Estimating the Follower Vehicle Platoon Delay due to "U" Turn Vehicles at Centre Median Openings

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Abstract

U-turn vehicles at centre median openings create queues while waiting for acceptable gaps. This phenomenon creates delays for the follower vehicle platoon. The current study aims to estimate the delay for the follower vehicle platoon due to U-turn vehicles at centre median openings. This study considered the movement of the U-turn vehicles at the centre median opening at Dehiwala, Sri Lanka. The road stretch considers here is operated as a two-lane divided dual carriageway. Data were extracted from video footage done on a weekday for six hours in a heterogeneous traffic condition. Here more attention was paid to select the U-turn vehicles when the near lane is having continuous vehicle flow. This makes the follower vehicles to wait in a platoon until the U-turn vehicle takes the gap. When other vehicles passed awaiting U-turn vehicle, that U-turn vehicle was not considered for the calculations. The average waiting times (critical gaps) of different U-turn vehicle types were calculated. Those critical gap values are 14.5, 10.5, 9.2, and 8.2 seconds for heavy vehicles, cars/vans/jeep, bikes, and three-wheelers respectively.

Data were analyzed using 'Queue Theory'. The M/M/1 queuing system that refers to 'arrival rate (λ)' and 'discharge rate (μ)' with a single lane queuing system was selected. Delay was calculated for the complete follower vehicle platoon due to U-turn vehicle. Using arrival rate (λ) and discharge rate (μ) to the equation of queue theory $\lambda / \mu (\mu - \lambda)$, 'delay for the follower vehicle platoon' was found. For a stable system, discharge rate (μ) should exceed arrival rate (λ) and here that requirement was fulfilled. U-turn three-wheelers created the highest platoon delay and the average time of delay created by three-wheelers is 70.6 seconds. Here λ and μ also depended on the traffic condition of both 'opposite' and 'same direction' of U-turn vehicle. Because of that reason, not only the 'type' of U-turn vehicle but also the traffic condition of both direction affects the delay caused by each U-turn vehicle. The vehicle type that more likely to make U-turn is 'three-wheeler'.

Further, 'delay cost' for the follower vehicle platoon due to each type of U-turn vehicle was found by using the average value of time of a person. Calculating the delay cost for each follower vehicle platoon depended on the different vehicle types in that platoon during the waiting time of that U-turn vehicle. When the U-turn vehicle was a van, the delay cost for the

follower vehicle platoon was rupees 10.93. It is the maximum delay cost. The delay cost created by other different U-turn vehicles were rupees 9.05, 7.85, 7.75 and 7.55 from a car, light goods vehicle, three-wheeler and bike, respectively. The results from this study can be further extended to optimize the number of centre median opening for U-turns mainly in arterial roads.

Key Words: *U-turn vehicles, Delay cost, Queue theory*

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