NEAR-MISS ACCIDENT ANALYSIS FOR TRAFFIC SAFETY IMPROVEMENT AT A 'CHANNELIZED' JUNCTION WITH U-TURN

MARTHA LENI SIREGAR, HEDDY R. AGAH & FAUZI HIDAYATULLAH
Faculty of Engineering Universitas Indonesia, Indonesia.

ABSTRACT

A near-miss is an unplanned event that can precede events in which a loss or injury could occur. Therefore, it is an indicator leading to an accident. Near-miss analysis does not look at what happened but look into what could have happened. Serious conflicts are the result of a breakdown in the interaction between the road user, environment and vehicle, which leads to traffic accidents. As the similarity between accidents and serious conflicts is striking, accidents can basically be prevented by isolating and handling the conflicts potentials. The Swedish Traffic Conflict analysis of near-miss accidents is adopted in this study to improve the traffic safety of a channelized junction with U-turn at LentengAgung, Jakarta. The junction is a two-way junction with a wide median and an island. The location has been indicated as an accident-prone location with high conflict rates. A set of traffic video-recordings employing a number of surveyors at different points of observations were carried out on-site to obtain real near-miss accidents. Prior to the survey, surveyors practiced judging vehicles running speeds until they reached a certain maximum error of judgment. Evasive actions such as braking, swerving and accelerating were recorded, and actions were classified into serious and non-serious conflicts based on the time-to-accidents and speeds. The results of the analysis show that almost all of the total recorded conflicts fall in the category of serious conflicts. An improvement scheme of the junction with reduced potential traffic conflicts is proposed, which can be expected to lower the accidents occurrences.

Keywords: channelized junction, near-miss accident, TCT, time-to accident, traffic conflicts

1 INTRODUCTION

An intersection is an area shared by two or more roads to allow different directions of movement. Minimum delays, safety aspects and safe and convenient operation for all road users, including cyclists and pedestrians are among the requirements an intersection has to meet. There are, however, intersections, which do not perform safety capacity as indicated by various types of conflicts and levels of severity. Higher accident proneness due to the adverse effect is reflected in delays, queues, conflicts and accidents, which leads to low safety performance of the intersection.

The more complex the driving situation, the higher the probability a driver makes mistakes and get involved in accidents. The driving environment needs to be more simplified to allow less complicated driving tasks to perform. The number and types of conflicts needs to be reduced and the level of seriousness has to be transformed to non-serious or no conflicts conditions to achieve higher safety level and improved traffic operation.

This study aims at traffic safety improvement at a 'channelized' junction with U-turn, which complicates with the presence of adjacent railways. The junction under study is Lenteng Agung, intersection, South Jakarta, in the direction of Ps. Minggu. The junction is 'channelized' by the bridges over an adjacent parallel 2-m wide waterway. The railway crosses one of the legs which functions as a two-way U-turn curve. The analysis is primarily not based on accident history data, but is more on the accident proneness of the junction, which is indicated by near-misses.

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2 METHODOLOGY

A near-miss is an unplanned event that can precede events in which a loss or injury could occur. Therefore, it is an indicator leading to an accident. Near-miss analysis does not look at what happened but look into what could have happened. The Swedish Traffic Conflict Technique defines serious conflicts as the result of a breakdown in the interaction between the road user, environment and vehicle, which leads to traffic accidents [1]. As the similarity between accidents and serious conflicts is striking, accidents can basically be prevented by isolating and handling the conflicts potentials. The Swedish TCT analysis of near-miss accidents is adopted in this study to improve the traffic safety of the junction under study. The technique has been applied, together with behavioural studies, in researches on the design and location of zebra crossings at intersections [2].

The junction under study is a two-way junction with a wide median and an island. The location has been indicated as an accident-prone location with high conflict rates. A set of traffic video-recordings employing a number of surveyors at different points of observations were carried out on-site to obtain real near-miss accidents. Prior to the survey, surveyors practiced judging vehicles running speeds until they reached a certain maximum error of judgment. Evasive actions such as braking, swerving and accelerating were recorded, and actions were classified into serious and non-serious conflicts based on the time-to-accidents and speeds.

