SPEED MANAGEMENT STRATEGIES AND DRIVERS' ATTITUDE IN THAILAND

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ABSTRACT

In Thailand where speeding on highways and roads has been a key contributing factor in road traffic crashes, considerable efforts to control vehicle speeds have been made, mostly involving speed law enforcement. However, the fact that speed limits are very often violated on a large scale in Thailand suggests the need for implementing more effective speed management strategies such as automatic speed camera, increasing speeding penalty, and smart vehicle design to control vehicle speeds. While the effectiveness of such measures depends mainly on how well they could lead drivers to change speeding behavior, public acceptability is also vital as a key to sustainability of most speed management programs. This paper attempts to identify public acceptability of speed management measures, both currently implemented and under consideration, in the context of Thailand. In doing so, data from the questionnaire surveys based on a random sample of 2180 drivers in Thailand including a wide range of individual characteristics of respondents and their attitudes to select speed management schemes are analyzed using an econometric technique. In particular, we introduce a simplified methodological framework to develop a better understanding of factors that explain drivers' attitudes towards speeding behavior and alternative speed management strategies. Findings from this research provide several important implications that could improve the current practices of speed management in Thailand.

1. INTRODUCTION

Speed management is one of the biggest challenges for policy makers and road safety professionals around the world. While controlling vehicle speeds on roads is clearly a crucial need for improving traffic safety, this inevitably encounters an enhanced capacity of modern cars to go faster and an increasing demand to build roads with a higher standard, which encourage speeding behaviors.

In Thailand, speed control is at the core of the most recent thinking about road safety, apart from other human related factors such as drunk driving and non-helmet wearing among motorcyclists. Though there are a number of alternative strategies for managing and reducing speed on streets and highways in the road safety knowledge arena, only some of which have been employed in Thailand. With traffic law enforcement as an integral part of the country's speed management policy, physical policing has been the most common method used for speed enforcement on highways located outside cities, though it appears to have been in operation sporadically. In this regard, speed offenders along the highway are detected by means of a radar gun, and they are immediately stopped by the highway police. For streets and highways in cities and metropolitan areas where regular police officers have been given the authority, however, it is sadly true that no enforcement of speeding offenders has been in action, partly due to the lack of speed enforcement equipments and training.

Apart from the law enforcement, another speed management initiative involves public education campaign which has been undertaken by various stakeholders. Information on the danger of speeding has been communicated to the public through media releases, tailored feature articles, on-street boards and posters, government publications, and websites. The engineering approach taken as part of speed management measures on streets and highways mainly involves installing rumble strips to alert drivers to the presence of potentially high crash-risk areas. Given the presence of non-standardization for the design and installation, the question of whether any appreciable reduction in vehicle speeds has been achieved in the Thai context remains unanswered.

Despite these efforts, the accident statistics compiled by Thailand's Department of Highways indicate the seriousness of speeding as the principal contributing factor for road traffic crashes and fatalities in the country. From the years 2001 to 2007, speeding involvement has been reported to be as high as nearly 80% of all traffic crashes on national highways, and about a two-third of fatal crashes on national highways was related to speeding. These crash and fatality risks associated with speeding are practically reflected by the fact that speed limits are very often violated on a large scale in Thailand. Some recent roadside surveys for the speed limit compliance rate show that 40% to 70% of the car drivers typically exceed the speed limit of 90 kph on highways, while similar results are found for truck and bus drivers who are not allowed to exceed 80 kph (Siwarochana et al, 2004; Kullueb et al, 2006; Thailand Accident Research Center, 2008; Department of Highways, 2009). Moreover, previous studies, as reviewed in Jiwattanakulpaisarn et al (2009), suggests that some obstacles to the success of speed law enforcement in Thailand could be limited understanding of speed regulation and negative public attitude of existing speed enforcement program.

These findings clearly suggest the urgent need for implementing more effective speed management strategies. Much attention among concerned agencies has increasingly been paid to some other new approaches such as automatic speed camera, increasing speeding penalty, making use of smart vehicle design to control speed of vehicles such as Intelligent Speed Adaptation (ISA), and installing roundabout to reduce traffic speeds through a junction. However, deterring the speeding behavior remains to a great extent a real challenge. While the effectiveness of such measures depends mainly on how well they could lead drivers to change speeding behavior, public acceptability is also vital as a key to sustainability of most speed management programs. The use of some aforementioned speed control measures, though presenting no technical difficulty, may not be feasible from the political point of view, if motorists who constitute a majority of electorate would not stand for such measures. For the successful implementation of speed management and control, it is therefore important for policy makers to determine the acceptability of specific strategies which were influenced from individual drivers' attitudes (Lonero 1995).

The purpose of this research is to gain insight into public acceptability of speed management strategies, both currently implemented and under consideration, in the context of Thailand. Our analysis utilizes the data obtained from questionnaire surveys of randomly selected 2,180 drivers in Bangkok and other six provinces. Respondents were asked to express their attitude towards speeding behavior and alternative speed management strategies, while providing personal and other information regarding type and age of their own vehicle, years of driving experience, driving characteristics (i.e., maximum speed used and travel distance), and accident history. In addition to descriptive analysis of the survey data, making use of an econometric technique permits us to empirically identify which particular groups of drivers tend to have positive or negative attitudes towards speeding behavior and specific speed management measures. Findings from this research have several important implications that could improve the current practices of speed management in Thailand.

2. DATA COLLECTION AND QUESTIONNAIRE SURVEY

2.1 Study Area for Data Collection

The selection of study area was based on the number of speeding-related crashes in the area. Figure 1 shows the selected study areas where mostly locating in the suburb of Bangkok, including seven provinces; Bangkok, Lopburi, Chonburi, Nakhon Ratchasima, Chachoengsao, Samutprakarn and Saraburi. The data collection was conducted at several locations such as gas stations, roadside rest areas, parking lots, public transit terminals, and etc. Respondents were randomly selected from different days of week, time of the day, places in each province and characteristics of drivers (gender, age, family status, occupation, education, and monthly income). However, the sample for this survey was limited to the drivers with an age of 18 and above who normally drive five vehicle types including passenger cars, pickups, vans, buses, and trucks.

