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Education influence in traffic safety: A case study in Vietnam

Khuat Viet Hung *, Le Thu Huyen

University of Transport and Communication, Hanoi, Vietnam

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ABSTRACT

It is well known that traffic accidents are of high importance to the public health spectrum around the world. Moreover, in developing countries such as Vietnam, the mortality rate from road traffic accidents is rather high in comparison with other Southeast Asian countries. Not only do the majority of the people killed and seriously injured significantly affect the quality of life of the citizens, but traffic accidents also negatively impact a nation's economic and social development. Statistics show that far more people are injured or die in traffic accidents than are afflicted by any of the most serious diseases. The very high occurrence of traffic accidents in Vietnam has become one of the country's major social issues. The importance of human factors in transport policy discussion is growing. There is a realization that policy options that appear beneficial in principle have to be checked for their feasibility of implementation. Understanding and describing driver behavior become a challenge when one tries to identify driver errors in determining accident/conflict causal factors and countermeasures.

In recent years, having understood the serious effects of traffic accidents on society at large, scientific researchers, traffic engineers and policy makers in Vietnam have developed many projects and conducted research in the field of traffic safety. The human factor is also considered to be the central element in the whole system. The final goal is to organize a traffic environment that is convenient and safe for road users. This article explains the application of the risk analysis approach in evaluating influences of education and enforcement in traffic safety.

1. General overview on traffic safety in Vietnam

There is a distinguishing characteristic between traffic flow in Vietnam (and in many other Asian countries) and those in developed countries: two-wheeled vehicles (so-called motorcycles) comprise a high percentage of the road traffic system.

Motorcycle-dominated (MD) traffic flow is very much different from car traffic flow due to the motorcycles' distinguishing characteristics (which can be summarized as flexibility and maneuverability). Therefore, there appears the need to evaluate and verify such findings and measures concluded from car traffic flow before applying them to MD traffic flow.

Statistical data proves that most road traffic accidents in MD traffic flow countries are caused by motorcycles. Motorcyclists are also classified as vulnerable users (along with pedestrians and bicyclists) because safety equipment for motorcyclists is not as adequate as equipment for car drivers.

The situation of road traffic accidents in Vietnam is nowadays in an emergency situation. Since 1992, road traffic accidents have rapidly increased until 2002, the peak year of traffic accidents. The number of accidents, fatalities and injuries has reached 27,134, 12,800 and 30,999, respectively. During this ten-year period, the number of fatalities in particular has increased 2.1-fold. From 2003, the number of accidents and injuries has dramatically decreased, but the number of fatalities is still critically high, numbering more than 11,000 persons per year. In comparison with other countries in the area, Vietnam has almost the worst record of traffic accidents (JBIC, Project SAPFOR for Traffic Safety Improvement in Vietnam, 2008). It is of particular note that the number of fatalities may not be completely reported. There is also no regulation in Vietnam for labeling the cause of death as death by traffic accident when patients die several days after an accident.

Fig. 1 shows the annual number of road traffic accidents, fatalities and injuries from 1992 to 2006. In 2006, there were 14,727 road traffic accidents which resulted to 12,757 fatalities and 11,288 injuries. Road traffic accidents increased rapidly from 1990 to 2002, the peak year of traffic accidents, with an annual increase rate of 13.5%. During this 12-year period, the number of fatalities has particularly increased 5.8 times. The number of accidents, fatalities and injuries totals to 27,993, 13,186 and 30,999, respectively. However, the number of traffic accidents and injuries dramatically fell after 2003, although the number of fatalities remained high and relatively constant, around 12,000 per year.

There may be a systematic bias in the reporting of data on road traffic accidents since Vietnam's 0.87 fatalities per accident (2006) is extremely high compared with its neighboring countries, with only

* Corresponding author.
E-mail address: kviethung@yahoo.com (K. Viet Hung).

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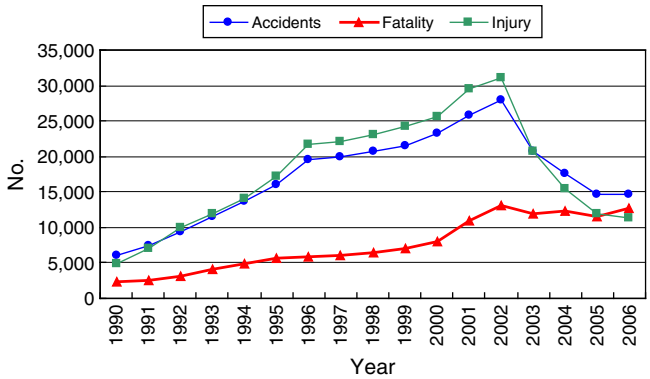

Fig. 1. Road Traffic Accidents in Vietnam (1990–2006).
Source: National Traffic Safety Committee (NTSC).