The junction can be categorized as a compound Y-junction, which complicates with the presence of an adjacent river and a railway running parallel with the main road with one leg crossing the railway. The short bridges channel the traffic to the curved leg that crosses the

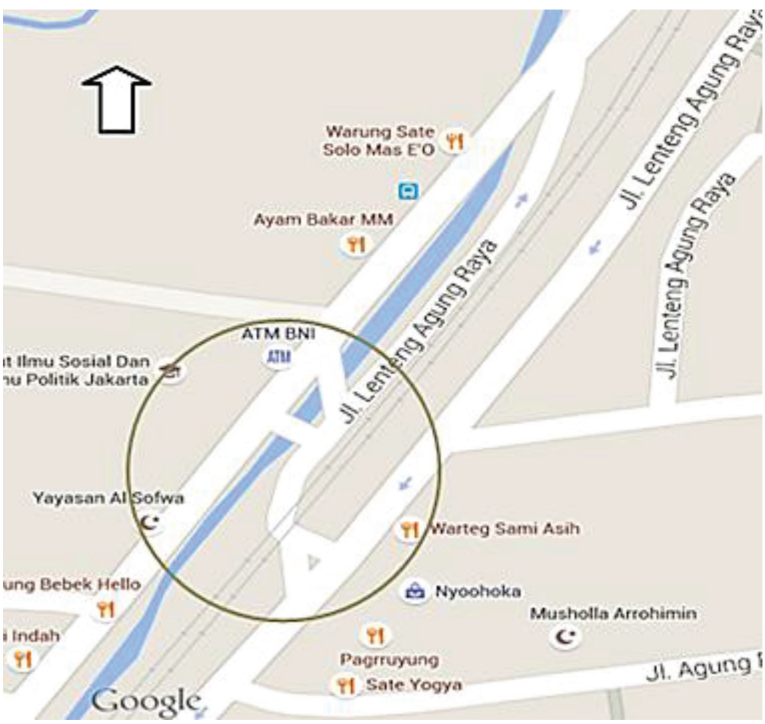

Figure 1: Junction under study.

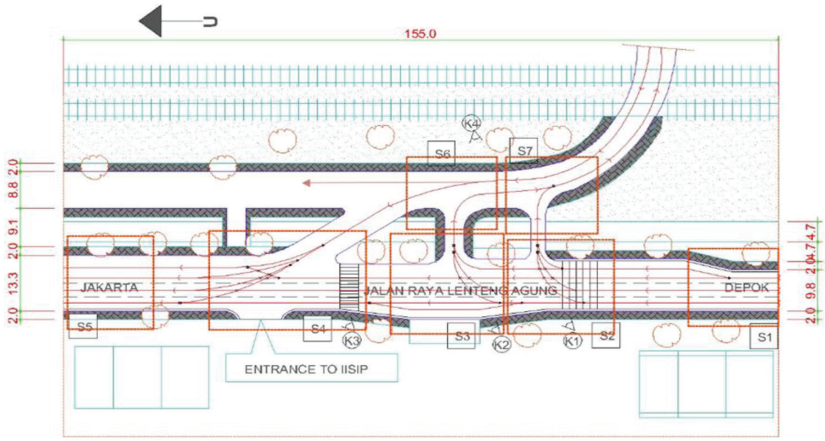

Figure 2: Locations of surveyor spots (S1–S7).

railway. The intersection is divided into seven sections for observations based on the characteristics of the intersection and the surveyor's capability of recording the manoeuvres speed and type of vehicles. A familiarization to the field and the traffic was planned preceding the survey and a training as well as on-site practice was conducted in order for the observers to be able to judge or estimate the speed and time to collision of the vehicles. Training was repeated several times until the minimum error of judgement was reached. Seven observers were assigned to certain observation location in such a way that all conflicts can be recorded without overlapping recording.

