycle.	1 = Strongly disagree 7 = Strongly agree
Proper helmet use	
PHU1: How often do you wearing a safety helmet properly before starting your riding activity?	1 = Never 7 = Always
PHU2: I intend to wear a safety helmet properly before starting riding activity.	1 = Never 7 = Always

TAM: Technology acceptance model; SHR: Safety helmet reminder system using safety helmet (either improper use or not wearing helmet at all) were recorded separately. The survey activities were carried out for two months (February 2010 to April 2010). The location of the study was subdivided further into six zones. Three zones consisted of a few sections in housing estates (zone 1: Bangi S1-S4, zone 2: Bangi S5-S8 and zone 3: Tmn Kajang) and, three zones in the countryside (zone 4: Dengkil, zone 5: Sg. Tangkas and zone 6: Bangi Lama), respectively.

Instrument and sample size: The questionnaire consisted of five sections: background, riding experience, knowledge and attitude, behavioral sciences model (Technology Acceptance Model) and feedback regarding Safety Helmet Reminder system (SHR). The information regarding SHR and TAM was collected using a seven-point Likert scale (1 = strongly disagree to 7 = strongly agree) except for self-reported on helmet use (1 = never to 7 = always) in response to statements about these variables (Table 1). A pre-tested questionnaire session was carried-out with 20 respondents and the reliability analysis was performed to improve the questionnaire. Three hundred (300) respondents were chosen as sample size to represent their general characteristics and the survey was achieved with a response rate of 57% (out of 533 respondents were approached). However, eight cases were dropped out for further analysis due to incompleteness and 292 sets of questionnaires were valid. This sample size was reasonably enough to analyze descriptive statistics, multivariate analysis and Structural Equation Modeling (SEM). A minimum sample size of 200 for any SEM analysis was recommended (Weston and Gore, 2006). Then, the Statistical Package for Social Sciences Software (SPSS) version 18 was used to analyze the data. Furthermore, the Analysis of Moment Structure (AMOS) version 18 for structural equation modeling was also used.

RESULTS AND DISCUSSION

Descriptive statistics: The characteristics of the respondents are demonstrated in Table 2. The mean age of the respondents was 30.6 years old and almost half (46.8%) of the respondents were within the age of 25 years and below. More than 60% of the respondents have completed secondary education level and half (52.4%) of them were working in private sectors. Most respondents (42.5%) earned monthly income less than RM1000 and 9.6% of the respondents were considered middle income earners (MYR 2000 to MYR 3000). Fifty-five percent of the respondents possessed a full license, but alarmingly 25.7% of the respondents were riding motorcycle without any license. In term of motorcycling experience, half of them (53%) have ridden motorcycle for over 6 years.

Table 2: Characteristics of the respondents (N = 292)

Demographic	Frequency (n)	(%)
Age (years)		
20 and below	67	22.9
21-25	69	23.9
26-30	36	12.3
31-35	31	10.6
36-40	20	6.80
Above 40	69	23.6
Gender		
Male	157	53.8
Female	135	46.2
Education level		
Never school	3	1.00
Primary school	19	6.50
Secondary school	202	69.2
Tertiary level	68	23.3
Working sector*		
Government	36	12.3
Private	153	52.4
Self-employed	44	15.1
Housewife	18	6.20
Student	23	7.90
*Exclude jobless and retirees		
Monthly income (1USD = RM3.1)		
RM1000 and below	124	42.5
RM1001-RM2000	73	24.7
RM2001-RM 3000	28	9.60
Above RM3001	9	3.10
Not relevant	58	19.9
Type of license		
Full license	161	55.1
Probation license	33	11.3
Learning license	23	7.90
None	75	25.7
Riding experience (years)		
Below 2	65	22.3
2-5	70	24.0
6-10	44	15.1
Above 10	113	38.7

Reliability and correlation analysis: The reliability analysis was conducted on specific questionnaire for TAM. The Alpha Cronbach (α) was used to evaluate the reliability of the items in the instruments. Theacceptable for Alpha Cronbach value is when α at least or greater than 0.7 (Bland and Atlman, 1997). The result shows that the coefficient value of Cronbach's (α), for the proposed model was 0.912 and that indicated the items used in the variables were reliable. Table 3 shows all variables in TAM model were viewed to be highly correlated and found to have significant positive correlations with behavioral intention to use SHR towards proper usage of helmet.

