

## Effects of a speed camera project on psychological factors influencing driver speeding intention on an urban arterial road

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**Abstract:** The aim of this study was to examine and compare psychological factors influencing the speeding intentions of drivers during two phases of speed control project in Khon Kaen city. Data were collected into two parts, including from before the project, and six months after implementation. This study used the Theory of Planned Behaviour (TPB) to develop framework of speeding intention, using the Structural Equation Model (SEM). Psychological factors of TPB were employed to explain speeding intentions at 57% and 66% of variance for speeding intentions models, respectively. Both models found that PBC factor was the most significant and highly influential factor, while the subjective norm factor was a more significant factor after implementation. The outcomes of this study could help to understand drivers' speeding intentions on the road studied when speed control measures are employed.

**Keywords:** Speeding, Perceived Behavioural Control, Speeding Intention, Speed Control Measure, Speed limit

### 1. INTRODUCTION

Thailand ranks second highest in the world for its road traffic accidents rate, with double the mean road traffic accident rate of all member countries (WHO, 2015). Accident data of Thailand found that excessive speed causes many traffic accidents (DOH, 2016; Thai Traffic Police, 2014; and TARC, 2008). This problem arises from many factor, such as the physical nature of the road, risk behaviors of road users, low enforcement of speed restrictions (TARC, 2008; WHO, 2013; WHO, 2015) and so on. The authorities in Thailand, are trying to change the speeding behaviour of road users, by using educational campaigns, police surveillance, speed cameras and so on. However, the success of these measures has been limited, especially in time and staff (Tankasem, P., *et al.*, 2015; Sateinnam, W., *et al.*, 2015). These limits on measures have an effect on speed control measures on every road, but especially on main highways such as Mrittraphap road in Khon Kaen province. Like many big cities in Thailand, Khon Kaen has a high of traffic accidents.

Khon Kaen city has a main highway, (Mitrtraphap road or highway no. 2) which passes through the city in a north-south direction for around 14 kilometers, and has a traffic volume of around 93,000 vehicles per day (DOH, 2016). Most local traffics are smaller vehicles travelling with slower speed (e.g. motorcycles) but through traffics are larger vehicles travelling with higher speed (e.g. sedans buses and trucks) as displayed in Figure 1. Both

types of road usage occur at the same time and together on the road. This factor caused high fatality rate on this corridor.

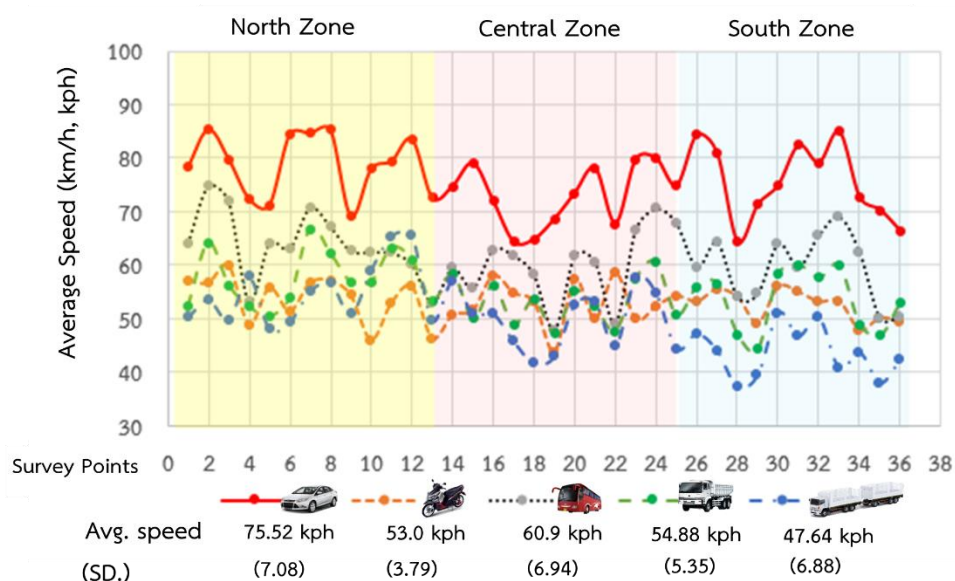


Figure 1 Average speed in the morning of before implementation project (Tankasem, P., *et al.*, 2016)