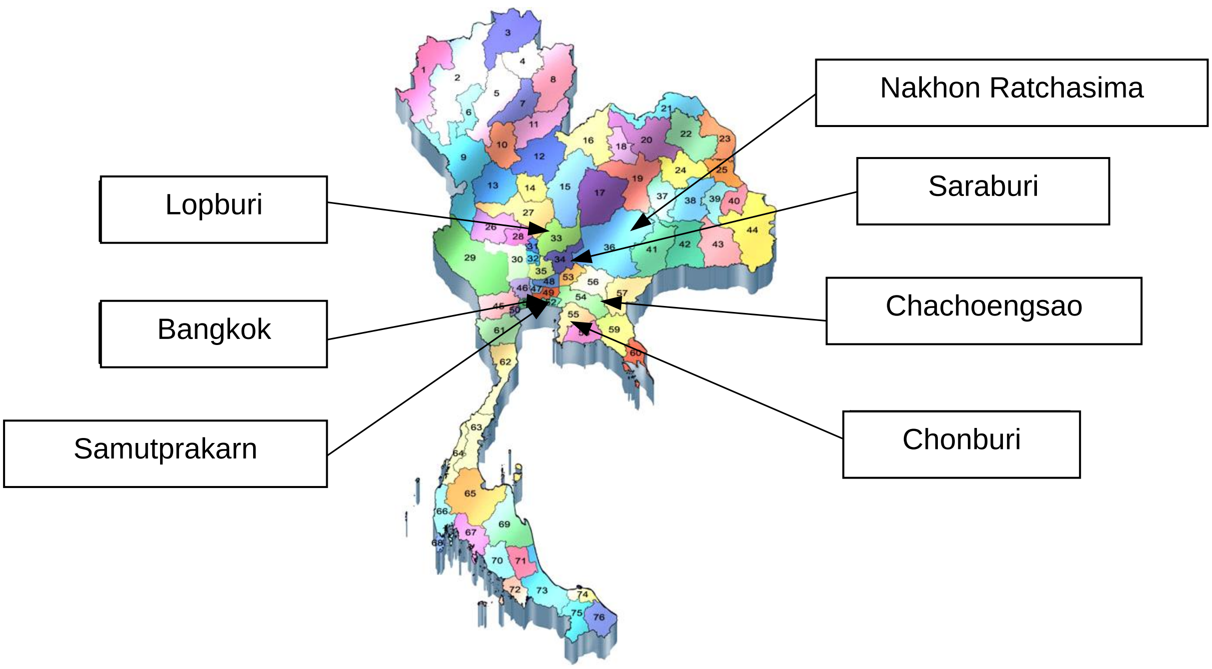

Figure 1 - Selected Study Areas

2.2 Questionnaire Survey

A questionnaire was designed in a simple and easy format for the respondents to understand. The questionnaire was divided to three parts. In the first part, the questions are related to the socio-economic characteristics, while the second parts are related to the vehicle use and driving characteristics of the drivers. The first two parts were designed based on the selected influencing factors of drivers' attitudes such as:

- Socio-economic characteristics: gender, age, family status, education, monthly income, occupation
- Vehicle use and driving characteristics: vehicle type, vehicle age, average maximum speed, average travel distance per day, average travel time per day, driving experience in years, traffic accident history

In the last part, a Likert's scale was used to obtain preference ratings which can quantitatively estimate the drivers' opinion. The rates obtained from the Likert's Scale were then analyzed by assigning a fix weight on each characteristic of response and then aggregate a total score for a specific group of respondents. The respondents were questioned to rate 17 different speed management strategies by using the four-point Likert's Scale, as shown in Figure 2.

Figure 2 - Four-Point Likert's Scale

In this part, the questions on speed management strategies were separated into two groups, Group 1 and Group 2. Group 1 is the selected speed management strategies that are feasible to be implemented on urban road in Thailand. The strategies in Group 1 were categorized into two sub-groups: speed information and engineering measures. Group 2 is the selected speed management strategies that are feasible to be implemented on interurban road in Thailand, and the strategies included in Group 2 were categorized into four sub-groups: speed information, engineering measures, installation of Intelligent Speed Adaptation (ISA), and speed enforcement. It should be noted that the speed enforcement strategies were not included for the urban road because the speed enforcement is not regularly implemented on the urban roads in Thailand. The strategies proposed in this study are some of the existing strategies that have been implemented in Thailand, and some of which have been proved as successfully implemented strategies in other countries. All selected strategies in Group 1 and Group 2 were listed in Table 1 and described in details as summarized in Table 2.

Table 1 - Speed Management Strategies in Group 1 and Group 2

Sub-Group	Group 1 (for Urban Road)		Group 2 (for Interurban Road)	
	No.	Strategies	No.	Strategies
1. Speed Information	U1A	Speed warning signs	I1A	Speed warning sign
	U1B	Speed limit signs	I1B	Speed limit sign
2. Engineering Measures	U2A	Roundabout	I2A	Roundabout
	U2B	Rumble strips	I2B	Rumble strips
	U2C	Speed humps		
3. Smart Vehicle Design			I3A	Intelligent speed adaptation (ISA) – advisory level
			I3B	Intelligent speed adaptation (ISA) – mandatory level
			I3C	Intelligent speed adaptation (ISA) – voluntary level
4. Speed Enforcement			I4A	Automatic speed camera
			I4B	Radar gun
			I4C	Stationary police vehicle
			I4D	Police checkpoint
			I4E	Punishment increase