3 RESULTS AND DISCUSSION

The traffic safety situation at a site can be described in many ways. For example, it can be characterised by the number of accidents that occur or by the risk of meeting with an accident. Risk has generally been calculated for safety-critical events, which groups together crashes, near-crashes, and incidents [3]. The core of TCT is the identification and recording of serious conflicts, which are characterized by the closeness to a collision is very imminent [4]. This near-miss approach combined with the traffic conflict based on vehicles manoeuvres not only reflect the number of accidents well but also their nature. In this study, time-to-accident and vehicles speeds are plotted on the TCT graph to find out the level of seriousness of potential conflicts of all observed vehicles movements.

The results show that the majority of movements are potential serious conflicts, which requires immediate improvement of the intersection. Serious conflicts are the results of a breakdown in the interaction between the road users, environment and vehicles. In such situation, evasive action taken is usually either braking, swerving, or acceleration, or the combination.

The high number of serious conflict as shown in Fig. 3 describes the complexity of problems at the intersection and how prone the intersection is to serious accidents. This finding is contrary to the common perception, as depicted in an accident pyramid, that severe accidents are expected to occur the least in frequency. This finding, however, is similar with that of a study on factors contributing to traffic conflicts between motor vehicles and non-motorized vehicles conducted by Zang [5] and Siregar [6] in which it was revealed that there are more serious conflicts than non-serious conflicts. The discrepancy lies on the types on

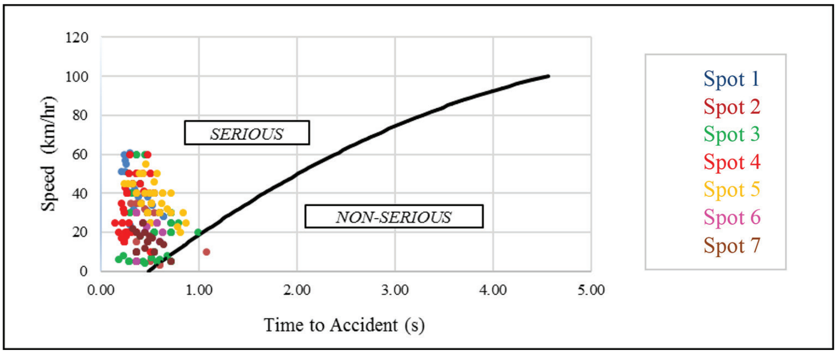

Figure 3: Plotting serious/non-serious conflicts potential.

conflicting vehicles. In this study, types of vehicles are categorized into MC (motor cycle), UM (unmotorized vehicle), and pedestrian, LV (light vehicle), and HV (heavy vehicle). The results of the conflict surveys are presented in the following graphs. Figure 4 shows that practically at all observation spots the involvement of motor cycle in various types of manoeuvres is relatively high, and crossing manoeuvres dominate as indicated in Fig. 5.

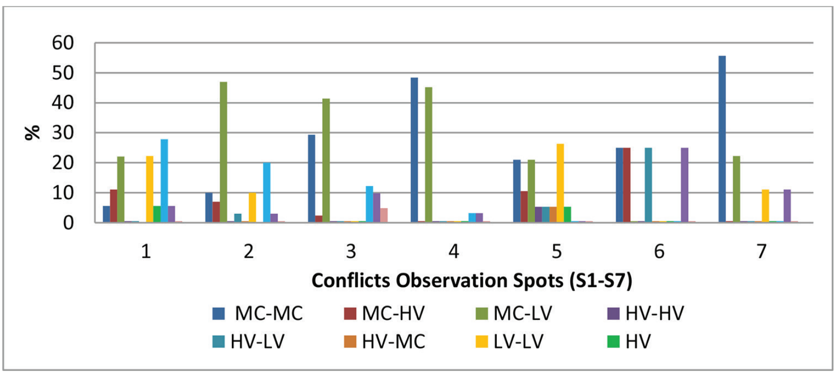

Figure 4: Types of conflicts by types of modes at the intersection.

