Evaluating the Powerful Prediction of Integrated Behavioral Model for Risky Road Behaviors

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Abstract

Risky behaviors lead to road traffic safety accidents in Vietnam. Some individual risky behaviors were studied through distinct models to understand road user behaviors and to propose measurements for traffic safety improvement. This paper generally aimed to evaluate powerful prediction of Integrated Behavioral Models (IBM) for three risky behaviors i.e., driving after drinking (DAD), illegal changing direction (IDC), and speeding. Potential countermeasures will be proposed based on results. Results indicate that IBM successfully explains risky behaviors, especially for DAD. Among explainable variables, perceived severity is the only factor affecting all three risky behaviors.

1. Introduction

Road traffic crashes are the major problem which annually accounted for about 1.2 million deaths around the world [1]. Road users’ risky behaviors e.g., speeding, driving after drinking, speeding, not wearing helmet, seatbelt, and illegal changing, have been highlighted as key contributors to road crashes [2]. Prediction of risky behaviors are, hence, necessary to improve the road traffic safety. Behavioral models e.g., Theory of Planned Behavior model (TPB), Health Belief Model (HBM), IBM have widely been applied to predict these behaviors. However, these models significantly contributed to the prediction of risky behaviors when they were applied for each risky behavior separately. The comparison of predictive power of these models still requires more studies for risky behaviors [3–6].

In Vietnam, the road traffic accident rate is high because of the mixed traffic environment. According to MOT

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[7], higher frequencies of road traffic accidents and deaths have occurred on the highways and urban roads in which the traffic volume is high. Ho Chi Minh City (HCMc) can be seen as a typical example of a mixed traffic environment with the high road traffic accident rate. The number of accidents, fatalities, and injuries in HCMc accounted approximately 9.14% of the whole country in the period of 1999 and 2009 [8]. Several studies that applied TPB, HBM, IBM models to predict these behaviors individually in HCMc. The results showed that IBM is the most powerful model to predict these risky behaviors in HCMc. Nevertheless, the powerful prediction of IBM has been proven in distinct researches. Besides, the explanation of studied variables have been lefted questions for researchers [3,9,10]. This study, therefore, aims at evaluating explanation of IBM models and their variables for three risky behaviors i.e., DAD, IDC, and speeding behaviors. Additionally, based on results, campaigns, or programs will be suggested to improve the road traffic safety from three risky behaviors.

2. Integrated Behavioral Models and their comparison

2.1. Integrated Behavioral Models

IBM is an integrated model (i.e., including 15 variables) that incorporates TPB, HBM and extended social-cognitive variables. IBM was successfully proven to predict DAD, IDC, speeding, and not wearing helmet behaviors in Trinh and Vo’s researches [3,9,10]. TPB was developed by Ajzen [11], including three main variables i.e., people attitude towards behaviors, subjective norm, and perceived behavioral control. Together with these variables, cues to action, threat perception and behavioral evaluation variables of HBM [12], and four extended social-cognitive variables i.e., descriptive norm, past behavior, personal norm and perceived behavioral in specific are utilize to determine intention and behaviors (Fig. 1).

- Subjective norm (SN) is defined as perceptions of important people about doing the risky behaviors i.e., DAD, speeding, and IDC.
- Perceived behavioral control (PBC) is determined by the easiness or difficulty of drivers towards the risky behaviors [11].
- Affective attitude includes the affective attitude (A_ATT), and cognitive attitude (C_ATT). The affective attitude explains reasons of doing risky behaviors e.g., fun, exciting. Meanwhile, cognitive attitude shows that drivers know risky behaviors are bad but they still do. These variables in TPB are not only powerful to predict such diverse behaviors as choosing careers, deciding to donate blood but also predict the traffic safety research i.e., DAD, speeding, illegal changing behaviors [3,4,6,13].
- Threat perception is determined by perceived susceptibility (P_Sus), and perceived severity (P_Sev). Perceived susceptibility is clarified as the perception about bad consequences of doing risky behaviors e.g., getting a ticket, damaging vehicle, getting hurt, hurting others. Perceived severity is understood as dangerous levels of doing risky behaviors.
- Behavioral evaluation includes perceived benefits (P_Ben), and perceived barriers (P_Bar). Perceived benefits are that drivers think they can have advantages from doing risky behaviors. By contrast, perceived barriers is considered as individual’s opinion as to what would stop him/her from adopting new behavior i.e., punish probability would prevent drivers from risky behavior.
- Cues to action (CA) is the factors or activities that would prevent drivers from risky behaviors e.g., increasing the number of polices, frequency of checking, and the amount of fine.
- Descriptive norm (DN) is defined as individual perception about seeing others carry out the risky behavior. This variable has moderate or strong impacts on intention of risky behaviors [14].
- Past behavior (PB) is considered as drivers’ habit about carrying risky behaviors. Many researches show drivers tend to execute risky behaviors due to having the experiences of the situation.
- Personal norm (PN) expresses which crucial thing people think to execute the risky behaviors. Numerous studies showed that this variable is crucial to explain the risky behaviors [15].
- Perceived behavioral control in specific situation (PBC_SS) describes easiness, or difficulty level of road users to control the transport modes in specific situations. Several studies show that this variable contributes to the impact of prediction of traffic behavior [3,9,10].
Behavioral intention (BI) indicates that drivers have intentions to execute risky behaviors in the near future and behavior (B) states about the frequency of doing risky behaviors.