0.17 in Thailand and 0.02 in Malaysia (2000). Fairly constant fatalities from 2002 to 2006, in contrast to rapidly declining accidents and injuries in the same period, also point to statistical inconsistency. Significant under-reporting of accidents and injuries are suspected, relative to the number of fatalities, which should be more reliable.

Table 1 shows the composition of traffic accidents by cause from 2002 to 2006. Most road traffic accidents in Vietnam are caused by road users' errors, among which speeding is the primary cause, accounting for 25%. Road infrastructure, especially national highways, has improved significantly in the last decade, but drivers' mindsets have not changed accordingly. As a result, road users tend to speed up on highways with relatively little traffic. Unsafe overtaking by trucks, buses and passenger cars expose low-speed vehicles, such as motorcycles and bicycles, to great risk in a mixed traffic situation. Under these circumstances, strict enforcement of traffic rules and effective traffic education of road users are crucial in reducing traffic accidents. In addition, physical measures such as improvement of surface conditions, paving of shoulders, re-designing of roads, and installation of traffic signs and signals are also necessary.

However, so far, research on unsafe behaviors in Vietnam just stops at using statistical data from analyzing police accident reports, though the original documents are normally very difficult to access due to security and legislation issues. Moreover, analysis results from accident reports depend very much on subjective and qualitative evaluations, forcing traffic engineering experts to use only secondary data.

There may be several reasons leading to a traffic accident. Inadequate infrastructure network is now considered to be one of the biggest reasons for traffic accidents. However, the problem is to find out whether it is worth investing in constructing and/or upgrading road networks. Sometimes, newly-built roads allow drivers to reach very high speeds, resulting in more serious traffic accidents. Almost other related elements in the whole road traffic system (such as public transport, vehicle quality, traffic management and operation) are facing such inappropriate problems with the significant increase in demand for mobility. The current unbalanced state of the traffic system can be seen in the amount of traffic congestion and serious accidents. At the moment, road users in Vietnam are also not qualified enough to adapt to the current situation of modern and advanced developments in the road traffic system.

Traditional methodologies mostly focus on single effects of causal parameters of unsafe traffic situations. For example, in most of statistical reports on traffic safety in Vietnam, it is written "Speeding behavior has the highest percentage in all causes of traffic conflicts and/or accidents." However, in most cases traffic accidents are not the result of just a single reason. If a driver drives at a very high speed, but he concentrates very much on his task of driving, and if there is no unexpected obstacle (a crossing vehicle, road sliding surface, etc.), then the probability of a traffic conflict or accident is rather low (may be equal to zero). Analyzing the impacts different parameters have on traffic safety as well as their interacting effects can be clarified only by the modular structural approach of risk-based methodologies.

Table 1
Traffic accidents by cause (2002–2006).
Source: Road and Rail Transport Division, MOPS.

Causes	Proportion (%)				
	2002	2003	2004	2005	2006
1. Speeding	24.4	24.1	26.0	25.8	24.8
2. Unsafe overtaking	18.9	16.8	15.8	12.7	13.7
3. Unsafe lane shifting	17.0	17.6	16.5	16.7	18.0
4. Turning without turn signal	4.1	3.4	2.4	1.6	1.7
5. Crossing intersection on red signal	1.1	0.1	1.7	0.6	0.2
6. Not keeping safe distance	6.9	0.9	2.4	1.8	0.4
7. Careless driving	15.9	12.1	8.1	10.0	8.2
8. Careless crossing of pedestrians	0.7	2.3	2.9	3.2	2.6
9. Others	11.0	22.7	24.2	27.6	30.4

2. Behaviors of violating traffic regulations

Causes of road traffic accidents include a high increase of registered vehicles, irrelevant infrastructure (as the mobility demand increases at a rapid pace), dangerous mixed traffic flow, traffic safety education and training without expected results, and irregular enforcement. It is reported that many serious accidents are caused by mixed traffic flow (with participants of different types of vehicles of varying sizes), in which drivers drive in the wrong lane, causing delays in average traffic flow speed as well as reducing road traffic capacity. Among those factors, driver behavior is reported to be the main cause of traffic accidents. Road user error includes speeding, unsafe overtaking, drunk driving, poor road observation, and misuse of lanes and pedestrian behavior.

