Evaluation of the Effects of Traffic Management at School Areas

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Abstract. Traffic accidents are known as one of the leading causes of mortality among teenagers and young adults in Vietnam. Specifically, the risky road behavior lead to 6.2 per cent of killed and injured persons are youth aged between 0 and 18 years. While children injured or killed when walking or travelling as passengers in motorcycles are a serious concern in Vietnam, it is obviously that road users perceive on traffic safety for children is one of the most significant factors affecting accident reduction. The proper application of traffic management measures at school areas needs to be recognized as one of the most common and vital ways to improve traffic safety for children.

Keywords: Children, traffic accident, school zones.

1 Introduction

Road crashes are recognized as one of the top two causes of mortality among young people. Children account for approximately 21% of injury-related mortalities worldwide and two thirds of child road traffic injury deaths occur in the South-East Asia [8]. Among risk factors, road behaviors are one of the most important predictors [3]. Children and young people are at risk in road environments around schools and colleges. Their behaviors can be less predictable than adults and they may have errors of judgement when dealing with traffic. Therefore, managing traffic and road safety at schools become a concern in worldwide.

There are different solutions are applied to the same safety issue. However, the reviewed literature [3,4,6] shows that the most appropriate solution for reducing traffic accident may involve the four Es approach (Engineering, Education, Enforcement and Encouragement). In which, **Engineering** focuses on implementing facility improvements; **Education** focuses on taking the normal road safety education curriculum; **Enforcement** focuses on campaigns by the police to reduce illegal actions by road users such as speeding, red light violation; and **Encouragement** aims to change the behavior of road users.

According to [1], one of the most important goals for a suitable city is ensuring traffic safety of all traffic movements, including children and elderly people. This

goal should be divided into four objectives (*i) safe road infrastructure, (ii) safe road user behavior, (iii) traffic safety management,* and *(iv) safety environment*. The effectiveness of traffic management measures is obtained by the achievement of these goals and objectives.

Table 1. Categorization of traffic management measures

Goup	Measures	Group	Measures
Engineering measures	ROW on unsignalized inter-section	Education measures	Provision of maps and guidebook
	Improvement of road surface		Production of textbooks
	Installation of safe facilities		Production of materials
	Effective pedestrian signal		Education by accident scenes
	Installation of crosswalk	Enforcement	Reinforcement of regulation
	Installation of pedestrian priority zone		Reinforcement of traffic crackdown
	Provision of ITS system	Encourage-ment	Active travel to and from school
			Establishment of school zone

2 Traffic Safety Issues at Schools in Vietnam

In Vietnam, where this study is carried out, road crashes account for approximately 6.2 per cent of fatalities among teenagers. As examined by statistics, children injured or killed while travelling as passengers constitute the largest category of children involved in road traffic crashes. However, the trend of children involved accident while driving is appallingly rising.

Table 2. Distribution of serious accidents for children

Children	2014	2015	2016
Passenger	157	141	263
Driver	146	198	219
Pedestrian	159	210	196

Source: Department of traffic police, 2017

To determine the contributing factors influencing the occurrence of each accident, 80 road traffic accidents involving children were analyzed in detail. Of the 80 accidents, human factor (91.4%) had contributed to majority of fatal/serious injuries, followed by the infrastructure and environment factor (7.4%) and vehicle factor accounted for the smallest proportion.

However, from road user's perspective, human errors are affected by many factors. According to School Traffic Safety Survey (SUD, 2017), it follows that road users

consider unsafe road facilities, and unsafe road environment as the contributing factors for risky behavior.

Table 3. Contributing factors influencing the occurrence of 80 accidents

Accident causes	Percent
Human error	91.4%
Infrastructure and environment error	7.4%
Vehicle error	1.2%

Source: Department of traffic police, 2017

Table 4. Road user's perception on the causes for human errors

Causes for human errors	Percent
Illegal occupancy of sidewalk	27.5%
Lack of sidewalk or ped. road	26%
Under-standard road design	18%
Damage road pavement	14.7%
Lack of crosswalk or ineffective crosswalk	4.8%
Others	10.5 %

Source: SUD, 2017

Combination the causes recorded from both sides, it can be concluded that the traffic safety issues raised may be caused by road users or by problems in the road environment. Maximizing safety for children depends on both addressing road infrastructure as well as the behavior of the people who use it.