Structural Equation Modeling (SEM) analysis: In SEM modeling analysis, the TAM model was adopted to test the relationship of constructs variables between

Table 3: Means, standard deviations and correlations for variables in TAM

	PHU	BI	PU	PEOU	Mean	S.D.
PHU	1				5.520	1.55
BI	0.212**	1			11.40	2.58
PU	0.220**	0.659**	1		17.68	3.25
PEOU	0.187**	0.709**	0.712**	1	11.52	2.29

HU: Proper helmet use; BI: Behavioral intention to use SHR; PU: Perceived usefulness; PEOU: Perceived ease of use; **: Correlation is significant at 0.01 level (2-tailed)

Table 4: Results of standardized coefficient and critical ratio

Path direction	Standardized coefficient	Critical ratio
Perceived usefulness → behavioral intention	0.272	2.92**
Perceived ease of use → behavioral intention	0.587	6.06***
Perceived ease of use → perceived usefulness	0.800	12.0***
Behavioral intention → proper helmet use	0.406	6.06***

: Significant at p<0.01; *: Significant at p<0.001

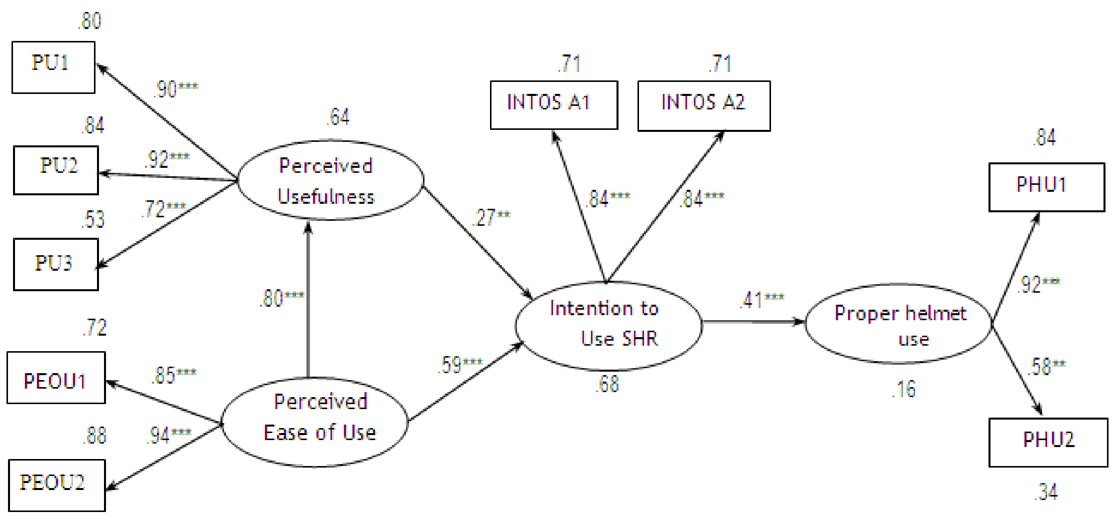

Fig. 3: TAM model for predicting behavioral intention to Use SHR toward proper helmet usage (**p<0.01, ***p<0.001)