The National Traffic Safety Committee has estimated an annual average of 11,909 fatalities due to road traffic accidents in Vietnam which is equivalent to 33 deaths every day. Human error is deemed to be the major contributing factor to road traffic accidents. Recent statistical records from the police and NTSC indicating personal injury accidents (an accident that occurred with no involvement of a second or third party) have been significantly increasing as well as the number of traffic violations. Reports from the conclude that the major cause leading to traffic accidents is the fact that traffic participants disobey traffic rules and regulations especially in respect to traffic safety and operation management. The number of accidents due to technical safety of vehicles is under 1%, while those due to infrastructure is approximately 1.8%. Unsafe behavior of traffic participants causes nearly 97%, whereas 73% are from motorcyclists. Automobile drivers cause 24% of accident cases, but most are particularly serious (from interprovincial buses, container trucks, etc.).

Interestingly, while the number of violators has gradually decreased in urban cities (e.g., the majority of motorcycle riders in Hanoi now wear helmets after enforcement of the helmet law took effect on December 15, 2007), the number of violators in suburban and remote or mountainous areas has increased. This therefore only proves that law enforcement is the key element in controlling traffic violation. But at the same time, traffic safety education plays an essential role in the enhancement of traffic safety measures.

Based on analyzing the current situation and collecting experts' opinions (as mentioned above), a survey on driver attitudes towards legislation was conducted in Vietnam in September, 2008, in order to determine the causes of such traffic rule violations. The survey brings to light two attitudes: that of imitation, and the tendency to avoid congestions.

(i) Imitation and the attitude of "disobey=no damage/punishment".

Almost everyday I see people breaking traffic rules without being punished.	71%
In the last one month, I was not punished by the police.	82%
Sometimes, I also break the rules.	72%
In the current state of traffic, it is impossible to drive without breaking traffic rules.	68%
At present, every traffic participant breaks traffic rules.	52%
In the event of traffic conflict, fault lies with the "big" vehicles.	33%
Police officers often do not punish bicyclists.	69%

(ii) Attitude "if I do not break the law then others still break the law" and "obey traffic rules=damage".

When there is congestion, if we yield to others, we can get stuck immediately.	68%
I have to use a wrong lane/wait in the wrong position to avoid congestion.	58%
Now everybody has to try to drive according to his/her own judgment, there is no orderly traffic flow in the city.	85%

(iii) Attitude "sometimes it is understandable to violate traffic regulations".

Sometimes it is understandable to drive at a higher speed than the regulation.	64%
Sometimes it is understandable to commit a small behavioral violation in order to drive faster.	60%
Sometimes it is understandable to run a red light.	44%

In conclusion, from theoretical and empirical aspects in Vietnam, it is assumed that traffic regulation-violating behaviors are the result of a continuous chain of attitudes towards legislation with the influence of such following parameters.