This road is especially dangerous; over the past four years, this road has had many traffic accidents, with an average of 1.5-2 cases per day and 1-1.5 deaths per month (EMS, 2013). Khon Kaen’s public officers are trying to reduce the number of road traffic accidents, especially by addressing speeding behavior. One of Khon Kaen’s measures for reducing the problem in by implementing speed controls measures by traffic highway police. The speed limit enforcement was not effective due to limitation of number of policeman and enforcing equipment. There was only one mobile speed camera and the police could enforce speed limit for a few hours per day. A previous study of public attitudes in Khon Kaen city in 2014 found that 87% agreed with enforcing speed control measures to increase road safety and to reduce the risk of traffic accidents. 67% agreed with issuing speeding ticket enforced by speed camera enforcement and payable by post ticket. Moreover, the study found that sampled members of the public who had experienced paying a penalty fine for speeding, agreed it had a significant relationship with speed control measures. This result indicates that speed enforcement has a direct effect on the speed behavior of road users (Tankasem, P., *et al.*, 2015; Sateinnam, W., *et al.*, 2015). From these reasons, Khon Kaen’s public officers together with the Road Safety Foundation suggested implementing a speed control project by using 24 hr. speed cameras to the Safer Roads Foundation (SRF). The SRF agreed to this project in 2014 and approved a budget of around 17.3 million baht (493,000 dollar) for financing.

The “14 km. safety corridor” project was established in Khon Kaen to reduce the number of traffic accidents, and control traffic speed, by using 24 hr. speed cameras, which were installed near black spots along Mittraphap road following a north-south direction through Khon Kaen city. Four enforcer cameras and eight dummy cameras were installed in different positions within the project area. The project was initiated on November 1<sup>st</sup> 2016, with three different speed limits set: 80 km./hr. for car and motorcycle, 60 km./hr. for bus and truck, and 45 km./hr. for trailer and three-wheeled taxi, in line with the urban national speed limits of Thailand.

Previous studies related to speed control measures in developed countries found that such projects could reduce the rate of road traffic accidents and create a positive change in speeding behavior (AUSTROAD, 2008; Elvik *et al.* 2004; Poonsuwan, 2014). Most previous studies were conducted in the field of engineering (e.g. results related to traffic speed), thus lacking results from the field of psychology, especially effects on traffic psychology, for example traffic psychology from a speed control project by using 24 hr. speed cameras. Speeding behavior is a part of traffic psychology which is not easy to understand, although traffic psychology explains driver behavior in great depth.

The Theory of Planned Behavior (TPB) has been used as a frame of reference to explain human behavior, and can be explained using three important psychological factors including: Attitude (AT), Subjective Norm (SN) and Perceived Behavioral Control (PBC) (Ajzen, 1991). Many studies related to speeding intentions have been conducted using the TPB framework (Chen and Chen, 2011; Cristea *et al.*, 2013; Dinh and Kubota, 2013; Leandro, 2012; Elliott *et al.*, 2005; Warner and Åberg, 2006; Warner and Åberg, 2008; Warner *et al.*, 2009, Tankasem *et al.*, 2016).

