Prediction of Helmet Use among Malaysian Motorcyclist Using Structural Equation Modeling

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Abstract: In Malaysia, 50% of fatalities in road traffic accidents were from motorcycle users. Head injuries found is a major cause leading to death. Despite the safety helmet is the best protective equipment to prevent or reduce head injury, majority motorcycle user did not use or did not fasten properly. In understanding this problem, the behavioral sciences theory and engineering aspect are needed to provide better explanation and comprehensive insights into solutions. The Theory Planned Behavior (TPB) and Health Belief Model (HBM) were used in predicting the behavioral intention toward proper helmet usage among motorcyclist. Results show that the constructs variables are reliable and statistically significant with the exogenous and endogenous variables. A multivariate analysis technique, known as Structural Equation Model (SEM) was used in modeling exercise. The full structured models were proposed and tested, thus the significant predictors were identified. Finally, the TPB model with good-of-fit indices was selected as the best model in predicting motorcyclist behavioral intention toward usage of safety helmet.

Key words: Helmet use, Theory of planned behavior, Health belief model, Structural Equation Model

INTRODUCTION

Road safety is one of major concern in Malaysia and becoming public health issues, since number of people killed on the road involved thousand of life. According to Royal Malaysian Police (PDRM), more than 6000 people killed in road accidents annually. In 2007 alone, PDRM reported that 6282 of fatalities were recorded in road crashes. Of this figure, the motorcycle users accounted for 50% (or 3197) of all road fatalities and as the major victims (PDRM, 2009). Furthermore, motorcycle has become a common and popular mode of transport in many developing countries (Conrad et al 1996). Many researches indicated that the major cause of death involving motorcycle users due to head injuries (Barbara et al 1995; Kulanthayan et al 2000; Radin et al 2005; Shoa 2005 and Zamani et al 2009). Facts from road accidents statistics showed that the most part of body injured lead to fatality is head by 65% (PDRM, 2009). Most researchers agreed that the safety helmet is the best equipment that can be used to protect motorcycle users from head injuries (NSTHA, 2009; Radin et al 2005 and Shuaieb et al 2002). Many studies shown that the helmet is 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 user did not use or did not fasten properly. There are several studies in developing countries found that the percentage of proper usage of helmet among motorcycle users is 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).

However, Radin et al (2005) highlighted that the Malaysian government has taken role of safety concern regarding helmet issue by implementing series of initiatives since early seventies. Beginning with Introduction of Motorcycle Safety Helmet Standard MS1: 1969, Implementation of Helmet Law in 1973, Targeted safety helmet campaign in 1997 to date and newly intervention program is the Community Based Program in 2007 to date. Then, the effectiveness of helmet initiatives has been evaluated with a few studies. Again, Radin et
al (2005) reported that since 1995, 1998 and 2000, the rates of proper usage of safety helmet were increased by 33%, 41% and 54% respectively. It is seem positively improve but the percentage rate was saturated at 66%. Furthermore, this figure is represents in average for both areas in urban and rural. But, the compliance rate in rural area was considered low at 33% (Kulanthayan et al 2004) and needs to do extra effort regarding their safety concerned. Li et al (2008) suggested that there is a need to implement new interventions to increase helmet use. Therefore, the aim of this study is to apply a behavioral sciences theory or model in predicting intention toward proper usage of helmet and to determine a significant predictor that contribute to the behavioral intention of safety helmet usage.

Behavioral and social 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. For instance, Lajunen and Rasinen (2004) were adopted the TPB and HBM in their study to understand why cyclist are so unwilling to use bicycle helmets. Warner and Aberg (2006) used the TPB as a conceptual framework in prediction of drivers’ decision to speed. Simsekoglu and Lajunen (2008) found that the social psychological theories provide potentially useful yet rarely used tools for explaining how attitudes, beliefs, and values influence seat belt use. Chen 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 (Geilen & Sleet, 2003).

Theory of Planned Behavior (TPB):

The Theory of Planned Behavior (TPB) is an extension of the Theory of Reasoned Action (TRA). Ajzen (1991) extended his earlier work with Fishbein and Ajzen in 1975 to include an explanation of all behaviors, not simply those under voluntary control by including measures of perceived behavioral control (Johnson and Hall 2005; Letirand and Delhomme 2005). According to the theory of planned behavior people’s attitude towards the behavior, their subjective norm, and their perceived behavioral control determine their behavior indirectly via their intentions (Warner and Abreg 2006). Attitudes are a person’s overall evaluations of a behavior while subjective norm consists of the person’s beliefs about whether significant others think he/she should engage in that behavior (Ajzen, 1985, 1991; Conner and Sparks, 1996). In addition, perceived behavioral control has both direct and mediated effects (by behavioral intention) on behavior and refers to the person’s perception of control on engaging in that behavior (Ajzen 1985, 1991; Conner and Sparks, 1996). Letirand and Delhomme (2005) mentioned that behavioral intention, is determined by the combination of attitude toward the behavior, subjective norm (perceived social pressure from important others to perform or not to perform a given behavior), and perceived behavioral control. According to these (TRA & TPB) models, behavioral intention is influenced by a person’s attitude toward performing a behavior, and by beliefs about whether individuals who are important to the person approve or disapprove of the behavior (subjective norm) and perceived behavioral control is construct has to do with people’s beliefs that they can control a particular behavior (National Institutes of Health, 2005).