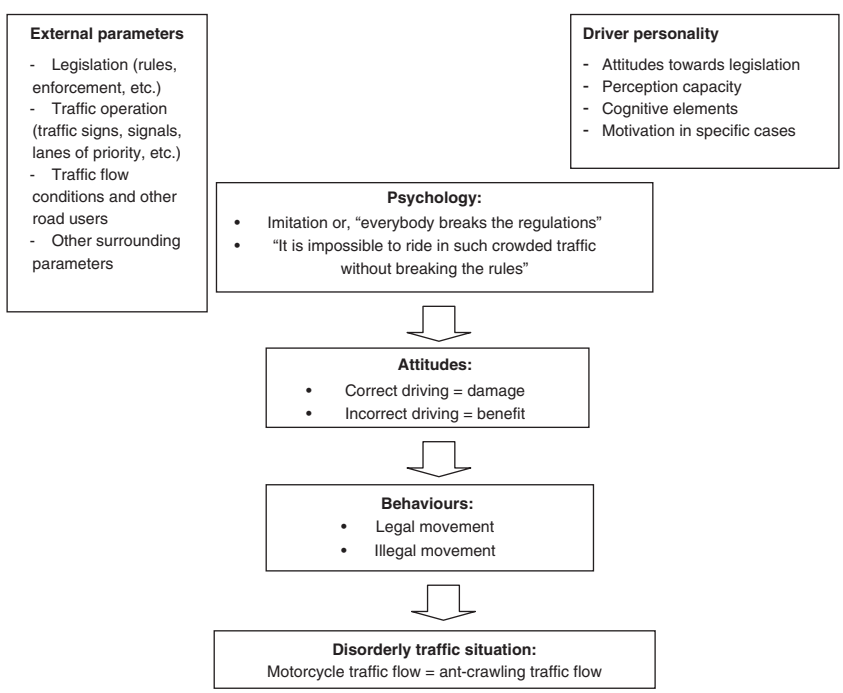

Fig. 2. Driver behavior chain of violating traffic regulations.

The theory of planned behavior (TPB) has been used as the basis of a number of road safety studies in an attempt to understand issues such as speeding and other traffic violations [6,7–9], bicycle helmet use [5,10,11], pedestrian behavior [2,3], transport modal choice [1], drunken driving and seatbelt use [4] (Fig. 2).

The theory of planned behavior from intentions to actions has been applied to studies of the relations among beliefs, attitudes, behavioral intentions and actual behavior in various fields including traffic safety, and in particular driving behavior.

The theory of planned behavior suggests that behavioral beliefs and attitudes toward behavior are related, normative beliefs have influence over subject norms, perceived behavioral control is determined by the total set of accessible control beliefs, and behavior is a compatible intention of perception of behavioral control and actual behavioral control (Fig. 3).

Applying this theory to the case study of Vietnam's situation, in line with empirical study, we find the following behavior chain of traffic regulation violations. The model (Fig. 4) assumes that the driver's decision of violating the regulation comes from his "attitude towards rules" and "specific-scenario acceptance of rules." The "attitude towards rules" is more long-term whereas "specific-scenario acceptance of rules" is more affected by those factors in the specific traffic conditions that the driver has to cope with, along with his own motivation and driving skill at that moment.

3. Influence of education and enforcement in traffic safety: Case study in Vietnam

So far, guidelines to conduct traffic safety measures, such as AASHTO (NHCRP report 500, 2004), often classify measures into groups based on their oriented objectives (due to elements of the whole traffic system). Such systems as 3E (engineering, enforcement, and education) are currently being applied to evaluate traffic measures in Vietnam (Source: JICA, ALMEC, TRAHUD projects). In fact, when applying such measures of traffic management and operation, they are not conducted separately. More often, such traffic safety measures are conducted in the broad scope (in the whole route or several routes, in one or several local areas, etc.). Moreover, influences of traffic safety measures on driver awareness and behaviors are very essential to take into consideration, even before applying. Evaluating the effectiveness of such measures is important but not very simple. The fact is, many traffic safety measures, which have been successfully applied in developed countries with considerable results in removing traffic accidents, require a rather long time to have the initial results when being applied in Vietnam. The first result mentioned here is

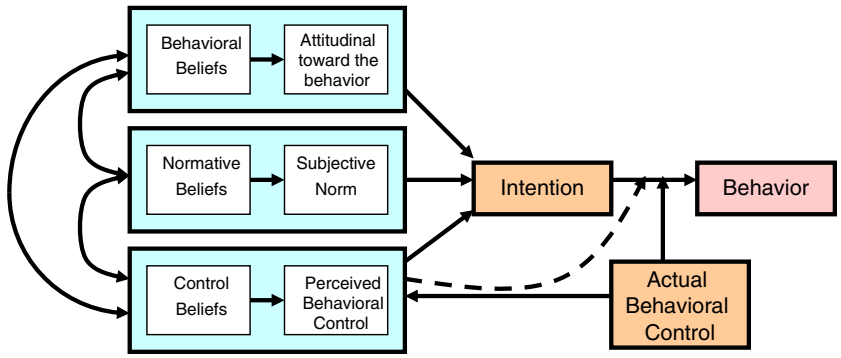

Fig. 3. Theory of Planned Behavior (Icek Ajzen, 1985, ver. 2006).

the high probability of road users to obey such regulations, which are very useful in traffic safety. Many measures need the procedure to be adjusted and come into effect (see examples in the next part). The problem is that most measures of traffic management and operation in general and traffic safety in particular are very costly, with large social effects.