Table 2 - Descriptions for Speed Management Strategies

No.	Strategies	Description
U1A and I1A	Speed warning sign	The installation of warning signs to notify and encourage drivers to slow down in advance and to warn drivers for potentially hazardous conditions or spatial situation ahead.
U1B and I1B	Speed limit signs	The installation of speed limit sign to show maximum speed permitted under ideal conditions and to inform motorists about speed limit imposed by government agencies.
U2A and I2A	Roundabout	The installation of roundabout to reduce the driving speed at the junction.
U2B and I2B	Rumble strips	The treatment of road surface on traffic lane at decreasing intervals which can create noise and vibration and increase sense of speed reduction.
U2C	Speed humps	The installation of traffic calming tool which is designed to slow down the traffic with vertical raised hump on road pavement surface.
I3A	ISA – Advisory level	ISA is the speed control technology system installed inside the vehicle in which the driver is warned and/or vehicle speed is automatically limited when the driver is intentionally or inadvertently, travelling over posted speed limit at a given location. ISA compare the current speed and position of vehicle with local posted speed limit and responds if vehicle exceeds the posted speed limit (Young and Regan, 2002). Advisory level – the driver is informed of the limit and of the violations only.
I3B	ISA – Mandatory level	Mandatory level – the system is linked to the vehicle controls to physically prevent driver going over the speed limit. For the mandatory purpose, driver cannot override the system.
I3C	ISA – Voluntary level	Voluntary level - the system is linked to the vehicle controls to physically prevent driver going over the speed limit, but the driver can choose to enable or override the system, so that compliance is voluntary.
I4A	Automatic speed camera	The installation of automatic speed camera which is operated by recording image (either videotape or photographic film) of vehicles passing by with exceeding speed over the predetermined trigger speed. Vehicle registration details are recorded from the photographic evidence, allowing the vehicle owner to be contacted.
I4B	Radar gun	The use of radar gun to detect vehicle speed by the police. The radar gun is currently used for the speed enforcement in Thailand.
I4C	Stationary police vehicle	The stationary police vehicle is a method used to create drivers' awareness of the police presence on the road.
I4D	Police checkpoint	The installation of police checkpoint is to reduce the number of traffic accidents by the deterrence of certain offenses such as driving exceed speed limit, driving under the alcohol influence or driving without driver license. It is also implemented to raise the level of public awareness and inform people the current enforcement by the police. This method is currently implemented in Thailand.
I4E	Punishment increase	The increase of fine and punishment for the violation of speed regulations.

The questionnaire survey was conducted from 2008 to 2009. A total of 2,180 people in the study areas were asked to complete the questionnaire. Table 3, Table 4, and Table 5 describe socio-economic characteristics, vehicle characteristics and driving characteristics of the respondents, respectively.

Table 3 - Socio-Economic Characteristics of Respondents

Socio-Economic Characteristics		Frequency	Percent
Gender	Female	273	12.52
	Male	1,907	87.48
	Total	2,180	100
Age	18-25	348	15.96
	26-35	818	37.52
	36-45	677	31.06
	46-55	269	12.34
	>55	68	3.12
	Total	2,180	100
Family Status	Single	707	32.43
	Married	1,384	63.49
	Others	89	4.08
	Total	2,180	100
Occupation	Soldier/Police	53	2.43
	Private Employee	384	17.61
	Government Officer	118	5.41
	State Enterprise Officer	86	3.94
	Student	139	6.38
	Private Business	220	10.09
	Driver	882	40.46
	Labor	244	11.19
	Others	54	2.48
	Total	2,180	100
Education	Primary school or lower	702	32.20
	High school	764	35.05
	Diploma	289	13.26
	Bachelor degree	291	13.35
	Master degree	60	2.75
	Doctoral degree	28	1.28
	Others	46	2.11
	Total	2,180	100
Monthly Income (Baht)	<= 5,000	290	13.30
	5,001-10,000	910	41.74
	10,001-15,000	567	26.01
	15,001-20,000	205	9.40
	20,001-30,000	135	6.19
	>30,000	73	3.35
	Total	2,180	100

Table 4 - Vehicle Characteristics of Respondents

Vehicle Characteristics		Frequency	Percent
Vehicle Type	Passenger Car	501	22.98
	Pickup	547	25.09
	Van	341	15.64
	Bus	450	20.64
	Truck	341	15.64
	Total	2,180	100
Age of Vehicle	< 2 years	392	17.98
	2-4 years	399	18.30
	4-6 years	358	16.42
	6-8 years	299	13.72
	8-10 years	276	12.66
	10-12 years	177	8.12
	12-14 years	100	4.59
	> 14 years	179	8.21
	Total	2,180	100
Vehicle Use	Work/meeting	558	25.60
	Personal trip/return home	459	21.06
	Carry passenger	767	35.18
	Transport cargo/goods	350	16.06
	Others	46	2.11
	Total	2,180	100

Table 5 - Driving Characteristics of Respondents

Driving Characteristics		Frequency	Percent
Ave.Max.Speed	< 80 km/h	524	24.04
	80-90 km/h	677	31.06
	90-100 km/h	391	17.94
	100-110 km/h	232	10.64
	110-120 km/h	237	10.87
	> 120 km/h	119	5.46
	Total	2,180	100
Ave.Travel Distance	< 10 km.	182	8.35
	10-25 km.	287	13.17
	26-50 km.	292	13.39
	51-100 km.	296	13.58
	101-200 km.	450	20.64
	> 200 km.	673	30.87
	Total	2,180	100
Ave.Travel Time	< 30 min.	151	6.93
	30-60 min.	354	16.24
	1-2 hr.	291	13.35
	2-4 hr.	283	12.98
	4-6 hr.	403	18.49
	> 6 hr.	698	32.02
	Total	2,180	100
Driving Experience (years)	< 1 years	129	5.92
	1-5 years	442	20.28
	5-10 years	410	18.81
	10-15 years	489	22.43
	15-30 years	581	26.65
	> 30 years	129	5.92
	Total	2,180	100
Accident History	None	1,307	59.95
	1 time	524	24.04
	2 times	242	11.10
	3 times or more	107	4.91
	Total	2,180	100

3. ANALYSIS OF FACTORS INFLUENCING ATTITUDE TOWARDS SPEEDING BEHAVIOR AND SPEED CHOICE OF DRIVERS

At the end of the questionnaire, the drivers were asked to express their attitude whether they agree or disagree with the following statement about speeding: "*Speeding behavior is one of the most significant influencing factors leading to the road crash*". Overall 79.26% of drivers strongly agree (16.42%) and agree (62.84%) with this statement. While those who oppose this statement are separated into disagree (16.79%) and strongly disagree (3.94%).