This study had two main objectives: First, to identify the applicable measures to ensure traffic safety for children; and second, to assess the effect of these measures on the road users' behavior.

3 Sample and Methods

3.1. Sample

To adopt with the objectives of this study, a total sample of n = 300 public citizens (170 males, being 56.67% of the sample, and 130 females, representing 43.33% of the sample) was used, all coming from Hanoi, Vietnam. The main age of the full sample was ‾. 31.4% of participants were students; 26.7% were self-employed; 26.1% of them were employees, and 7.3% of them were government.

The reason for choosing the citizens derived from the fact that they are main beneficiaries from the outcome of traffic management measures and under the position of consumers, they easily assess whether the solution are appropriate and how help them to change their behaviors.

3.2. Methodology

Firstly, the weights of effectiveness criteria groups are estimated through the Analyti-cal Hierarchy Process (AHP). Seven-point scale was assigned to calculating the weights of criteria and sub-criteria. In which, the first level indicates the equal importance and the seventh level shows the extreme importance between one criteria

over another. The comparison matrices of each respondent was individually analyzed to examine the consistent ratios and to calculate the weights. And because they are general public, an experience's rate was not considered in this study. The group's weights were calculated by simple geometric means of the individual weights.

In the next step, effectiveness of measures is assessed by estimating the impacts on the transport system toward the traffic safety at school zones. Levels of impact are qualitatively scaled (High, Medium, Low, and Non) and corresponding points (from 3 to 0 scale) are given for further evaluation.

Finally, based on the given rates of measure's impacts and the given weights of goals and objectives, one can simply calculate the Effective Score (ESij) of measure by below formula. Measure would be more effective if the Effectiveness Score is higher, vice versa.

$$ES_i = \sum_{m=1}^{4} WC_m * \left[\sum_{n=1}^{k} WS_{mn} * EP_{mn}^{j} \right] \qquad (1)$$

Where

ES$_i$: Effectiveness score of measure I; ES$_i \geq 2.4$: Measure i has high level of effectiveness; $1.5 < ES_i < 2.4$: Measure j has medium level of effectiveness; and ES$_i \leq 1.5$: Measure j has low level of effectiveness

WC$_m$: Weight of criterion m (m = 1 to 4)

WS$_{mn}$: Weight of sub-criterion n, under criterion m

EP$_{mn}^{j}$: Effective point of measure j, on objective n, under goal m

4   Results

Table 5 shows aggregate opinions of participants that ensuring safe road infrastructure is the most important traffic management measure with a weight of 45.5%, safe road user behavior ranked second (29.7%), while traffic safety management (S3) and safety environment (S4) ranked third and fourth with 12.8% and 12% weight, respectively.

Table 5. Weights of the assessment criteria

Weigh of criteria	Criteria
45.5%	Safe road infrastructure (S1)
29.75%	Safe road user behavior (S2)
12.8%	Traffic safety management (S3)
12%	Safety environment (S4)

In accordance with the definition in above section, fifteen candidate measures are selected for further analysis. After getting through the assessment, three traffic management measures have been selected to be in the first priority group, which includes two engineering measures, and one encouragement measures. The other five measures are assigned in the second, which includes four engineering measure, and one education measure.

The assessment results indicate that the most recommended traffic management improvements on engineering are *facility installation,* and *crosswalk establishment*. Implementation of these two measures will help to prevent illegal movement. Looking at engineering measures in the second priority group, one can recognize that the next recommended improvement of infrastructure, *the pedestrian oriented signal* will provide better physical accessibility, high priority right of way for pedestrian. The second rank of *ROW on unsignalized intersection* and *improving road surface* provide the good condition for travelling.