In Vietnam's current traffic system, research shows that enforcement has different influences on driver behavior of "obeying the rule" based on different policies (the process of applying policy in real traffic conditions). The reason for this practical situation fits well with the conclusion that enforcement has influence on driver behavior through the role of driver attitudes towards legislation whereas education is more likely an influence on long-term attitude towards rules.

Let's consider the following two traffic safety polices as examples.

Policy 1: "Motorcycle drivers must wear safety helmets."

- In 1995, the first motorcycle safety helmet regulation was adopted, requiring motorcyclists to wear safety helmets when driving in Decision 36/CP of the government. There was no provision on the punishment of violators.
- In 2001, the Ministry of Transportation released a guide for wearing safety helmets when driving motorcycles.
- In 2002, there was an article added to road traffic law stating that wearing safety helmets when driving motorcycles is regulated by the government.
- In Feb. 2003, the government released an instruction under road traffic law designating certain road segments upon which motorcyclists are obligated to wear safety helmets.
- In Dec. 2005, the government issued a decision regulating the punishment of driving motorcycles without a safety helmet (punishable by a fine and by motorcycle confiscation).
- In 2006, the helmet law began being enforced.
- During the time (from 1995), they released education and training on the policy.
- On June 29th, 2007, the government issued Decision 32/2007/NQ-CP, which states, "from September 15, 2007, motorcyclists are obligated to wear safety helmets when driving motorcycles on all national roads," and, "from December 15, 2007, motorcyclists are obligated to wear safety helmets when driving motorcycles on all types of roads."

Policy 2: "Lane separations for different types of vehicles." The policy is applied first at specific intersections (in one road line), then

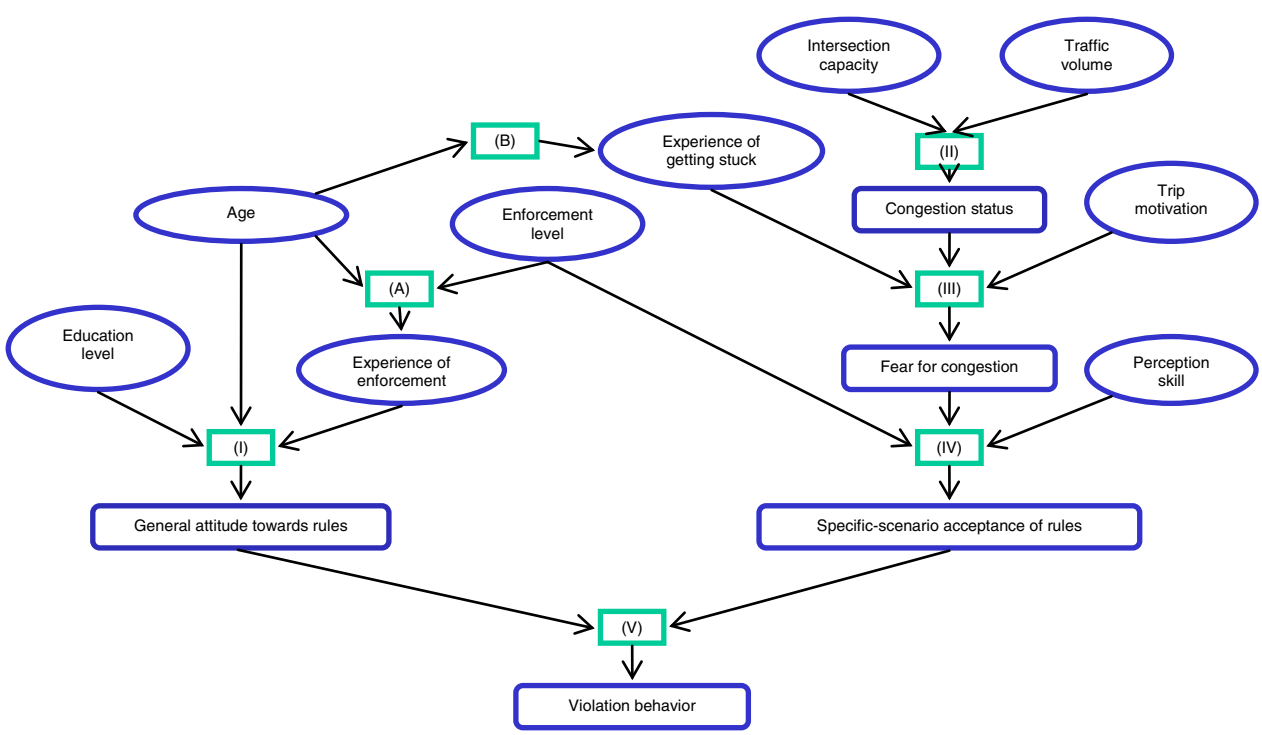

Fig. 4. Model of cause-and-effect chain of driver behavior.