Previous studies focused on speeding intentions have had different results, especially in the significant factor, and many vary depending on the geographical area studied, for example, previous studies in European countries found that PBC was the most significant factor and highly influential on drivers' speeding intentions (Warner and Åberg, 2008; Warner *et al.*, 2009), while other studies in France and Japan identified AT as the significant factor (Cristea, *et al.*, 2013; Dinh. and Kubota, 2013). Previous studies in Thailand, Laos and Cambodia have focused on urban road environments, and it was found that the most significant psychological factor for Khon Kaen car drivers was determined by AT, while Laos's and Cambodian driver behaviors were attributed to PBC (Tankasem, *et al.*, 2016). Most of these previous studies focused on urban or rural road environments, while this current study focused on an urban arterial road where speed control measure by using automatic speed cameras was implemented. The aim of this study was to examine and compare psychological factors influencing the speeding intentions of drivers, using TPB to explain the effect of psychological factors both before and after the implementation of the speed reduction project.

## **2. METHODOLOGY**

### **2.1 Participants**

Data was collected from a population of workers at government officers and private officers in Khon Kaen city. There were 408 drivers which were collected before the project implementation in three month. Then, they were collected again after the implementation in six month which got questionnaires from respondents around 275 samples. For analysis process and discussion was selected equal samples at 200 samples.

### **2.2 Questionnaire survey**

The questionnaire was divided into two sections. The first asked for demographics (personal data). The second consisted of psychological questions that examined latent variables, following the principles of TPB (Francis *et al.*, 2004; Ajzen, 2016). This study examined direct measurements only. All questions were measured on a 5-point scale and related to reasons for driving fast over the speed limit. Each data for testing in SEM must over 150

samples per test which has seven constructs or less (Hair, J.F. *et al.*, 2010). Therefore, this study selected some correct and complete data at 200 samples of each period for analyzing process and comparing in discussion.

### **2.2.1 Attitude**

Attitude towards the behavior (AT) was measured by four items: “AT-AT4: For me driving fast over the speed limit in this road in the next time that would be...” *bad/good, harmful/beneficial, not acceptable /acceptable and should not to get the penalty/should to get the penalty*

### **2.2.2 Subjective norm**

Subjective norm (SN) was measured using four items: “SN1&SN2: I think people who are important for me (Parent/friend/relative) would ... with me to drive fast over the speed limit in this road in the next time” *should not to do/ should to do, strongly disagree/ strongly agree*, “SN3: I think people who are important for me would be ...me to drive fast over the speed limit in this road in the next time” *Never support/always support* and “SN4: I think people who are important for me would drive fast over the speed limit in this road in the next time” *Not likely/ likely*.

### **2.2.3 Perceived behavioural control**

Perceived behavioural control (PBC) was measured by three items: “PBC1: How confident are you that you will always be able to drive fast over the speed limit in this road in the next time” *not very confident/very confident*, “PBC2: For me to drive fast over the speed limit in this road in the next time” *very difficult/very easy*. and “PBC3: Driving fast over the speed limit in this road in the next time which depend on me only” *strongly disagree/ strongly agree*

### **2.2.4 Intention**

Intention (IN) was measured by three items: “IN1: Would you intend to drive fast over the speed limit in this road in the next time?” *definitely not/definitely do*, “IN2: How likely would you like to drive fast over the speed limit in this road in the next time?” *very unlikely/very likely*, and “IN3: How often would you like to drive fast over the speed limit in this road in the next time?” *not at all/very much*.

### **2.2.5 General attitude related to driving over the speed limit**

General attitude was measured by three items, including, “Acknowledgement the correct driver’s speed limit in this road” *60 km./hr., 80 km./hr., 90 km./hr. and other speed limit*, “Did you always drive at below the speed limit when you were on this road?” *Yes and No* and “How often you drive at over the speed limit?” *Never, Rarely, Average, Often and Always..*