Fig. 1. 15 variables of Integrated Behavioral Models [3,9,10].

2.2. Comparison of behavioral models

Previous studies indicated that TPB is better fit to the data over the HBM in terms of health behaviors. Additionally, the TPB was reported to be a more integrated and extended model that had more predictive success compared to the other specific theories. HBM was reported to be more economical than TPB in terms of questions employed [16, 17]. However, review of the studies comparing the behavioral models showed that there are not many comparison of IBM, especially for the risky behavior prediction.

3. Data collection and Method

3.1. Data Collection

This study utilized results from three previous studies of DAD, IDC, and speeding behaviors in HCMc [3, 4, 10]. Hence, all data of three previous ones was applied in this research. Particularly, questionnaires were designed to measure these three risky behaviors. Before conducting surveys, pre-test surveys were implemented for all three behaviors in order to test the validation of the questions. The results were utilized to adjust the final questionnaires.
Face-to-face interviews were implemented in 24 districts of HCMc in 2011. Approximately 400 questionnaires were asked for both IDC, and speeding behaviors, while this number was nearly 300 for DAD.

3.2. Method

All three risky behaviors were estimated in the same method to ensure the fair comparison. Combination between Likert and nominal scales were applied to measure all variables i.e., all variables were measured by using 5-point scale from 1: disagree/never to 5: agree/very often [3,9,10]. Besides, the process of developing models are the same i.e., multiple linear regression was applied to predict the behavioral intention, and behavior after checking the reliability and correlation.

In order to evaluate the predictive power of IBM, the between subjects regression analysis will be applied. This analysis method includes two main steps, the first step is comparing explained variation of IBM for three risky behaviors and R-squared will be utilized for comparison in this step. The next step is evaluating influences of explainable variables on each risky behavior [18]. In this study, five percent (\( \alpha = 0.05 \)) was chosen as the threshold value to check the significance of studied variables.

4. Results

4.1. Comparison of explained variation

<table>
<thead>
<tr>
<th>Predicted variables</th>
<th>DAD</th>
<th>Speeding</th>
<th>IDC</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-squared of behavioral intention</td>
<td>0.46</td>
<td>0.68</td>
<td>0.34</td>
</tr>
<tr>
<td>R-squared of behavior</td>
<td>0.63</td>
<td>0.48</td>
<td>0.52</td>
</tr>
</tbody>
</table>

The results represented IBM effectively predicted all three risky behaviors in general but the powerful prediction is different among three risky behaviors (R-squared values are varied in Table 1). Expressly, IBM is far more powerful to predict intention of speeding behavior, compared to the other variables. IBM can explain 68% variance of speeding while these percentages were 46 % and 34% for DAD and IDC respectively. Additionally, the explanation for three behaviors is comprehensively different in behavioral prediction. DAD behaviors were received the best explanation by IBM (63% of variance was explained, Table 1). Meanwhile, the explanation for IDC was 52% of variance. Interestingly, the prediction for speeding behavior is the least powerful thought it is the most powerful in prediction of intention (Table 1, R-squared = 0.48).

4.2. Influence of variable comparison

In general, IBM showed the successful explanation for all three risky behaviors. Although the IBM model included many variables, not all variables contributed to the explanation of DAD, speeding and IDC behaviors. As to the prediction of intention for DAD, among 13 explainable variables, only 6 variables are significant to predict intention (Table 2). Subjective norm and past behavior are the most influenced variables which discourages intention of DAD (\( \beta = -0.26 \) and - 0.19 for subjective norm and past behavior respectively, Table 2). By contrast, perceived behavioral control, perceived barrier, cues to action and personal norm are the remained variables that promote drivers having DAD’s intention. Perceived behavioral control is the most powerful variable to push drivers having intention of DAD. Though cues to action and personal norm promote drivers having intention of DAD, their effects are not as vigorous as the others.