in some specific road lines (so-called standard traffic roads). The policy supposedly applies to several roads in the whole city. However, standard roads still do not have good results, so the policy needs some adjustments.

- In early 2005: The first road of Kim Ma–Cau Giay started to conduct lane separation for different types of vehicles. The separation was conducted by continuous lane marks in some obligated segments. Other segments in the road are marked just by dash marks.
- Feb. 4, 2007: The road of Chua Boc–Thai Ha applied lane separation in the area of intersections and their approaching roads. The infrastructure was improved by reducing the area of roadside to broaden the road area for vehicles and intersection areas, lane marking, changing traffic signals from two-phase cycles into three-phase cycles (one intersection adopted a four-phase cycle to completely separate potential conflicting movements), promotion in mass media, and one month of strict enforcement with the appearance of policemen (no punishment by fines).
- Mar. 2007: The four-phase cycle at the intersection of Chua Boc–Thai Ha was removed.
- Jan. 20, 2008: Applying lane separation in the whole road of Dai Co Viet–Tran Khat Chan: Traffic signals, hard lane separation (in some segments), lane markings (with symbols and writing on the road surface), and promotion in mass media and traffic signs.
- Feb. 28, 2008: Began fining violators.
- Aug. 2008: Lane separation by painting columns (instead of lane markings only).
- Feb. 2009: Provided five additional locations of policemen (near intersections) to instruct drivers to obey the regulation of lane separation and punish those road users violating the regulations.

3.1. Evaluation and assessment

In October 2006, the Project Management Committee (PMC) of Traffic Safety Human Resource Development project in Hanoi (TRAHUD) was formed by the Ha Noi People Committee (HPC). This project came about through a collaboration between Japan International Cooperation Agency (JICA), and Ha Noi city's administration in order to improve the Hanoians' social awareness of traffic safety.

In Feb. 2007, improvements on the model road project of Thai Ha–Chua Boc, which was implemented in the first phase of the program, were completed with the help of traffic safety equipment, traffic safety construction, traffic safety policies, and traffic safety education. After nearly one year of new assignments, the Vietnamese and especially Hanoians were impressed by the well-done improvement of social awareness, driving skills and traffic participating behaviors shown by a series of transport safety data. The result of this phase strongly expresses the active effects and the need to widen the model program in the next phase applied on three national roads, and the Thai Ha–Chua Boc street.

Based on the purposes of survey locations, one field survey has been released showing quantitative data in each location in three periods of time: before, during, and after new assignment (see details from field survey location in the Appendix).

The results of two surveys can be summarized as follows (based on the report of Traffic Engineering Evaluation, by TRAHUD study system, 2008):

Policy 1: Helmets

- Before the last Decision in December 2007, the percentage of drivers wearing safety helmets was low on national highways (the lowest percentage being 9.75%, on National Highway No.1 in the afternoon). Motorcyclists give out many reasons for their violation behaviors such as inconvenience, limitation of visibility, hot weather, inconvenient storage of the helmet after reaching their destination, lack of awareness about which particular roads require motorcyclists to wear helmets, and infrequent and irregular punishment.
- After the decision was issued, the percentage increased to 95% of motorcyclists wearing safety helmets on average. The lowest percentage can be found also in the afternoon at the rank of 92.12% (also on National Highway No.1).
- The percentage of motorcyclists obeying the policy was even higher after the enforcement campaign than it was during the campaign.

Policy 2: Lane separation has obtained initial achievements.
In the road segment:

- Lane separation increases the average travel speed along the Dai Co Viet–Tran Khat Chan route, reducing travel time and making road users more comfortable when driving along this route.
- Lane separation stabilizes traffic flow by decreasing traffic vehicle lane changing percentages, positively affecting traffic safety.
- Separating traffic by vehicle type makes the traffic flow more uniform. Harmful factors in the traffic flow are averted due to the reactions between different types of vehicles with different traffic characteristics within the traffic flow.
- Lane separation increases road capacities due to increased travel speeds and by making the traffic flow more uniformly.