Health Belief Model (HBM):

The HBM was developed in the early 1950s by a group of social psychologists at the U.S. Public Health Service in an attempt to understand “the widespread failure of people to accept disease preventives or screening tests for the early detection of asymptomatic disease” (Janz et al 1984). The basic components of the HBM are derived from a well-established body of psychological and behavioral theory (Becker et al 1977). The concept of the HBM focuses on two aspects of health behavior: threat perception and behavioral evaluation (Rosenstock, 1966, 1974). Threat perception refers to a perceived susceptibility to illness and a perceived severity of the consequences of such an illness, whilst behavioral evaluation concerns the perceived benefit and the perceived barriers to enacting behavior (Sheeran and Abraham, 1996). Additionally, the HBM proposes cue to action and health motivation as two other cognitive components were included to the model (Sheeran and Abraham, 1996). According to McClenahan et al (2007) the HBM is a health-specific model, which suggests that health behaviors are a result of a set of core beliefs and it has been used to predict many health behaviors. The HBM suggests that the core beliefs should be used to predict the likelihood that a behavior will occur but recently it has been suggested that intention should be included as a mediator between beliefs and health behavior (Quine et al 1998).
Structural Equation Model (SEM):

The development of structural equation modeling (SEM) methods and software has proceeded rapidly since the 1970s (MacCalum 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). 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, 2006). 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 (MVs) and latent variables (LVs). LVs are hypothetical constructs that cannot be directly measured (MacCalum & 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 considered together, the model may be called the composite or full structural model (Weston, 2006). Figure 1 shows a basic example of component in structural equation model. Where, \( x \) is vector of observed exogenous variables, \( y \) is vector of observed endogenous variables, \( \xi \) is vector of latent exogenous variables, \( \eta \) is vector of latent observed endogenous variables, \( \delta \) is vector of measurement error terms for observed variables \( x \), \( \epsilon \) is vector of measurement error terms for observed variables \( y \), \( \lambda \) is coefficients of observed variables, \( \zeta \) is vector of the error terms in structural model and \( \beta \) is coefficient of expected changes after a unit increases in \( \eta \) or \( \xi \).

Methodology:

Since the previous studies show the compliance rate of proper helmet usage in rural area and outside-town area was low, the collections of data were carried out within outside-town centre including country sides, housing estates and residential areas. Selangor state was chosen as location of study due to this state recorded highest road accidents statistical report (PDRM, 2009) and Bangi was represents as typical suburban in the state.

Face-to-face approached and self-administered questionnaire were distributed to motorcyclist (respondent) those using their motorcycles in daily activity such as to sundry shop, working, send children to school, etc. If they refuse to do so, another respondents were approached and prior to giving the questionnaire, the way they using a helmet were noted (either unfastened properly or with-out helmet) and recorded separately. Locations of data collection were divided into six zones. Three zones consist of a group number of section in housing estate and three zones in countryside respectively.

The questionnaire is consists of five sections: background, riding experience, knowledge and attitude, behavioral sciences model (Theory Planned Behavior, Health Belief Model and Technology Acceptance Model)
and feedback. A pre-tested questionnaire session was carried-out with 20 respondents and the reliability analysis was carried out to improve the questionnaire and to meet respondent acceptance level. Three hundred (300) respondents were chosen as sample size to represent their general characteristics and the surveyed was achieved with response rate of 57% (out of 533 respondents were approached). However, eight cases were dropped out for further analysis due to incomplete. This sample size is reasonably enough to analyze descriptive statistics, multivariate analysis and structural equation model. There are several studies using less than 300 of sample size, such as seatbelt use (N=277) by Simsekoglu and Lajunen (2008), motorcyclists’ intention to speed (N=110) by Elliot (2010), drivers’ decision speed (N=250) by Warner and Aberg (2006) and truck driver behavior (N=232) by Poulter et al (2008). Then, the data were analyzed using the Statistical Package for Social Sciences Software (SPSS) version 18 and Analysis of Moment Structure (AMOS) version 16.

RESULTS AND DISCUSSION

Reliability and Correlation Analysis:
The reliability analysis was conducted on specific questionnaire for TPB (with seven items) and HBM (with eleven items) respectively. An Alpha Cronbach (α) was used to evaluate the reliability of those items that used in the instruments. The acceptable for Alpha Cronbach value is when α > 0.7 (Bland and Atlman, 1997). The results show that the value of Cronbach’s α , for TPB is 0.738 and HBM is 0.778 respectively, and indicated that the items used in the measurements were acceptable. Thus, all the variables in TPB and HBM model are viewed as distinct but highly correlated and were found to have significant positive correlations with intentions and behavior toward helmet usage.