The ordered probit regression model was applied to analyze the significant factors influencing the drivers' attitude towards speeding behavior and to evaluate the key attributes influencing speeding behavior of drivers. The independent variables considered in the analysis include socio-economic characteristics of the respondents, such as gender, age, family status, occupation, education, income, vehicle use characteristics such as vehicle types, vehicle age, trip purpose, and driving characteristics such as average maximum speed, travel distance, travel time, driving experience, and accident history. However, the test of multicollinearity indicates the existence of strong correlation among the variables: driver, work/personal trip, carrying passenger, cargo transportation, bus, truck, travel distance, and travel time (i.e. all pair-wise correlation coefficients are higher than 0.6). Four variables are therefore excluded in the preferred model specification which are work/personal trip, carrying passenger, cargo transportation, and travel time. Table 6 shows the definitions of the independent variables remaining in the analysis.

Table 6 - Definitions of the independent variables

Variables	Definition
GENDER	Gender (1 if male, 0 otherwise)
AGE	Age (Continuous variable)
FAM	Family status (1 if single, 0 otherwise)
DRIVER	Occupation (1 if driver, 0 otherwise)
EDUCATE	Education (1 if college level, 0 otherwise)
INCOME	Income (1 if > 10,000 baht, 0 otherwise)
CAR	Car (1 if driving car, 0 otherwise)
PICKUP	Pickup (1 if driving pickup, 0 otherwise)
VAN	Van (1 if driving van, 0 otherwise)
BUS	Bus (1 if driving bus, 0 otherwise)
TRUCK	Truck (1 if driving truck, 0 otherwise)
VEHAGE	Vehicle age (1 if 0-6 years, 0 otherwise)
SPEED	Average maximum speed use (1 if > 90 km/h, 0 otherwise)
DIST	Average travel distance per day (1 if > 50 km, 0 otherwise)
EXPER	Driving experience (1 if > 10 years, 0 otherwise)
ACCIHIST	Accident history (1 if having accident at least 1 or more, 0 otherwise)

Model 1 was used to evaluate the significant factors influencing drivers' attitude towards speeding behavior. The dependent variable in Model 1 is the attitude towards speeding behavior about the statement of "*Speeding behavior is one of the most significant influencing factors leading to the road crash*", with four orders: strongly agree, agree, disagree, and strongly disagree. The regression analysis results of Model 1 were presented in Table 7. It is evident from the model that the significant factors influencing attitude towards speeding behavior are gender, family status, occupation, education, vehicle type used, vehicle age, travel distance, and driving experience. The coefficients of these variables are statistically significant at 1-5% level; however, the signs are varied depending on the effect of each variable. Male drivers are more likely to disagree that speeding behavior is one of the most significant influencing factors leading to the road crash. The results are similar to the answers obtained from the groups of driver with single status, professional drivers, highly educated drivers, drivers who normally use newer vehicle, and drivers with longer driving experience. In contrast, drivers who normally use cars, pickups, buses, and trucks tend to agree with the questioned statement about speeding behavior.

Table 7 - Results of regression analysis on attitude towards speeding behavior and factors influencing speeding

	Model 1: Attitude			**Model 2: Speeding Behavior**		
Variables	**Coefficient**	**Z-test**		**Coefficient**	**Z-test**	
AGE	0.004	1.27		-0.012	-4.02	***
GENDER	-0.327	-4.00	***	0.196	2.57	***
FAM	-0.144	-2.33	**	0.115	1.97	**
DRIVER	-0.232	-2.92	***	0.318	4.11	***
EDUCATE	-0.251	-3.85	***	0.184	3.00	***
INCOME	0.012	0.23		0.211	4.11	***
CAR	0.299	2.73	***	0.211	2.03	**
PICKUP	0.247	2.44	**	-0.031	-0.33	
BUS	0.373	4.50	***	-0.552	-7.04	***
TRUCK	0.538	5.99	***	-1.226	-13.84	***
VEHAGE	-0.127	-2.51	**	0.305	6.33	***
DIST	-0.185	-2.84	***	0.474	7.59	***
EXPER	-0.124	-2.01	**	0.238	4.03	***
ACCIHIST	-0.061	-1.22		0.071	1.49	
ATTITUDE				-0.415	-11.98	***
Log likelihood	**-2136.66**			**-3223.60**		
No.of observations	**2180**			**2180**		

Note: *** indicates significance at the 1% level.
** indicates significance at the 5% level.

In Model 2, the significant factors influencing speed choice of drivers were analyzed. The dependent variable is the average maximum speed, with six orders defined as the average maximum speed of less than 80 km/h, 81-90 km/h, 91-100 km/h, 101-110 km/h, 111-120 km/h, and above 120 km/h. In this model, the attitude towards speeding behavior which is the dependent variable in Model 1 was also included in the analysis as another independent variable. This is to evaluate how the drivers' attitudes influencing their speeding behavior. Table 7 also presents regression results of Model 2. On the basis of the model results, contributing factors to the drivers' speeding behavior include age, gender, family status, occupation, education, income, vehicle type used, vehicle age, travel distance, driving experience, and attitude towards speeding behavior. The result of the ordered probit model shows that all these factors were significant at 1-5% significance level.

As one would expect, younger drivers tend to drive faster than older drivers. Male drivers are more likely to drive faster than female drivers. Drivers with single status have a tendency of driving faster than drivers who have family. Professional drivers are more likely to drive faster than other occupations. This might be a reason that most of the professional drivers have a schedule of dropping passengers or transporting goods, and probably have time constraints to reach the destination on time. The groups of drivers with higher education or higher income tend to drive faster. Car drivers are more likely to drive faster, while bus and truck drivers were found to drive slower. The results can be explained due to the fact that the speed limit of buses and trucks is normally lower than the speed limit of cars and other 4-wheel vehicles in both urban and interurban areas; therefore, the finding is somewhat expected. It is interesting to see that drivers who drive new vehicle with age below 6 years tend to driver faster, probably because of the high performance of new vehicle. Drivers who drive longer trip per day tend to use higher speed than those who drive in short trip per day. Drivers with longer driving experience are more likely to drive faster, and this might be a result of their self-confidence or perception of driving at high speed without any danger. Lastly, drivers who disagree that speeding behavior is one of the most significant influencing factors leading to the road crash are more likely to drive faster than those who express their opinion concerning the impact of speeding behavior to the road crash. The results obtained from Model 1 and Model 2 are similar in the sense that drivers who express their negative attitude towards the speeding behavior and agree that speeding behavior is one of the main causes of road crash, tend to use lower speed, while those who express their attitude in another direction tend to use higher speed. Therefore, it is clearly seen from the finding that the drivers' attitude is one of the significant factors influencing the speeding behavior of drivers.