Issues:

- Drivers just obey the lane separation when there are policemen.
- Lane separating by type of vehicle increases the number of conflict at intersection areas, thus increasing the risk of local congestion at intersection areas. Lane separation according to vehicle type could be used in cases of low traffic volumes.
- Increases in the amount of conflict at intersections increase waiting time and travel time at intersections.
- High densities of connections with main routes decrease the effect of lane separation.
- Unbalanced traffic volume distribution on lanes during peak hours sometimes “forces” road users to make lane violations.

After a period of applying the policy of hard lane separation (in order to encourage road users to obey road traffic rules), we can see the following situations such as:

At intersections:

- The violation rate (number of violations/total volume of traffic) seems to have decreased during the campaign, then increased again after the campaign.
- The campaign seems to have different effects on different types of violations (lane/traffic signal violations). Specifically, after the campaign the rate of traffic signal violations was significantly reduced, while the rate of lane violations increased after the campaign.
- The influence varies depending on the time of day (peak and off-peak hours, morning and afternoon-peak hours).

[TRAHUD study team, 2008, Traffic Engineering Evaluation]

However, as we can see from the field survey (manual counting), it is obvious that the effects of enforcement (policemen's campaign) and engineering measures are not the same (or at least similar trends) as the violation behaviors of all groups of drivers (motorcycles, cars, bicycles, etc.). The risk analysis approach with the help of the model describing the driver behavior chain provides a supporting tool to analyze more deeply different aspects of enforcement effectiveness.

In order to better evaluate the effectiveness of the traffic safety campaign, it is better to take a look at the long-term influence of the whole campaign.

These two policies aim at improving the current situation of traffic systems in urban areas. The first objective is influencing driver awareness of traffic safety and their behaviors of obeying traffic regulations (especially those relating to traffic safety). However, the influence of enforcement in the two policies gets different results in

driver behavior in regard to obeying traffic regulations (as opposed to violating traffic regulations).

Policy 1 has been in effect for many years (from 1995) with different types of measures (such as promotion bands, education at schools, exhibitions of traffic safety, etc.). The last result showing a high percentage of drivers obeying the rule even increased after the enforcement campaign. Regarding Policy 2, most drivers were only observed obeying the regulation during the campaign, which means that the campaign has only the effect with the presence of policemen (in that case, their presence also means the presence of monitoring measurements). It can be concluded that enforcement does not directly influence driver behavior, but only influences their attitudes of safe and unsafe behavior. Combining enforcement with education and training will have long-term effects on driver attitudes towards legislation.

In the view of risk analysis, it can be seen that Policy 1 has effects on driver decisions to obey rules just by shifting the curve of "risk of being punished" without any influence on the curve of "risk of getting stuck" (see Fig. 5). Policy 2 shifts both curves of "risk of getting stuck" and "risk of being punished" at the same time, reducing its effects on driver attitudes.

Taking Policy 2 into consideration, when analyzing more detailed data from the field survey (before, during and after the campaign), we can see that the campaign has different influences on different types of violation behaviors (lane violations and traffic signal violations). The result proves that besides the influences of the enforcement campaign, driver attitudes toward legislation are also influenced by other elements of traffic environments such as infrastructure, traffic operation and management, and congestion in traffic flow.

Moreover, it is important to pay attention the fact that the two traffic safety campaigns conducted at two field sites of national highway and urban roads differ from each other under the light of the risk analysis approach. At the national highway, besides the police presence, the punishment level is clearly regulated if the driver does not wear the safety helmet. Whereas, in urban roads, the measure of enforcement (with police presence) is conducted along with other traffic management and operation measures such as lane marking and changing traffic signal cycles.

However, based on the theory of long-term and short-term effects of external factors, it is obvious that elements related to the police presence and fines belong to the group of enforcement. The enforcement level has a temporary influence when the driver perceives that he has some percentage of ability to be monitored and punished. However, in the long term, the driver can obtain the experience of enforcement (due to a subjective norm, for example). Then his general attitudes toward traffic rules will improve, whereas measures of traffic management and operation will affect the intersection level service. In its turn, LOS has an influence on the specific-scenario acceptance of road users.