exogenous (behavioral intention to use SHR) and endogenous (proper usage of helmet use) variables. The proposed model was adapted from Chun-Der *et al*. (2007) and Polančič *et al*. (2010) that were successful in predicting behavioral intention in their studies. The full structural model was estimated using a Maximum Likehood (ML) method and displayed in Fig. 2. Based on the results, the model in Fig. 3 indicates an excellent goodness-of-fit with χ^2 statistic of 28.438 (degrees of freedom = 17, p = 0.003) and Chi-square-to-degree of freedom (χ^2/df) ratio having a value of 1.994. Joreskog and Sorbom (1993) suggested that χ^2/df should be between 1 and 3 with smaller values indicating a better fit. The model (TAM) showed the evaluation of goodness-of-fit indices such as GFI (0.995), AGFI (0.975), CFI (0.997) and TLI (0.990) which more than 0.9 showed excellent fit. These scores were very close to 1.0, where a value of 1.0 indicated perfect fit (Joreskog and Sorbom, 1993). Also, Root Mean Square Error Approximation (RMSEA) was 0.058 that indicated a good fit. Browne and Cudeck (1993) proposed that values less than 0.08 indicated good fit and values high than 0.08 represented reasonable errors of approximation in the population. While, Square Multiple Correlation (SMC) showed the highest variation percentage with value of 68% meaning that the amount of construct variables was able to be explained in the model.

Hypothesis testing: The full structural model (TAM) presented in Fig. 2 was tested using the SEM modeling approach and the goodness-of-fit the structural model shows excellent of indices value. For hypothesis test, Table 4 demonstrates the results of standardized coefficient and critical ratio for path analysis in TAM model. All four path directions were found to be statistically significant and supported the hypotheses. Perceived usefulness had a significant effect toward behavioral intention to use SHR (γ = 0.272, t = 2.924, p<0.01) and support for H1.

As hypothesized also, perceived ease of use had a significant positive effect toward behavioral intention to use SHR (γ = 0.587, t = 6.056, p<0.001), thus supporting H2. In path analysis, perceived ease of use had a strong effect (p<0.001) on perceived usefulness and the direct effect of this construct value was 0.800. Therefore, H3 was found to have supported the hypothesis. Finally, the path from behavioral intention to use SHR toward proper helmet usage was also significant (β = 0.406, t = 6.061, p<0.001) and had a positive direct effect, supporting H4.

CONCLUSION

Motorcycle crashes cannot be totally prevented but resultant head injuries and their severity can be avoided or minimized by protective equipment like safety helmet (Kulanthayan *et al*., 2001). Hence, the present study indicates that the issue of lower rate of safety helmet compliance still occurs even when the Malaysian government shows great concern on this problem. It seems that those helmet initiative programs including the helmet law enforcement, safety helmet campaign and Community Based Program are insufficient to overcome the problem. Therefore, a new approach is needed to be introduced to mitigate the current issue as recommended by Li *et al*. (2008). They suggested the need to implement new intervention actions to increase helmet use. Also, Ambak *et al*. (2009) suggested the possibility to adapt and apply the seat belt reminder system as being used in cars to motorcycles as a helmet reminder system.

In fact, an interdisciplinary approach that involves behavioral sciences, injury prevention and engineering aspect would offer a better solution (Winston and Jacobsohn, 2010). The applications of such behavioral sciences theories or models (TAM) are able to predict and explain the significant predictor (perceived ease of use and perceived usefulness). The relationship between construct variable and target behavior can also be determined. Consequently, the implication of the model would bear fruit to some strategies to be used in intervention programs.

The present study demonstrates both constructs, perceived ease of use and perceived usefulness are significant predictors in predicting behavioral intention to use SHR. Perceived ease of use is determined as the stronger predictor than perceived usefulness. Moreover, the model postulates that there is a significant relationship between behavioral intention to use SHR and proper usage of safety helmet. With regards to this new approach, the model (TAM) to be proposed with a new intervention (SHR system) regarding motorcycle safety program is particularly on increasing compliance rate of proper helmet usage related to head injuries prevention strategy.

ACKNOWLEDGMENT

The authors would like to thank Universiti Tun Hussein Onn Malaysia (UTHM) and the Ministry of Higher Education (MOHE) of Malaysia who sponsoring this research.

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