4. ANALYSIS OF DRIVERS' ATTITUDE TOWARDS SPEED MANAGEMENT STRATEGIES

4.1 Descriptive analysis

A total of 17 speed management strategies were rated based on the drivers' opinion. These strategies are separated into two groups (Group 1 and Group 2) including the speed management strategies that are feasible to be implemented on urban and interurban roads. The results from the descriptive analysis of drivers' attitude towards the speed management strategies on urban road are presented in Figure 3, and those on interurban road are presented in Figure 4.

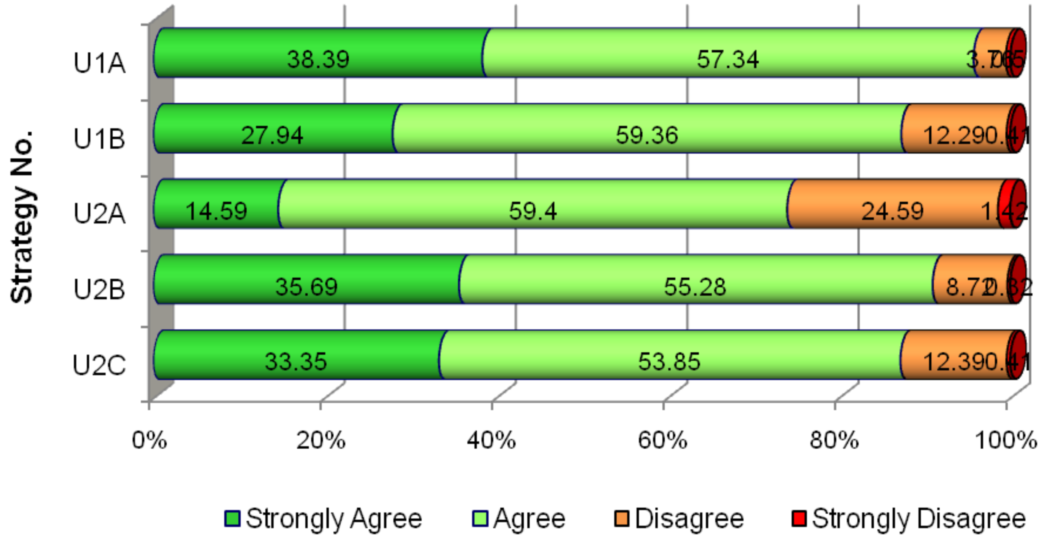

Figure 3 - Drivers' Attitude towards Speed Management Strategies on Urban Roads

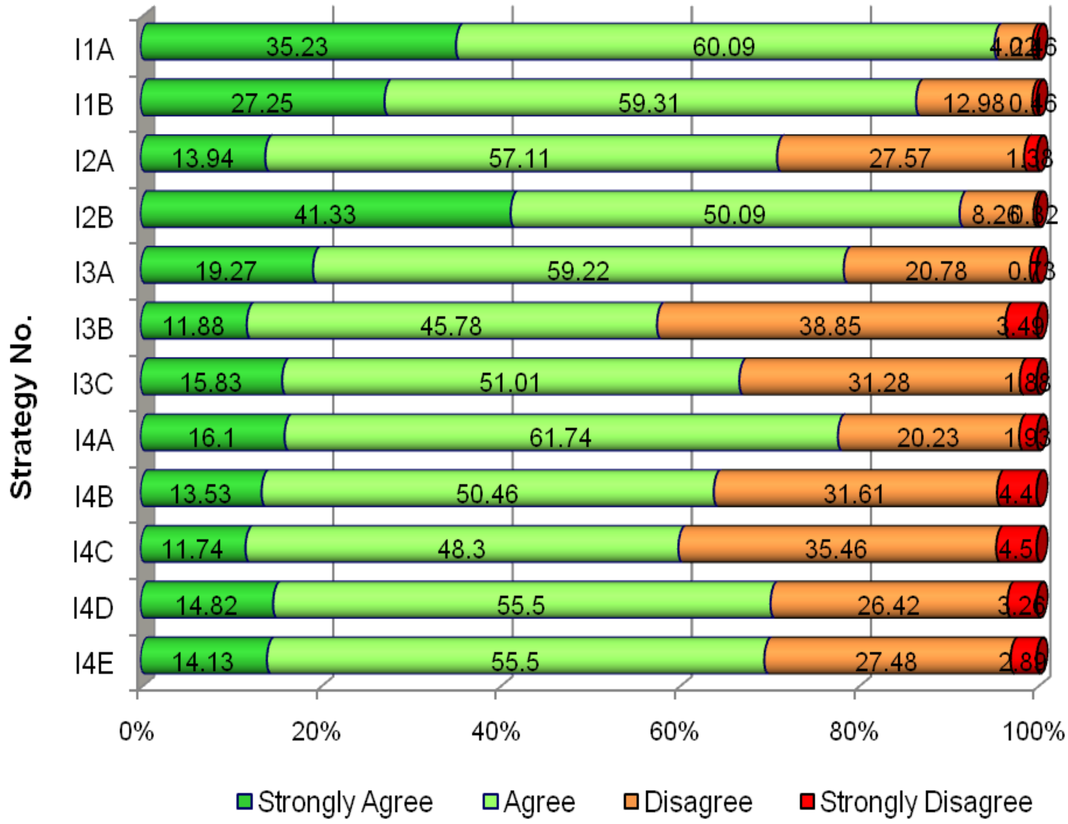

Figure 4 - Drivers' Attitude towards Speed Management Strategies on Interurban Roads

For urban road, it is found that 87-96% of the respondents agree with the installation of speed warning signs (U1A), speed limit signs (U1B), rumble strips (U2B), and speed humps (U2C). Less people give their support to the installation of roundabout as can be seen that 74% of the respondents agree with this strategy.