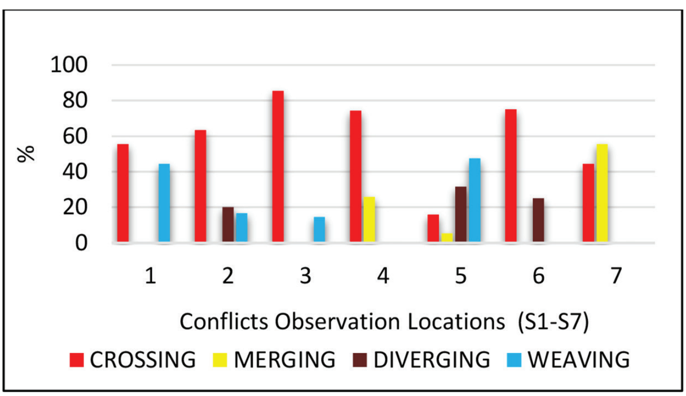

Figure 5: Types of conflicts by types of manoeuvres at the intersections.

Table 1: Conflicts by types of vehicles and types of manoeuvres.

Observation Spots	Conflicts by Types of Vehicles	Conflicts by Types of Manoeuvres
S1	MC-LV, LV-LV, UM-LV	Crossing, Weaving
S2	MC-LV, UM-LV	Crossing
S3	MC-MC, MC-LV	Crossing
S4	LV-LV, UM-LV	Crossing, Merging
S5	MC-MC, MC-LV, LV-LV	Weaving, Diverging
S6	MC-MC, MC-HV, UM-MC	Crossing, Diverging
S7	MC-MC, MC-LV	Crossing, Merging

Taking the types of conflicts that contribute more than 20% in all observation spots, Table 1 summarizes that conflicts are dominated by motorcycles and light vehicles involvement indicating the high prevalence in accident occurrences.

At S1, the conflicts are dominated by crossing and weaving manoeuvres, which strongly suggests traffic violations as the main road is a one-way road, which does not allow such manoeuvres.

At S2, crossing dominates the conflicts despite the presence of pedestrian crossing

At S3, crossing conflicts occur between the vehicles going north and vehicles crossing the bridge before reaching the railway crossing.

The railway crossing basically functions as a U-turn for vehicles going to the direction of Depok. It is practically illegal and dangerous to make a U-turn at or near a railway crossing as queue may build up obstructing the downstream traffic flow and sight distance may be limited.

At S4, crossing conflicts between cars as well as pedestrians are the highest, which is mainly because of vehicles coming out of the nearby campus. The location of campus entrance adds to the complication of the intersection.

At S5, weaving and diverging conflicts dominate. Conflicts involve motorcycles and light vehicles. This clearly indicates serious violations by unruly drivers who have very minimum safety concerns.

At S6 and S7, conflicts involving motorcycles crossing and diverging dominate.

The potential conflicts incurring at the intersection are primarily the results of the following:

- The channelization is formed by the water ways adjacent to the lanes and the railway. There are two bridges relatively close to one another where vehicles can cross before taking a U-turn at the railway crossing.
- The presence of entrance to a campus very close to the intersection adds to the complication. Numerous studies over the past 40 years have shown accident rates rise with greater frequency of driveways and intersections [7].
- Poorly managed access in the functional area of an intersection can result in traffic-operation, safety, and capacity problems. These problems can be caused by blocked driveway ingress and egress movements, conflicting and confusing turns at intersections, insufficient weaving distances, and backups from far-side driveways into intersections.
- The intersection is close to the railway crossing as the crossing is on one of the intersection legs. Washington State Department of Transport [8] states that operations at

> roadway intersections located near grade crossings can present significant challenges for grade crossing safety. In particular, vehicle queues originating from the roadway intersection and extending back to the grade crossing must be clear of the tracks before the arrival of any trains.