Interestingly, personal norm and subjective norm affected IDC’s intention as the same way they did in DAD’s intention prediction (\( \beta = -0.256 \) and .188 for subjective norm, and personal norm respectively, Table 2). Cognitive attitude is not significant to predict IDC’s intention, likewise DAD’s intention. The difference between DAD and IDC’s model is that significance of the remained variables is not similar. Particularly, past behavior, perceived behavioral control, cues to action and perceived barrier are not significant to predict intention of IDC. Meanwhile,
perceived behavioral control in specific situation promoted IDC’s intention (Table 2). Perceived severity and descriptive norm stimulate intention of driver, though the effects of perceived behavioral control in specific situation is the obvious lowest.

The most distinctive explanation is that drivers have a vigorous intention of speeding because of their cognitive attitude (β = -0.228, Table 2). In the meanwhile, this attitude does not have any effect on intention of two above behaviors. Besides, subjective norm cannot explain the intention of speeding while it does in IDC and DAD. Similarly to IDC, speeding intention does not affected by cues to action. Past behavior and perceived barrier has the same sign effect on speeding’s intention with DAD’s intention. Meanwhile, perceived severity affects intention of speeding in the same way with IDC’s intention.

Affective attitude becomes to the most affected variable that pushes drivers to execute DAD behavior though it does not affect IDC and speeding behaviors (β = 0.419, Table 2). Perceived susceptibility, perceived behavioral control in specific situation encourage drivers’ DAD behavior. Past behavior and subjective norm are predicted to promote DAD behavior though these variables has the reverse effect on intention. By contrast, perceived severity and barriers prevent drivers from DAD behavior.

Only four variables can explain IDC behavior. Among them, intention negatively has the strongest effect on IDC behavior. Cognitive attitude discourages drivers doing IDC. Meanwhile, affective attitude and perceived benefits encourages behavior of IDC. The influence of perceived severity is the same for both DAD and IDC behavior, but it is not for the case of cognitive attitude. Cues to action lightly promotes IDC behavior though it does not on DAD.

Remarkably, one similar finding in three behaviors is that perceived severity discourages DAD, and speeding behaviors. Similar to IDC, speeding behavior is affected by four variables. Perceived benefits is the most important variable affecting speeding behavior. Cues to action again encourages drivers speeding lightly. Additionally, both attitudes does not influence on speeding as on the others. Among three risky behaviors, DAD can be explained by many variables, compared to the others (Table 2).

Table 2. Predicting Intention and behaviors of three risky behaviors with TPB model [3,9,10].

<table>
<thead>
<tr>
<th>Predicted variables</th>
<th>Explainable variables</th>
<th>DAD Estimate (β)</th>
<th>DAD P-value</th>
<th>IDC Estimate (β)</th>
<th>IDC P-value</th>
<th>Speeding Estimate (β)</th>
<th>Speeding P-value</th>
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</thead>
<tbody>
<tr>
<td>DN</td>
<td></td>
<td>.142</td>
<td>.41</td>
<td>.119</td>
<td>.005</td>
<td>.016</td>
<td>.643</td>
</tr>
<tr>
<td>PB</td>
<td></td>
<td>-.187</td>
<td>&lt;.001</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>PBC</td>
<td></td>
<td>.177</td>
<td>&lt;.001</td>
<td>.16</td>
<td>.729</td>
<td>.182</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>CA</td>
<td></td>
<td>.167</td>
<td>&lt;.001</td>
<td>-.013</td>
<td>.725</td>
<td>-.07</td>
<td>.816</td>
</tr>
<tr>
<td>A_ATT</td>
<td></td>
<td>-.087</td>
<td>.14</td>
<td>.053</td>
<td>.281</td>
<td>-.06</td>
<td>.253</td>
</tr>
<tr>
<td>C_ATT</td>
<td></td>
<td>.109</td>
<td>&lt;.001</td>
<td>.083</td>
<td>.122</td>
<td>-.228</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>BI</td>
<td></td>
<td>.164</td>
<td>&lt;.001</td>
<td>.188</td>
<td>.001</td>
<td>.19</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>SN</td>
<td></td>
<td>-.256</td>
<td>&lt;.001</td>
<td>-.254</td>
<td>&lt;.001</td>
<td>-.038</td>
<td>.276</td>
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<tr>
<td>P_Bar</td>
<td></td>
<td>-</td>
<td>-</td>
<td>.106</td>
<td>.064</td>
<td>.105</td>
<td>.051</td>
</tr>
<tr>
<td>P_Sev</td>
<td></td>
<td>-</td>
<td>-</td>
<td>.130</td>
<td>.018</td>
<td>.132</td>
<td>.002</td>
</tr>
<tr>
<td>P_Ben</td>
<td></td>
<td>-</td>
<td>-</td>
<td>.006</td>
<td>.920</td>
<td>-.022</td>
<td>.714</td>
</tr>
<tr>
<td>SS_PBC</td>
<td></td>
<td>-</td>
<td>-</td>
<td>.085</td>
<td>.048</td>
<td>.071</td>
<td>.071</td>
</tr>
<tr>
<td>P_Sus</td>
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<td>.017</td>
<td>.661</td>
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<td>.949</td>
</tr>
<tr>
<td>BI</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-.253</td>
<td>&lt;.001</td>
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<td>.057</td>
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<tr>
<td>DN</td>
<td></td>
<td>-</td>
<td>-</td>
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<td>.300</td>
<td>.039</td>
<td>.368</td>
</tr>
<tr>
<td>PB</td>
<td></td>
<td>.178</td>
<td>&lt;.001</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>PBC</td>
<td></td>
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<td>-</td>
<td>-.010</td>
<td>.832</td>
<td>-.059</td>
<td>.322</td>
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<tr>
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<tr>
<td>A_ATT</td>
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<td>.026</td>
<td>.085</td>
<td>.193</td>
</tr>
<tr>
<td>B</td>
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<td>C_ATT</td>
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<td>-.139</td>
<td>.010</td>
<td>-.242</td>
<td>.002</td>
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</table>
5. Discussion