For interurban road, the speed information strategies (I1A and I1B) are well supported by most drivers and more preferable to most drivers when comparing to other strategies such as engineering measures, ISA, and speed enforcement. Among the engineering measures strategies, the installation of rumble strips (I2B) is the most favorable option in the view of drivers' opinion. The installation of ISA and the speed enforcement are less supported by most drivers, especially for the installation of ISA-Mandatory level (I3B) and the use of stationary police vehicle (I4C) with only 60% supported by the drivers. It is evident that most respondents prefer the strategies that they can reduce speed voluntarily such as speed information and the installation of rumble strips, but do not prefer the strategies that forcing them to reduce their driving speed by using either the technology or the legal punishment, such as the installation of ISA or the speed enforcement.

4.2 Preferential Ranking of Speed Management Strategies

The preference responses of the respondents are analyzed to evaluate drivers' attitude towards the possible speed management strategies in the quantitative measures. The rates obtained from the Likert's Scale are analyzed by assigning a fixed weight on each response and summing individual scores to determine the total score. The total scores are used to represent the level of preference responses of the respondents. In this study, it is assumed that the weights associated with the responses are equivalent to the values of 2, 1, -1 and -2 which are assigned to strongly support, support, disagree and strongly disagree respectively. Thus, the higher the total score, the higher the preference that the driver gave to the speed management strategies. Response ratings are summarized in Table 8.

Table 8 - Preferential Rankings of Speed Management Strategies

a) Urban Roads

Strategies	Speed Information		Engineering Measures		
	U1A	**U1B**	**U2A**	**U2B**	**U2C**
Average Score	1.294	1.021	0.611	1.173	1.073
	1.158		0.952		

b) Interurban Roads

Strategies	Speed Information		Engineering Measures		ISA			Speed Enforcement				
	I1A	**I1B**	**I2A**	**I2B**	**I3A**	**I3B**	**I3C**	**I4A**	**I4B**	**I4C**	**I4D**	**I4E**
Average Score	1.254	0.999	0.547	1.239	0.755	0.237	0.476	0.699	0.371	0.273	0.522	0.505
	1.127		0.893		0.489			0.474				

Given the speed management strategies on urban road, the results obtained from the survey indicate that the installation of speed warning sign is the most desirable strategy to reduce the speed on urban area. The installation of rumble strips is found to be the second most popular strategy based on the drivers' responses.

Similarly, for the speed management strategies on interurban road, the survey indicates that the installation of speed warning sign is the most popular strategy, followed by the installation of rumble strips. One of the engineering measure strategies which is the installation of roundabout, the ISA, and the speed enforcement are rated with lower scores (0.237 to 0.7) on the Likert's scale. The advisory level is rated with the highest score among the ISA strategies, and the use of automatic speed camera is the most popular strategy when comparing to other speed enforcement strategies.

The results strongly suggest that the speed enforcement strategies were not supported from drivers, as one would expect. The percentages of drivers who were against the speed enforcement are practically higher, compared to the speed information and engineering measures which are not associated with legal punishment. Focusing on the current practice of speed enforcement which are the use of radar gun and police checkpoint, it was found that speed detection by radar gun did not receive much support from most drivers. Moreover, the stationary police vehicle was the least desirable method to the drivers among the strategies in speed enforcement group. The drivers show different opinions among three levels of intelligent speed adaptation (ISA) installed in vehicles. The advisory system is more likely to be supported due to the flexibility for drivers to speed up in some situations, while the mandatory system is strongly against by the drivers.

4.3 Factors Affecting Drivers' Attitude towards Speed Management Strategies

To evaluate the significant factors affecting the preference rate of speed management strategies, the ordered probit regression technique has been applied in this study. Given the drivers' opinion on Likert's scale, an observed rating for speed management strategies is an indicator of the utility distribution. The data obtained from the survey are analyzed using ordered probit models so as to determine the factors that influence the choice process of individuals in the context of speed management strategies. The dependent variable in this regression model is the response rated from the Likerts scale, with four orders defined as -2 for 'strongly disagree', -1 for 'disagree', 1 for 'support' and 2 for 'strongly support'. The independent variables used in the analysis were previously described in Table 6.

Table 9 and Table 10 present estimation results from the ordered probit models. The relative magnitude of estimated coefficients indicates the extent to which socio-economic, vehicle use, and driving characteristics affect individual preferences to speed management strategies on urban and interurban roads in Thailand.

Table 9 - Coefficients of Ordered Probit Model for Speed Management Strategies on Urban Roads

Variables	Signs		Engineering Measures		
	U1A	**U1B**	**U2A**	**U2B**	**U2C**
	Speed warning sign	**Speed limit sign**	**Roundabout**	**Rumble strips**	**Speed bumps**
AGE	**-0.011** ***	0.002	-0.003	**-0.021** ***	-0.002
GENDER	**-0.172** **	**-0.164** **	-0.018	**-0.220** ***	-0.051
FAM	**-0.110** *	**0.119** *	-0.072	-0.081	**0.153** **
DRIVER	0.106	-0.007	**-0.148** *	**0.443** ***	-0.0003
EDUCATE	-0.010	0.094	0.069	**0.149** **	**0.173** ***
INCOME	0.030	0.025	**-0.111** **	**-0.213** ***	-0.015
CAR	**0.365** ***	-0.089	-0.149	**0.476** ***	0.037
PICKUP	**0.270** **	0.124	-0.032	**0.533** ***	**0.200** **
BUS	0.067	**-0.227** ***	**-0.307** ***	**0.172** **	**-0.337** ***
TRUCK	**0.213** **	**-0.205** **	**-0.231** **	**0.433** ***	**-0.230** **
VEHAGE	**-0.094** *	0.035	-0.021	0.046	-0.060
SPEED	**-0.143** **	**-0.280** ***	-0.051	**0.238** ***	**-0.265** ***
DIST	-0.093	-0.003	-0.031	0.079	0.054
EXPER	0.052	-0.079	-0.068	**0.243** ***	0.043
ACCIHIST	-0.005	-0.061	-0.052	-0.009	-0.009
Log likelihood	-1792.26	-2014.94	-2139.11	-1929.93	-2079.69
No. of Observation	2180	2180	2180	2180	2180

Note: *** indicates significance at the 1% level. ** indicates significance at the 5% level.
* indicates significance at the 10% level.