## 2.3 Analysis of results

The first analyzed the different demographics between the sampling groups, using the independent T-test at the 5% level of significance. The second step involved factor analysis for checking reliability of latent variables by Cronbach's alpha ( $\alpha$ ) which should be closely valued at 1.0 or over 0.7 for an acceptable value. Next, the relationship between TPB's latent variables (AT, SN and PBC) and IN was examined by a correlation coefficient. After that, all variables were used to analyze relationship of latent variables that were based on TPB by confirmatory factor analysis (CFA) for checking reliability of latent variables that was analyzed by two indices including: Construct Reliability (CR) and Average Variance Extracted (AVE) are representative values of latent variables and they should be at a value over 0.6 and 0.5, respectively. The final step used structural equation modeling (SEM) to analyse the whole variables. The model to be tested strictly followed the TPB concept: Respondent's factors (AT, SN and PBC) are positively related to the behavioral intention of speeding. Overall model fit was evaluated against a number of recommended fit statistics and fit indices. These main fit indices were Chi-Square, GFI, CFI, RMSEA and SRMR. In other words, Chi-Square was used to evaluate the fit between the measurement models and the data. The Goodness of Fit Index (GFI) should be greater than 0.95. The Comparative Fit Index (CFI) should be greater than 0.90. The Root Mean Square Error of Approximation (RMSEA) should be between 0.03 and 0.08. The Standardized Root Mean Residual (SRMR) should be less than 0.1. These values can be considered as a good fit of the model (Hair, J.F. *et al.*, 2010).

## 3. RESULTS AND DISCUSSION

### 3.1 Demographics

Table 2 shows the demographic differences between drivers within two periods. The data was selected from total sampling (408 respondents for before the data and 275 respondents for after the data) at, 200 respondents per period. It was found that all demographics in table 2 were not considerably different, with a significant level of 5%. Therefore, both two wave data sets were assumed identical data. In other words, both data showed the average age of drivers as 38 years old, with average experience of driving vehicles of around 13 years, car drivers drove an average distance of around 29 kilometers. 35% of car drivers drove on this road daily, 43% between 3-6 days per week, and 20% for 1-2 days per week.

Table 2. Demographics between two waves

Demographics	Before	After	Value*
Gender, %			
Men	47	55	2.51
Women	53	46	
Education, %			
Under bachelor	23	25	
Bachelor	55	52	1.42
Higher bachelor	23	24	

Demographics	Before	After	Value*
Age			
Mean (SD.)	38.64 (10.29)	38.08 (10.53)	0.54
Driving experience			
Mean (SD.)	14.18 (8.96)	13.21 (8.70)	1.08
Mileage in kilometers per day			
Mean (SD.)	28.54 (28.65)	29.12 (30.78)	-0.17
Frequency to drive on this road, %			
Every day	35.8	35.1	
5-6 day/week	28.2	28.3	1.12
3-4 day/week	15.4	16.2	
1-2 day/week	20.6	20.4	

Remark: \* refer to statistics value form Pearson Chi-Square test or T-test

### 3.2 Mean of psychological factors

Table 3 shows the mean psychological factors (latent variables) between two waves. It was found that all factors prior to project implementation had values higher than after implementation. Therefore, the project had a significant effect on changing driver attitudes, related to speeding, especially in subjective norm (SN) and intention (IN) factors.

Table 3. Differences in driver rating of psychological factors between two waves

Factors	Before		After	
	Mean	SE	Mean	SE
Attitude (AT)	2.68	0.08	2.62	0.08
Subjective norm (SN)	2.39	0.08	2.07	0.08
Perceived behavioural control (PBC)	2.68	0.06	2.51	0.07
Intention (IN)	2.32	0.07	2.13	0.07

### 3.3 Reliability and validation of latent variables

Table 4 shows that all indexes of reliability and validation followed a good rule of internal consistency and rule of thumb, suggesting adequate convergence. In other words, these indexes indicate consistent answers from identical group questions, and are a reliable representative of latent variables in both periods.

