Evaluation of Operation and Safety for School Zone Application of Ulaanbaatar 46th School Using Microscopic Traffic Simulation Model

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1. Introduction

According to the 2012 traffic accident data of the Ulaanbaatar City in Mongol, children's injuries were 113 and fatalities were 13. This is the high traffic accident rate considering the population and number of vehicles. Therefore, it is important to reduce children-related traffic accident in the Ulaanbaatar City. KICT has conducted the Localization Project in Mongol of diminishing children-related accident in school areas. The goal of this study is to verify the effectiveness of the school zone system which contains traffic signal, speed hump, and driver feedback system *(hereafter DFS)* comparing the present by analyzing traffic operation and safety.

The subject school area is the 46th school of the Ulaanbaatar City. In the past three years, 15 children's traffic accidents were occurred on 46th school area and this number is outnumbered comparing to the others of the Ulaanbaatar City. The road in front of the school is connecting the downtown of a provincial city to adjoined residential area. The vertical and horizontal curves of the road make traffic accident higher.

2. Methodology

To evaluating the effect of operation and safety of school zone system before and after installation, micro-simulation Verkehr In Städten-SIMulationsmodell *(hereafter VISSIM)* was used to analyze the operation effect, and then the trajectory files of vehicle and pedestrian extracted from VISSIM were estimated by Surrogate Safety Assessment Model *(hereafter SSAM)* which analyzes a number of conflict. A research flow is shown as below fig. 1.

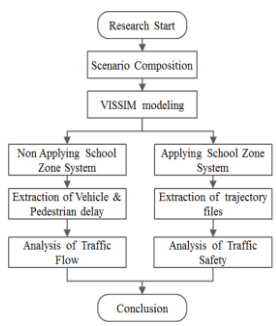

Figure 1. Research Flow Chart

2.1. Scenario of Simulation

The simulation of 46th school of traffic flow and safety was realized for morning peak hour. The geometry design and traffic volume of the target area were configured as shown in fig. 2 and table 1. In a scenario of school zone system, speed bumps located in front of pedestrian crossing and driver feedback system in southbound entrance of down slope at school zone area were applied. In these sections, the speed reduction was implemented in accordance with the driver's behavior as a real field.

[Table 1] Vehicle and Pedestrian Volume of 46th School Area (Vehicle / Pedestrian, Unit: veh per hr / ped per hr)

Origin \ Destination	①	②	③	④	⑤	⑥	⑦
①	-	0 / 2	0 / 2	0 / 2	1,782 / 2	18 / 128	0 / 14
②	0 / 18	-	-	0 / 10	0 / 11	0 / 151	0 / 19
③	30 / 8	-	-	-	20 / 0	0 / 64	0 / 8
④	20 / 5	0 / 16	0 / 8	-	-	0 / 49	0 / 6
⑤	510 / 10	0 / 30	17 / 15	12 / 0	-	-	0 / 10
⑥	15 / 15	-	-	-	85 / 0	-	0 / 15
⑦	0 / 7	0 / 1	0 / 1	0 / 1	0 / 1	0 / 59	-

Figure 2. Present (Left) and Application School Zone System (Right) of 46th School in the Ulaanbaatar City

2.2. Analysis of Traffic Flow

For evaluating the traffic operation before and after school zone system, the 46th school area was modelled by VISSIM. At this point, vehicle's speeds in speed bump and DFS were set 30 kph and 40 kph. These speeds were resulted from a Korean study, "Guideline Integration and Effectiveness Analysis of the Children・the Elderly・the Disabled (Koroad, 2011)".

In the results of simulation, average vehicle delay was decreased by about one second, however average vehicle speed also diminished around 4 kph. The reduction of average vehicle delay was caused by diminishing of conflicts between vehicle and pedestrian at the pedestrian crossing. And the decrease of vehicle speeds was appeared by speed limit area as speed humps and a DFS section. In pedestrians, the average pedestrian delay was increased by about eight seconds, and the average speed had a reduction in about 14 kph. The increase of pedestrian delay was caused by signal's storage at the pedestrian crossing. However, the fluctuation of the pedestrian speed was not significantly different. Table 2 describes the delay time and speed of vehicle and pedestrian for 'before' and 'after'.

[Table 2] Vehicle and Pedestrian Average Delay and Speed Results

Contents	Present (Non School Zone)	Application School Zone System
Average Vehicle Delay (sec)	13.4	12.5
Average Vehicle Speed (km/h)	55.9	51.9
Average Pedestrian Delay (sec)	5.8	13.1
Average Pedestrian Speed (km/h)	4.8	4.6

2.3. Analysis of Traffic Safety

The conflict numbers of vehicle and pedestrian were evaluated by SSAM. However, the conflict number of SSAM cannot be distinguished from vehicles, pedestrians, or between vehicle and pedestrian. Therefore, the crossing conflict number of just pedestrian crossing area was fixed for estimation in this study. The conflict thresholds for the TTC (time to collision) was set to 1.5 seconds, PET (post-encroachment time) to 5 seconds, and crossing angle to 80 degrees. As a result, while the number of conflict before the installation of school zone system was 462 times, the number of conflict after installation was 278 times (decreased 39.8%.)

3. Conclusion

This study estimated the effect of the school zone system on operation and safety in a road near the 46th school, the City of Ulaanbaatar. The estimations were conducted by VISSIM and SSAM. The results show that vehicle was deceased by about 1 second, the pedestrian delay by about 7 seconds, and the conflict number by 184. Therefore, although there is no difference in operation between 'before' and 'after', the school zone system appeared to improve safety.

4. Acknowledgements

This study was performed in a research, "Practical Application of Mongolia Urban School Zone Utilizing Korean Safety System of School Zone", and I would like to express thanks for support.

5. Reference

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