Table 10 - Coefficients of Ordered Probit Model for Speed Management Strategies on Interurban Roads

Variables	Signs		Engineering Measures		ISA			Enforcement				
	I1A	**I1B**	**I2A**	**I2B**	**I3A**	**I3B**	**I3C**	**I4A**	**I4B**	**I4C**	**I4D**	**I4E**
	Speed warning sign	**Speed limit sign**	**Roundabout**	**Rumble strips**	**ISA-Advisory**	**ISA-Mandatory**	**ISA-Voluntary**	**Automatic Speed camera**	**Radar gun**	**Stationary police vehicle**	**Police checkpoint**	**Punishment increase**
AGE	**-0.015** ***	**0.002** *	**-0.008** **	**-0.025** ***	0.002	0.004	0.004	0.0008	**-0.008** ***	-0.0003	0.005 *	**0.006** *
GENDER	**-0.121** **	-0.158	0.036	**-0.048** ***	**-0.206** **	**-0.141** *	-0.043	**-0.204** **	**-0.260** ***	**-0.182** **	-0.181 **	**-0.258** ***
FAM	**-0.127** *	0.103	-0.053	**-0.181** ***	-0.049	-0.021	-0.044	-0.078	-0.090	-0.033	-0.065	**-0.132** **
DRIVER	0.052	-0.054	**-0.329** ***	**0.312** ***	**-0.154** **	**-0.208** ***	**-0.168** **	0.029	**-0.206** ***	**-0.347** ***	-0.043	-0.114
EDUCATE	-0.059	0.062	0.021	**0.196** ***	-0.073	**0.109** *	**0.111** *	**0.017**	**0.156** **	**0.114** *	**0.107** *	**0.123** *
INCOME	0.046	0.029	-0.002	**-0.187** ***	-0.039	-0.059	0.013	**0.096** *	0.018	-0.023	**0.105** **	**0.101** *
CAR	**0.400** ***	0.004	**-0.220** **	**0.419** ***	-0.104	**-0.360** ***	**-0.275** ***	**0.348** ***	-0.065	-0.070	0.085	0.045
PICKUP	**0.240** **	0.126	-0.122	**0.386** ***	**-0.204** **	**-0.203** **	**-0.163** *	**0.249** **	-0.126	-0.083	0.104	0.050
BUS	0.138	**-0.206** **	**-0.260** ***	**0.258** ***	**-0.219** ***	-0.090	-0.133	0.017	-0.031	0.018	0.025	0.026
TRUCK	**0.250** ***	**-0.185** **	-0.125	**0.246** ***	-0.135	-0.103	-0.147	0.060	-0.074	-0.117	0.057	-0.034
VEHAGE	-0.079	0.069	-0.043	-0.031	-0.054	0.038	0.055	-0.055	-0.027	-0.056	-0.006	-0.058
SPEED	**-0.109** *	**-0.264** ***	**-0.172** ***	0.083	**-0.113** **	0.010	-0.053	**-0.254** ***	**-0.186** ***	**-0.161** ***	**-0.320** ***	**-0.294** ***
DIST	**-0.180** ***	-0.036	-0.034	**0.129** *	-0.096	-0.079	0.011	0.020	-0.038	0.042	0.001	0.013
EXPER	**0.156** **	-0.006	0.022	**0.281** ***	**0.110** *	0.010	-0.061	**0.158** ***	**0.204** ***	0.061	0.076	0.035
ACCIHIST	-0.014	-0.045	-0.043	0.036	0.050	0.064	0.008	0.002	0.030	-0.013	-0.012	-0.038
Log likelihood	-1777.35	- 2031.75	-2159.77	-1967.41	-2139.29	-2374.10	-2328.67	-2124.62	- 2402.02	-2386.86	-2299.07	-2264.62
No. of Observation	2180	2180	2180	2180	2180	2180	2180	2180	2180	2180	2180	2180

Note: *** indicates significance at the 1% level.
** indicates significance at the 5% level.
* indicates significance at the 10% level.

4.3.1 Results for Speed Management Strategies on Urban Roads

Speed Information

Male drivers show less support on both strategies in providing speed information signs. Younger drivers are more likely to support the installation of speed warning signs. Car, pickup, and truck drivers show a strong positive attitude towards the installation of speed warning signs, while the bus and truck drivers express a negative attitude towards the installation of speed limit signs. Respondents who normally drive with average maximum speed higher than 90 km/h do not support both of the speed information strategies.

Engineering Measures

High income respondents and those driving buses and trucks do not give their support to the installation of roundabout. This could be the fact that larger size of vehicle may need extra space to complete their turn within a roundabout, and the vehicle turning movement may be more difficult for the drivers to control their vehicles moving inside the roundabouts. It is therefore necessary to design roundabouts with a truck apron which is a raised section of pavement around the central island that acts as an extra lane for large vehicles. The back wheels of the oversize vehicle can ride up on the truck apron so the truck can easily complete the turn.

Male and older drivers express their negative attitude towards the installation of rumble strips, while highly educated and professional drivers indicate a strong support for this strategy. Surprisingly, higher income respondents were found to disapprove the use of rumble strips. The drivers of all vehicle types and those who normally drive with average maximum speed higher than 90 km/h are favorable to the use of rumble strips as the engineering measure for speed control. Drivers with longer driving experience also strongly support this strategy.

Single and highly educated drivers support the idea of speed hump installation on the roads in urban area. Pickup drivers are supportive of the speed hump, while bus and truck drivers dislike using the speed hump for speed control in urban area. Respondents who normally drive with average maximum speed higher than 90 km/h express negative attitude towards the strategy of speed hump installation.

Discussion

Several groups of drivers seem to differently express their attitude towards each speed management strategy for the roads in urban area. The ordered probit model estimation reveals that highly educated drivers are supportive to the engineering measure strategy including the installation of rumble strips and speed humps. However, there is the presence of disagreement among the higher income group of drivers expressing their opinion against the engineering measures of roundabout and rumble strips installation. The installation of rumble strips and speed warning signs are found to be favorable to the drivers of most vehicle types, but the installation of speed limit sign, roundabout, and speed humps are disliked by larger vehicles such as bus and truck. The drivers who normally drive faster tend to dislike all speed management strategies proposed for the urban road in this study, except for the rumble strips. It is well known that the installation of rumble strips is to create the noise or vibration within the car and to give warning to drivers for reducing speed. However, there are some questions concerning whether any appreciable reduction in vehicle speeds has been achieved and whether the rumble strips are appropriate to be installed in urban areas as they could generate too much noise and disturb nearby residential areas.