Table 6. Assessment of traffic management measures at school zones

No	Measures	Effectiveness				ES_i
		S1	S2	S3	S4	
1	**Engineering**					
1.1	ROW on unsignalized intersection	High	High	Low	Medium	1.75
1.2	Improvement of road surface	High	High	Low	Medium	1.75
1.3	Installation of safe facilities	High	High	Low	High	**2.48**
1.4	Effective pedestrian signal	High	High	Low	High	1.85
1.5	Installation of crosswalk	High	High	Medium	High	**2.41**
1.6	Installation of ped. priority zone	Medium	Medium	Medium	High	1.59
1.7	Provision of ITS system	Low	Low	High	Low	1.28
2	**Education**					
2.1	Provision of maps and guidebook	Non	High	Low	Low	1.19
2.2	Production of textbooks	Non	High	Low	Low	1.10
2.3	Production of materials	Non	High	Low	Low	1.54
2.4	Education by accident scenes	Non	High	Low	Low	0.74
3	**Enforcement**					
3.1	Reinforcement of regulation	Non	Medium	Medium	Low	1.24
3.2	Reinforcement of traffic crackdown	Non	Medium	Medium	Low	1.11
4	**Encouragement**					
4.1	Active travel to and from school	Non	Medium	Medium	Medium	1.46
4.2	Establishment of school zone	High	Medium	Medium	Medium	**2.60**

● High ◉ Medium ◎ Low ○ Non

One encouragement measure is selected in the first priority group and it is the most important solution among measures. In practical, the school zone is popular applied nationwide and is the effective way to reduce traffic accidents of children. The basis of school zone comes from engineering because this measure also focusses on installing traffic safety facilities around the school zone, such as installation of traffic signal and safety sign, installation of carriageway and road appurtenance for leading speed reduction.

5   Conclusion and Discussion

The study aims to assess the effect of traffic management in ensuring traffic safety for young people and children. To obtain this objective, a multi-criteria assessment model is applied to recommend the most suitable traffic management measures. In this model, four goals and ten objectives are selected for assessment. In which, the safe road infrastructure was rated as the most expected improvement of traffic safety in Vietnam (45.5% weight). The followings are safe road user behavior (29.7%), safe traffic management (12.8%) and safe road environment (12%). It is necessary to emphasize here that designated users of this model are not the traffic managers or a decision makers who have to make a "Yes" or "No" decision for a specific school. The model's users stay in a neutral position to assess and recommend traffic management measures based on the specific conditions of Vietnam.

Based on the Effectiveness Score, the priority of traffic management measures are recommended, three traffic management measures have been selected to be in the first priority group, which include two engineering measures, and one encouragement measure. The other five measures are assigned in the second; four are at engineering measure, and one is at education. In general, these groups were built from a good mix of engineering, education, and encouragement, which represent the traffic management activities in all forms. Although the levels of impacts may be varied according to specific conditions of schools, each measure of the list is highly recommended to apply in every school in Vietnam. It is necessary to emphasize that the recommended measures are qualitatively assessed and selected according to the existing transport conditions of Vietnam. Therefore, the results of this study may be different from others. The final emphasis here is that, the implementation of any traffic management measure needs sufficient protection of traffic laws, effective and promptly enforcement service, and good awareness of all stakeholders.

References

1. Albert Speer and Partner: Frankfurt Urban Integrated Traffic Management, Dezernat Bau and Straßenverkehrsbehörde, Stadt Frankfurt am Main (1993)

2. Bowen, W. M.: AHP: Multiple Criteria Evaluation. Klosterman R. et al, Spreadsheet mod-els for urban andregional analysis, New Brunswick: center for urban policy Research (1993).

3. Ibrahim, J.M.; Day, H.; El-Setouhy, M.: Road risk-perception and pedestrian injuruies among students at Ain Shams University, Cairo, Egypt. J.Inj.Violence Res. (2012).

4. Juillard, C., Labinjo, M., Kobusingye, O. & Hyder, A.A.: Socioeconomic impact of road traffic injuries in West Africa: exploratory data from Nigeria. Injury Prevention, BMJ, 16, pp 389-392 (2010).

5. Lassarre, S.: Analysis of progress in road safety in ten European countries. Accident analysis and prevention, 33, pp. 743-751 (2001)

6. Natulya, V.M. & Reich, M.R.: The neglected epidemic: road traffic injuries in developing countries. BMJ, 324, pp. 1139-1141 (2002).

7. School Traffic Safety Survey. SUD (2016).

8. World report on child injury prevention, http://www.who.int/violence_injury_prevention/child/en, last accessed 2019/03/21.