Table 4 Reliability estimation and construct validation

Factors	Before			After		
	$\alpha$	CR	AVE	$\alpha$	CR	AVE
Attitude (AT)	0.86	0.68	0.56	0.86	0.75	0.62
Subjective Norm (SN)	0.87	0.85	0.72	0.92	0.93	0.83
Perceived Behaviour Control (PBC)	0.76	0.72	0.59	0.78	0.71	0.58
Intention (IN)	0.90	0.86	0.74	0.92	0.92	0.83

Remark : $\alpha$  = Cronbach's (alpha), CR= Construct Reliability and AVE= Average Variance Extracted

### 3.4 Speeding intention models

Table 5 shows the recommended statistics and indices fitted for both models. In other words, the numbers for each model had values over the number of recommended statistics and indices, except p-value, and had closed values in two models. Moreover, project implementation had a significant effect on factors influencing intention, especially AT and SN.

Table 5 Overall model fit and factors influencing with standardized path coefficients

Model fits	Speeding intention	
	Before	After
$\chi^2$	90.188	93.401
Chi-square/df (< 3.0)	1.804	1.868
p-value (> 0.05)	0.00	0.00
GFI (> 0.90)	0.93	0.93
CFI (> 0.90)	0.97	0.98
RMSEA (< 0.08)	0.06	0.07
SRMR (< 0.08)	0.06	0.06
Factors influencing to intention		Standardized path coefficients
AT → IN	-0.12	-0.15
SN → IN	0.25**	0.44***
PBC → IN	0.64***	0.52***

\*\*Significant at 1% level, \*\*\*Significant at 0.1% level, AT refer to attitude toward speed, SN refer to subjective norm and PBC refer to perceived behavioural control

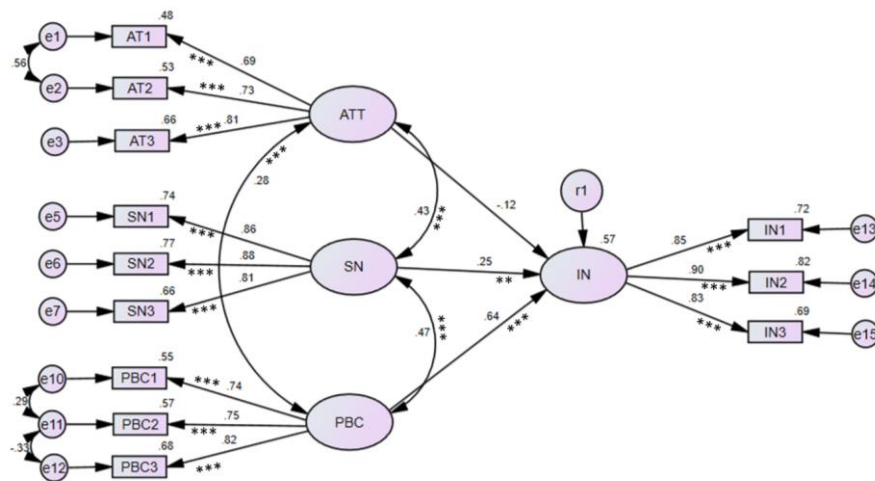


Figure 2 Structural model with standardized in before the project

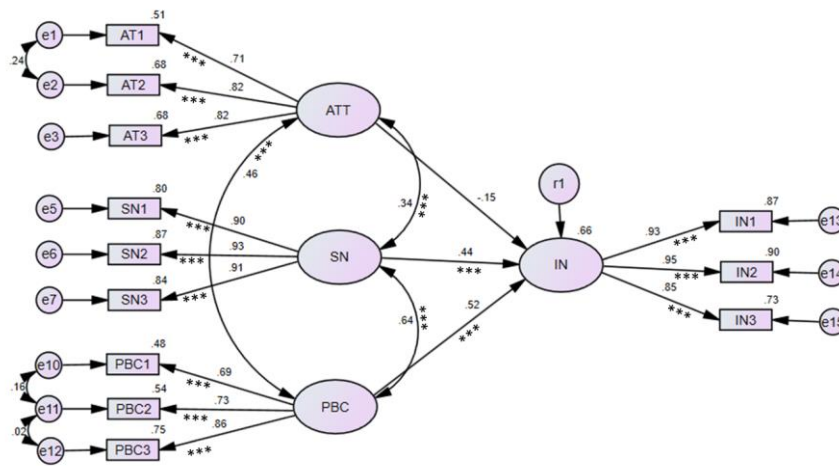


Figure 3 Structural model with standardized in after the project implementation

These models could explain 57% and 66% of variance for speeding intentions of drivers before (figure 2) and after project implementation (figure 3), respectively. Both models found that PBC was the most significant factor at 0.1% level, and a highly influential factor related to speeding intention, while SN was a significant factor at 1% before the project, and 0.1% after implementation.