From such arguments, the risk analysis model will be useful in analyzing in detail the multi-directional effects of influencing parameters on the output of violation behaviors. Of course, with the current available data, the task of constructing practical quantified parameters and relationships is still impossible.

Another point to be considered is the fact that policies and measures of traffic safety conducted during campaigns at urban intersections and national highways (NH) (December, 2007) only focus on the enforcement of a single traffic regulation. In other words, the onsite police presence has an enforcement objective, aiming at some main (expected) behaviors of violating traffic regulations. In this specific case, enforcement aims at the behavior of "no helmet" along NH, and traffic signal violations as well as lane violations in urban intersections. In addition, the target group of the strict enforcement level is mobile drivers (automobiles or motorcycles).

In general, the difference in the enforcement influence on driver behavior in the two cases of Policies 1 and 2 is due to the influences of the experience of enforcement (long-term) as well as the enforcement level. Basically, the onsite police presence is just a single factor of the enforcement level. The enforcement level includes the punishment level and the monitoring mechanism. In the case of Policy 2, the regulation of fines have imposed an awareness in drivers, leading them to a better general attitude toward regulations.

The other factors in applying Policy 1 can be seen in the history of its progress of application since 1995. Prior to the regulation of administrative punishment, a lot of education measures, mass media promotion and other measures were applied. Those measure belong to the group of traffic safety education, increasing the driver education level. Moreover, the perception of wearing helmets when using motorcycles was improved.

Meanwhile, in the case of Policy 2, enforcement was simultaneously applied with measures of improving service levels in intersections (by adjusting traffic signal cycles and lane separation). Policy 2 differs from Policy 1 in its enforcement level, general attitude towards regulations and perception skill.

Analyzing in detail, we can see that the influences of traffic safety campaigns (with such measures as police presence, punishment of violation behavior, increasing intersection capacity by adjusting traffic signal cycles, etc.) differ for different types of violation behaviors. This means that the driver experience of enforcement obtains different influences or enforcement levels in different types of violation behaviors. Similarly, influences of enforcement levels are different in different types of vehicles, which can be explained with the difference in enforcement level and perception.

It is important to emphasize that comparing two different policies is a difficult task. Each policy (and its relevant measures of traffic management and operation) has different objectives in influencing driver behavior. After applying the model to evaluate, we can see that the "enforcement level" only has a long-term impact when being

Fig. 5. Illustration for behaviors of violating the regulation of "lane separation".

applied along with other measures such as education, promotion (as they have impacts on general driver attitudes toward traffic regulations) and engineering (with the influence on intersection LOS). The enforcement level has only short-term effects on driver specific-scenario acceptance of rules.

4. Conclusion and recommendation

So far, traffic accidents are of high importance to the public health spectrum around the world. In developing countries such as Vietnam, the mortality rate from road traffic accidents is rather high in comparison with other countries in this region. Discussion about the importance of the human factor in transport policy is growing. Aware of the serious effects traffic accidents have on the whole society, scientific researchers, traffic engineers and policy makers in Vietnam have developed many projects and conducted research in the field of traffic safety over the past few years. The human factor is considered the central element in the whole system. The final goal is to organize a traffic environment that is convenient and safe for road users.

The research aims at establishing a modular structure to conduct risk analysis of driver behaviors relating to violating traffic regulations at intersections in motorcycle dominated traffic flow. The final goal will be to obtain answers to the question: why and how often do drivers (in mixed traffic flow) violate traffic regulations at intersections, and what are the consequences of such violation behaviors? These questions have been organized systematically into discrete steps that involve identifying different behaviors of violating traffic regulations, determining the likelihood of their occurrence, and identifying their consequences.

At the very first stage of study in the field, the risk analysis model of the driver behavior chain is just constructed in the qualitative approach. Many assumptions based on empirical and previous studies and research are used. The disadvantage of the model is that in order to evaluate and verify it, it is required to have more and more data. However, it is also the advantage of risk analysis methodology to improve the model and integrate new knowledge from other disciplines whenever they are provided. The next step to improve and apply the model to practice should be:

- Quantifying parameters in the model, with their probability distributions
- Evaluating and verifying relationships among parameters
- Refining the model in specific areas, which have been identified in the prior analysis.

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