Structural Equation Modeling (Sem) Analysis:
For modeling exercise, the TPB and HBM models were applied and to test the relationship of constructs variables between exogenous (intention) and endogenous (behavior) variables. These proposed models have been adapted from Lajunen and Rasanen (2004), Simsekoglu and Lajunen (2008) and McClenahan et al (2007) those successful in predicting behavioral intention in their studied.

Using the Structural Equation Model analysis, the models were tested and displayed in Fig. 2 and 3. TPB is presented by seven items and based on results, this model indicate an excellent fit with χ² statistic of 27.575 (degrees of freedom = 21, p=0.153), with the χ²/df ratio having a value of 1.313. Joreskog and Sorbom (1993) suggested that it should be between 0 and 3 with smaller values indicating better fit.

The goodness fit index (GFI) is 0.979, adjusted goodness of fit index (AGFI) is 0.955, comparative fit index (CFI) is 0.991, and Tucker-Lewis coefficient (TLI) is 0.985. These scores are very close to 1.0 where a value of 1.0 indicates perfect fit (Joreskog and Sorbom, 1993). The root mean square error of approximation (RMSEA) is 0.033. Browne and Cudeck (1993) proposed that values less than 0.08 indicates good fit, and values high than 0.08 represent reasonable errors of approximation in the population.

For HBM, all indexes except GFI were unacceptably low. The result of the model indicated a poor fit, χ²/df = 3.808 (p=0.000) with GFI=0.915, AGFI=0.848, CFI=0.875, and TLI=0.809. RMSEA also show a poor fit with value of 0.098.

![Fig.2: TPB model for predicting motorcyclists’ intention to use helmet (*p<0.05, ***p<0.001)](5266)
Fig. 3: HBM model for predicting motorcyclists’ intention to use helmet (**p < 0.01, ***p<0.001)

Table 1: Means, standard deviations and correlations analysis for variables in TPB (n=292)

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Note: 1- Intention, 2-Behavioral, 3-Attitude, 4-Subjective Norm, 5-Perceived Behavioral Control
** Correlation is significant at .01 level (2-tailed)

Table 2: Means, standard deviations and correlations analysis for variables in HBM (n=292)

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Note: 1- Intention, 2-Behavioral, 3-Health Value, 4-Cue to Action, 5-Perceived Benefit, 6-Perceived Susceptibility, 7-Perceived Barrier, 8- Perceived Severity; * Correlation is significant at .05 level (2-tailed), ** Correlation is significant at .01 level (2-tailed)

Conclusion:

Motorcycle crashes cannot be totally prevented but resultant head injuries and their severity can be avoid or minimized by protective equipment like safety helmet (Kulanthayan et al 2001). Hence, present study indicates that the lower rate of compliance of safety helmet issue still occurs, even though Malaysian government concerned on this problem seriously. It seems those helmet initiative programs namely 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 current issue as recommended (Li et al 2008). They suggested the need to implement new interventions to increase helmet use. Also, Ambak et al (2009) suggested possibility to adapt and apply a seat belt reminder system into motorcycle as helmet reminder system.
In fact, an interdisciplinary approach that involves behavioral sciences, injury prevention and engineering aspect all together would be better solution. Behavioral science when combined with engineering, epidemiology and other disciplines creates a full picture of the often fragmented injury puzzle and informs comprehensive solutions (Winston and Jacobsohn, 2010). Trifiletti et al (2005) stated that the behavioral and social sciences theories and models have the potential to enhance efforts to reduce unintentional injuries. The applications of such behavior sciences theories or models (TPB and HBM) are able to predict and explain the significant predictor (e.g attitude toward behavior). The relationship between construct variable and target behavior also can be determined. Then, the implication of the model analysis would suggest some strategies to be taken onto intervention program.

For instance, Simsekoglu and Lajunen (2008) found that the TPB results emphasize the important role of attitudes and subjective norms in developing intentions to use a seat belt. Also, they suggested that seat belt campaigns should be aimed at forming and strengthening positive attitudes towards seat belt use. While, Lajunen & Rasanen (2004) mentioned that both the HBM (perceived barriers) and TPB (subjective norm) results emphasize the role of parents and peers in a teenager’s intention to use a bicycle helmet. According to the results of their study, bicycle helmet campaigns should aim mainly at changing peers’ and parents’ attitudes. With regards to these significant approaches, the TPB model was tested and had best good-of-fit indices. Attitude toward intention was found as strong predictor in predicting motorcyclists’ behavior to use the safety helmet. Subjective norm and perceived behavioral control was found not a significant predictor to intention of motorcyclist to use the safety helmet. Therefore, present study shows that the TPB model is applicable to predict helmet use and the HBM model is not met as good model-fitted.

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