### 3.5 General attitude related to driving over speed limit

The result of general attitude is presented in figure 4. It was found that driver attitude were more negative before the project, especially in acknowledgement of urban speed limit. Acknowledgment of the correct speed limit, and frequency of speeding over this limit improved after project implementation. Therefore, this project had a positive effect on driver attitude.

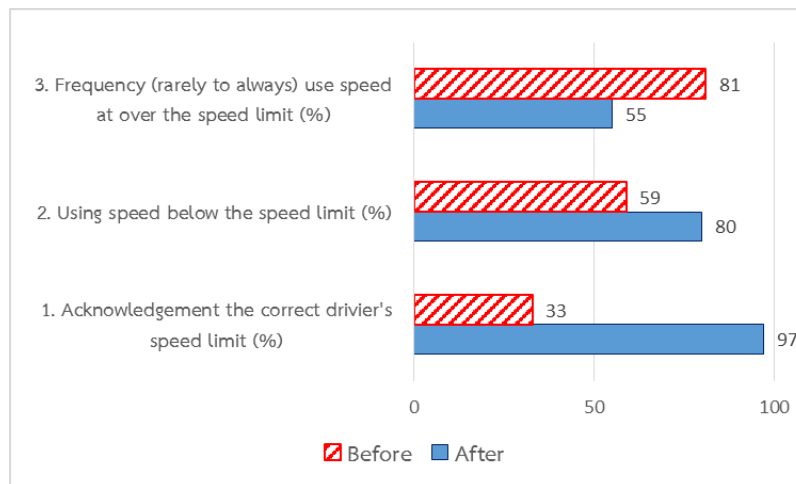


Figure 4 Comparison of general attitude related to driving over speed limit



#### 4. CONCLUSION AND DISCUSSION

The aim of this study was to evaluate and compare psychological factors influencing the speeding intentions of drivers in urban road environments controlled by automatic speed cameras. Psychological factors of TPB were evaluated and effects on intention to speed behavior were compared. The results present different psychological factors influencing intention (IN) before the project and after implementation. It was found that models could explain 57% and 66% of variance for speeding intentions respectively, while a previous study could explain 37-85% of variance for speeding intention (Cristea *et al.*, 2013; Dinh and Kubota, 2013; Warner and Åberg, 2008 and Warner *et al.*, 2009).

This study found that Perceived Behavior Control (PBC) was the most significant factor and a highly influential factor in both models. Accordingly, the previous study indicated PBC as an important factor in explaining speeding intention. (Warner and Åberg, 2008; Warner *et al.*, 2009). Subjective Norm (SN), was another significant factors. Moreover driver attitudes related to the speed limit were positive when the speed control project was implemented. In other words, acknowledgment of the correct speed limit, and frequency of speeding over these limits were changed when the project was implemented. These results found that the speed control project had a effect on speeding behavior. Accordingly, TPB explain show actual behavior would be adapted by changing intentions influenced by each psychological factor of TPB (Ajzen, 1991).

Influencing factors related to speeding intention differ after intervention by speed control project. Drivers did not control their speed when they drove on this road, before the project began, but changed their behavior after implementation of measures such as speed control by 24-hr. automatic cameras, as well as information campaigns on TV, radio, online and so on. These activities had a effect on driver behavior, especially speeding. These interventions influenced and changed psychological factors. The results of this study help the understanding of driver speed behavior, and should prove useful for determining future road safety policies.

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