The parallel railway runs only several meters from the road causing queue that impacts the traffic on the main road, and the railway crosses a roadway curve, which is not a recommended geometry [9].

Based on the analysis on level of seriousness of conflicts, involvement of vehicles and types of manoeuvres, a scheme is proposed to be adopted for the improvement of the intersection. This proposal is aimed at reducing serious conflicts potential by minimum geometric design changes and improvement of road furniture and intersection features.

Figure 6 shows the proposed changes at the intersection based on the principle of conflicts reduction and prevention of road users violations such as contra-flow manoeuvres in particular during rush hours. One of the prominent types of conflicts occurs due to drivers' lack of lane obedience causing frequent unnecessary lane changing, traffic regulation violations and intersection geometric deficiency.

At spot 1, as the major type of conflict is crossing and weaving, speed bumps is to be provided before zebra crossings as well as combined continuous and broken lines to allow lane changing from the left lane only. At spot 2, the manoeuvres of vehicles turning to the right through the first bridge results in serious crossing conflicts mainly between motorcycles and light vehicles. As the distance between the bridges are short, the bridge at spot 2 needs to be restricted for pedestrians only and vehicles who are changing direction have to make U-turn at the next bridge. At spot 3, the major type of conflict is crossing conflicts, and serious conflicts involve motorcycles and light vehicles, chevron or island marking needs to be provided allowing only vehicle on the inner lane to make left turn. The presence of zebra crossing at spot 4 is basically inappropriate as it does not fully facilitate pedestrian to reach the far side of the roads. Serious conflicts involving motorcycles and light vehicles are the two highest in percentage. Crossing and merging manoeuvres at spot 5 dominate, indicating the need for separation of directions. Barriers or solid continuous lane marking are to be adopted to

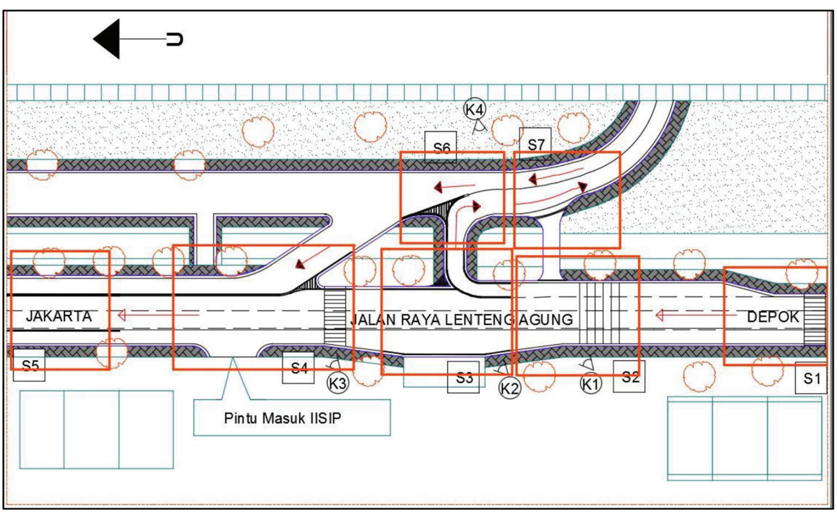

Figure 6: Intersection improvement scheme.

channel the merging traffic. At spot 6 chevron or island marking needs to be provided to guide the traffic. At this spot, crossing and diverging manoeuvres dominate, and serious conflicts involve all types of vehicles including unmotorized vehicle/pedestrian. At spot 7 the traffic is two-way traffic, and the prominent type of conflicts involve motorcycle and light vehicles and the types of manoeuvres are crossing and merging. Solid continuous lane marking to separate the traffic direction need to be applied along with the closing of the first bridge. The railway crossing which functions as a U-turn is not a safe crossing and may need to be redesigned or eliminated as suggested by the MUTCD [10]: 'Any highway-rail grade crossing that cannot be justified should be eliminated.' The improvement scheme is expected to prevent conflict potential, in particular the serious conflicts, from occurring as well as improve the safety level of the intersection. Changes in road design features can be expected to change the patterns in traffic interactions, which will lead to the decrease in the probability of accident occurrences [11].