The present research examined potentially relevant factors across three risky behaviors. The results clearly indicated that IBM is successfully proven to predict all three risky behaviors in HCMc. The percentage of explanation for IDC’s intention is higher than speeding and DAD’s intention. However, IBM predict DAD behavior better than the other and the level effects of variables on DAD is higher than the others in general. Besides, the explanation of each variable varied from three risky behaviors.

- **Subjective norm:** This variable affects both DAD’s intention and behavior, as well as IDC’s intention. This is the most important variables discouraging DAD’s and IDC’s intention. This finding support the findings of previous studies [11,19]. In other words, when the important people of drivers though drivers should never IDC or DAD, drivers will not have intention of these behaviors. However, this variable does not impact on speeding intention and behavior. Besides, this variable becomes less vital to predicting behaviors when intention variables were used to predict behaviors.

- **Attitude:** Results generally confirm the findings of pioneers’ studies about the significant of attitude variables in predicting risky behaviors [20,21]. As to the cognitive attitudes, this variable has the strongest impacts on speeding’s intention and IDC behavior. However, the impacts are not similar. Particularly, though drivers do not like speeding, they still have the intention of speeding since they think that speeding is occasionally acceptable. Meanwhile, cognitive attitude prevents drivers from doing IDC. Affective attitude is the strongest variable to predict DAD behavior but it does not affect IDC and speeding.

- **Perceived behavioral control in specific situation:** This variable lightly affects behavioral intention of IDC and speeding. Besides, it also has minor effect on DAD behavior. Particularly, belief of controlling transport mode while doing risky behaviors promotes drivers having intention or executing risky behaviors.

- **Perceived severity:** Although this variable was not showed its high contribution of predicting risky behaviors of HBM [3,9,10], this is the only one variable influencing all three risky behaviors in the recent study. Particularly, perception of dangerousness from these behaviors discourage drivers from doing risky behaviors. Besides, this is the second important variable of DAD behavior. In case of IDC and speeding behavior, this is not the strongest variables but it somehow affect the intention as well as the behavior of IDC and speeding.

- **Perceived barriers:** The influence of this variable on DAD is lightly less. In other words, drivers will not do DAD behavior because of acknowledge of getting fine from DAD behavior. By contrast, though drivers receive difficulties of DAD and speeding, this cannot stop drivers having intention of these behaviors.

- **Perceived benefits:** Acknowledge of benefits from risky behaviors does not affect drivers’ intentions. However, it strongly leads drivers to speeding and IDC behavior. This finding is an agreement with the previous finding [3,9,10]. It means that drivers did IDC or speeding since they think these behaviors can help them to save time, create a good impression to others or give them a feeling of troll over the transport modes.

- **Perceived susceptibility:** Similar to perceived benefits, this variable does not affect intention of three risky behavior. However, it is somehow promote drivers executing DAD though they are aware of consequences of DAD behavior (e.g., increasing the chance of getting a ticket, damaging the vehicle or getting hurt when having accidents).