4.3.2 Results for Speed Management Strategies on Interurban Roads

Speed Information

The results analyzed from the ordered probit model of speed management strategies for interurban roads are similar to those obtained from urban road model. Male and older drivers have less support on the installation of speed warning. Car, pickup, and truck drivers strongly support the installation of speed warning signs, while the bus and truck drivers express a negative attitude towards the installation of speed limit signs. Respondents who normally drive with average maximum speed higher than 90 km/h do not support the installation of speed limit signs. Drivers who travel longer distance strongly oppose the strategy of installing speed warning signs, while those who have longer driving experiences support this strategy.

Engineering Measures

For the highway outside urban areas, the results are different from the highway inside the urban areas. Older drivers express negative attitude towards both engineering measures including the installation of roundabout and rumble strips. Single drivers show less support on the use of rumble strips. Professional drivers are less supportive of the roundabout, but strongly support the rumble strips. The rumble strips are also strongly supported by the highly educated driver, but not by the high income drivers. Car and bus drivers dislike the roundabouts, while the drivers who use all types of vehicle are in a favor of installing the rumble strips. Respondents who normally drive with average maximum speed higher than 90 km/h do not strongly support the use of roundabouts to control speed. Drivers with longer driving experiences are found to support the rumble strips. In general, among the proposed engineering measures for interurban roads, the rumble strips seem to be more favorable option when comparing to the roundabout. This might be the result of the drivers' familiarity of the measures since the rumble strips are commonly installed on many streets and highways in Thailand, whereas the roundabout has not been widely implemented.

Intelligent Speed Adaptation (ISA)

For the strategy of installing three levels of ISA inside the vehicle, the results show that most drivers express negative attitudes toward them. Professional drivers do not support any of ISA levels. Car drivers dislike the ISA with mandatory and/or voluntary levels. Pickup drivers strongly opposed to all ISA levels. Bus drivers give the opinion against the advisory level. The drivers who normally use average maximum speed higher than 90 km/h do not strongly support the use of ISA-advisory level.

Speed Enforcement

Older drivers give a negative opinion on the use of radar gun for speed detection. Male drivers seem to strongly oppose all speed enforcement strategies. Single drivers dislike the increase of punishment level. Professional drivers do not support the use of radar gun and stationary police vehicle for speed enforcement. Highly educated drivers support the use of radar gun, while higher income drivers have less support on the idea of the police checkpoint setup. Car and pickup drivers like the idea of installing the automatic speed camera. It is obvious that drivers who normally use higher speed strongly disapprove all speed enforcement strategies. Longer experience drivers tend to support the use of automatic speed camera and radar gun for speed enforcement.

Discussion

A review of the results of the speed management strategies on interurban roads made quite apparent that many factors are associated with the attitudes towards each strategy. It became clear that certain variables such as male, professional drivers, highly educated drivers, different types of vehicle drivers, high speed drivers, drivers with longer driving experience give different attitudes towards the strategies.

Male drivers express their strong negative attitude towards all speed enforcement strategies. As can be seen from the previous analysis that male drivers tend to drive with avergage maximum speed higher than 90 km/hr which is the speed exceeding the current speed limit on interurban roads in Thailand, it is therefore not surprising to find that they do not support the speed enforcement strategies. Even though the highly educated drivers are more likely to drive using higher speed, they are supportive of most of the speed management strategies. Professional drivers dislike the ISA and the speed enforcement by using radar gun and stationary police vehicle. Car and pickup drivers who normally use higher speed give the opinion against the ISA installation, but they are in a favor of the use of speed camera. Bus and truck drivers who normally use lower speed do not support the roundabout with the possible reason that the roundabout could be more difficult for the turning movement of larger vehicles. Obviously, the drivers who often use higher speed above 90 km/h tend to be strongly against most of the strategies used to reduce the speed, especially for the speed enforcement strategies. Inevitably, this raises another concern about speed and safety of this group of drivers. Similar to the results from urban roads, the installation of rumble strips seems to be only strategy that is accepted by most groups of the drivers.

5. SUMMARY

This paper attempts to examine drivers' attitude and their acceptability of the speed management strategies on both urban and interurban areas aimed at the speed control for highways in Thailand. The methodology used in this study also provides the approach to quantify the relative preferences of different groups of drivers and their attitude towards any policy decision, which could facilitate the decision making process in selecting appropriate strategies for predetermined target groups.

Several groups of drivers seem to give their support to implementation of speed management strategies. However, there is the presence of disagreement among specific groups of people expressing their opinion against some strategies which need to be taken into account in policy formulation and implementation. The ordered probit model estimation reveals that highly educated drivers are supportive to the engineering measures for the speed control on both urban and interurban roads, except the roundabout use. They are found to be favorable to the current method of speed enforcement which is the use of radar gun to detect the speed. Professional drivers are against all ideas of speed management strategies except the installation of rumble strips. This reflects driver attitudes towards the favor of rumble strips. The results also reveal that the drivers who normally use speed higher than 90 km/h do not support all speed management strategies. Drivers with longer experience are supportive of the installation of speed warning signs, rumble strips, the automatic speed camera, and the radar gun.

Overall, the results suggest that the speed enforcement strategies were not strongly supported from most drivers, as one would expect. The majority of drivers tend to be against the speed enforcement campaign, compared to speed information and engineering measures which are not associated with legal punishment. Focusing on the current practice of speed enforcement, it was found that speed detection by radar gun did not receive much support from those who drive with average maximum speed higher than 90 kph. The public opinion was also undesirable with the police checkpoint in all cases expect for high income drivers. Again, motorists who often drive over the limit tend to be more strongly against the idea of blocking roadways to slow down the traffic. To some extent, it could increase the prevalence of speeding after passing the checkpoint as some drivers may respond to compensate their losing time.

The results show that the installation of rumble strips were mostly supported by the drivers, although it is still in question whether the rumble strips can be effectively used to reduce the speed. Some studies indicate that the drivers perceive the noise and vibration effect from the rumble strips to be reduced at faster speeds and accelerate accordingly. The installation of ISA seems to be strongly opposed by most drivers. To promote this strategy, the responsible agencies need to concern about the acceptability of public in using the technology for the speed control.

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