4 CONCLUSION

Drivers make more mistakes and are more likely to have collisions when they are presented with complex driving situations created by numerous conflicts. A less complex driving environment is accomplished by limiting the number and type of conflicts between vehicles. As the analysis indicate that there are only a small, insignificant number of conflicts which fall into non-serious categories, it can be concluded that basically the intersection under study is in such a condition that all directions lead to potential accidents and all types of road users are vulnerable. This intersection is a highly accident-prone intersection and therefore requires immediate improvement and betterment. As the site is constrained by the presence of adjacent railway and river that run parallel with the main road, the countermeasures adopted should take the principle of minimum but efficient changes. As accidents occurrence and serious conflicts are very similar in nature, accidents can basically be prevented by isolating and handling the conflicts potentials. The proposed scheme can therefore be expected to prevent accidents at the intersection. In addition to the geometric and road markings improvement, traffic regulation enforcement is highly required to increase the traffic safety level at the intersection and the environment.

REFERENCES

[1] The Department of Traffic Planning and Engineering, Lund Institute of Technology, Lund University, *The Swedish Traffic Conflict Technique (Brochure)*, Lund, Grahns Boktryckeri AB, 1992.

[2] Hydén, C. & Várhelyi, A., The effects on safety, time consumption and environment of large scale use of roundabouts in an urban area: a case study. *Accident Analysis and Prevention*, **32**, pp. 11–23, 2000. https://doi.org/10.1016/s0001-4575(99)00044-5

[3] Victor, T., Dozza, M., Bärgman, J., Boda, C-N., Engström, J., Flannagan, C., Lee, J.D. & Markkula, G., *Analysis of Naturalistic Driving Study Data: Safer Glances, Driver Inattention, and Crash Risk*, Transportation Research Board. Washington D.C., 2015.

[4] Almqvist, S. & Hydén, C., Methods for assessing traffic safety in developing countries. *Building Issues*, **6**, 1994.

[5] Zhang, G., Zhang, Q. & Qi, Y., Exploring Factors Contributing to Traffic Conflicts Between Motor Vehicles and Non-Motorized Vehicles at Signalized At-Grade Intersections. *International Conference on Transportation (ICTR 2013)*, pp. 14–19, 2013. ISBN 978-1-60595-146-1.

[6] Siregar, Martha Leni., TCT (the Swedish Traffic Conflict Technology) Method for Safety-Based Evaluation of the Provision of With-Flow Bus Lane on Fast Lane. *Jurnal Teknologi* (ed.), pp. 17–25, 2001. ISSN 0215-1685.

[7] Transportation Research Board, *NCHRP Report 420: Impacts of Access Management Techniques*, TRB National Research Centre, Washington, DC, 1999.

[8] Washington State Department of Transport, *Design Manual M22.01*. WSDOT, Washington, DC, 2016.

[9] Departemen Perhubungan*, Peraturan Direktur Jenderal Perhubungan Darat Nomor : Sk.770/Ka.401/Drjd/2005 Tentang Pedoman Teknis Perlintasan Sebidang Antara Jalan Dengan Jalur Kereta Api*, Jakarta: Departemen Perhubungan Direktorat Jenderal Perhubungan Darat, 2005

[10] www.wsdot.wa.gov/publications/manuals/mutcd.htm (Accessed 13 March 2016).

[11] Siregar, M.L., Alawiyah, T. & Tjahjono, T., Remedial safety treatment of accident-prone locations. *International Journal of Technology*, **6**, pp. 680–688, 2015. https://doi.org/10.14716/ijtech.v6i4.1097