- **Cues to actions:** Programs or campaigns to reduce risky behaviors have really less impact on three risky intention and behaviors. Interestingly, they have reversed effects, they promote drivers executing speeding and IDC. This results helps researchers confirms the previous findings [3,9,10].
Past behavior: This variable only affect DAD and speeding but not for IDC. However, the effects of past behavior varied from intention to behavior. Particularly, executing risky behaviors will prevent drivers from having intention of DAD and speeding but drivers still doing these behaviors in reality. Besides, this is the second important factor leading to speeding behavior or discourage intention of DAD.

Behavioral intention and perceived behavioral control in general situation. These variables cannot explain intention or behaviors of three risky behaviors. This finding is not accord to the previous studies about apply behavioral models to predict the risky behaviors [3,9,10].

Through explanation of variables, the programs or campaign (e.g., increasing punish, or fine, traffic polices) should not be considered as countermeasures [22] since the reversed expected outcomes may occur. In other words, programs or activities that directly aim to reduce risky behaviors are not successful easily. Hence, indirect programs or activities should be considered in this case. Social marketing campaigns can be seen as potential and successful method. Besides, all variables prevent drivers from executing risky behaviors are related to cognitive (i.e., perceived barriers, severity and cognitive attitude) [3,9,10]. Policy makers should help drivers to have cognitive about bad consequences of risky behaviors. In order to prevent drivers from doing risky behaviors successfully, social-marketing can be considered as countermeasures and these campaigns should focus on helping drivers’ cognitive about bad consequences of risky behaviors. Besides, the policy makers can improve the traffic accidents by proposing programs or campaigns aiming at individual risky behavior. This may be more effective than the programs or campaign preventing all risky behaviors. Particularly, programs preventing drivers from DAD may focus on increasing the subjective norm of drivers or increasing drivers’ perception about the severity and barriers of DAD behavior. As to IDC behavior, subjective norm and cognitive attitude of drivers and perception of severity should be considered as priority in campaigns or programs. In order to improve traffic safety through speeding behavior, Similar to IDC and DAD, perception of severity should be taken into account when policy makers want to discourage drivers from speeding. However, individual programs or campaign may not reach economic objectives, compared to integrated programs or campaigns since it they costs more resources e.g., money resources, time resources and human resources.

This current study have focused on three risky behaviors while the other risky behaviors have not taken into account e.g., fatigue when driving, wearing helmet, seatbelt. Hence, furthers studies are needed in the future to improve the traffic safety in HCMc.

6. Conclusion

The results showed that IBM can explain DAD, speeding, and IDC behaviors and intention. Among three risky behaviors, DAD behavior received the best prediction from IBM, followed by IDC and speeding. Additionally, only several variables in IBM are significant to explain these risky behaviors and their explanation varied from each risky behavior. Expressly, speeding is the best case for predicting intention by IBM. Additionally, variables have various ability for each risky behaviors. To be more specific, subjective norm is the most important variable for prediction of DAD and IDC intention. While cognitive attitude is the most vital one explaining speeding intention. In the case of predicting behaviors, affective attitude shows its strongest power for DAD but not for the others. Perceived benefits were the only one has the strongest impact on both speeding and IDC behaviors. One remarkable result is that perceived severity is the unique one reducing all three risky behaviors. Cues to action created disappointed to the policy makers because of its reversed effects and its effect on these risky behaviors are not robust.

Though various variables have different level effects on these risky behaviors, there are some similar ones. Particularly, the attitudes and the perceptions of drivers promoted or discouraged the risky behaviors or intentions. If drivers perceived the bad consequences of the risky behaviors, they would not execute the risky behaviors. Besides, when drivers thought the risky behaviors can bring benefits, they would increase potential of taking risks. Therefore, in order to reduce these behaviors, campaigns or programs should be implemented. Depending on the purpose of policy makers, integrated programs or campaigns can be applied in order to improve traffic safety problem through preventing drivers from three risky behaviors. Besides, programs or campaigns for each individual behavior can be taken into account. But economic objectives may not be reached in this case because of consuming resources. In
In order to understand deeply about the causes of traffic accidents in HCMc, further studies on other risky behaviors e.g., wearing helmet and seatbelt, fatigue when driving, should be considered.

The present research examined potentially relevant factors across three risky behaviors. The results clearly indicated that IBM is successfully proven to predict all three risky behaviors in HCMc. The percentage of explanation for IDC’s intention is higher than speeding and DAD’s intention. However, IBM predict DAD behavior better than the other and the level effects of variables on DAD is higher than the others in general. Besides, the explanation of each variable varied from three risky behaviors.

Reference

[8] HCMc_Statistic Department, Annual average Income per person, 2009.