MICROSCOPIC SIMULATION OF PARKING VIOLATIONS IN CURBSIDE WITH-FLOW BUS PRIORITY LANES USING SUMO TRAFFIC CONTROL INTERFACE (TRACI)

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ABSTRACT – This study is focused on developing a methodology for microscopic simulation of parking violation behaviours in Bus Priority Lanes (BPLs) to understand the impact of frequency and duration of such violations on their performance. Parking violations were simulated in SUMO by a process that automates vehicle insertion and the act of performing the violations, incorporating the randomness of violation position and time as observed in real-world parking violations. The advantages of the developed methodology were its efficiency by automation of scenario and output generation and its ability to be easily adapted to other networks.

Keywords: Microscopic Simulation, Bus Priority Lanes, Parking Violations, SUMO, TraCI

1. INTRODUCTION

The Bus Priority Lane (BPL) is a relief measure where the buses are given priority in a dedicated lane. BPLs typically don't involve grade separation of lanes, which was the case in Sri Lanka. Therefore, it is very easy for unauthorised vehicles to enter the BPL. This causes BPLs to be as effective as their enforcement in their contribution toward congestion relief [1]. A parking violation can be identified as a vehicle fully entering the BPL and performing an unauthorised stopping for a duration, disrupting the bus flow. BPLs in Sri Lanka are curbside, with-flow lanes, which are at the most risk from parking violations due to the abundance of curbside activity such as pick-up and drop-off of passengers, loading, and unloading of goods, etc. Therefore, measuring the impact on the performance of curbside BPLs is crucial [2]. However, there is a research gap in the investigation of this impact.

Traffic Simulation provides a cost-effective and flexible alternative for replicating real-world traffic movements in a virtual environment. Simulation of Urban Mobility (SUMO) is an open-source microscopic simulation application that allows all the benefits of microscopic simulation of traffic while providing additional functions that allow for greater control of the simulation. SUMO has been used to simulate road incidents to analyse their impact by stopping a vehicle in a lane for an extended period [3]. The methodology developed in this study extends the previous work to simulate parking violations.

In investigating the impact of parking violations, literature shows that both frequency and duration of the parking violations are the two major determinants of the degree of impact [5,6]. Therefore, both frequency and duration of parking violations were investigated in this study. This study aims to develop a methodology for microsimulation of parking violations in a BPL that can emulate real-world violation behaviours using the functions available in SUMO TraCI.

2. METHODOLOGY

A traffic scenario developed in SUMO primarily has three files: the route file (.rou.xml), the network file (.net.xml), and the additional data file (.add.xml). All three files are called in the configuration file (.sumocfg), which runs the simulation. SUMO **Tra**ffic **C**ontrol **I**nterface (TraCI) contains methods that allow retrieval of values of simulated objects and manipulate their behaviour "online" [6]. TraCI can perform various manipulations, including but not limited to vehicle insertion, changing vehicle routes, and value retrievals such as lane-based values, edge-based values, and individual vehicle-based values such as travel time, speed, etc. The methodology developed uses TraCI to insert violating vehicles ('violators') and make them perform a violation of a given duration by making the 'violator' vehicle stop in the BPL.

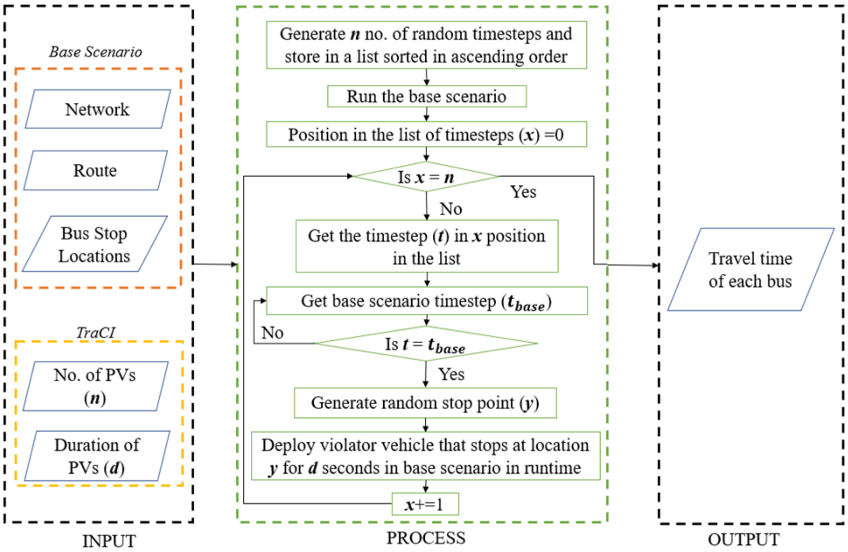

Figure 3. Workflow of simulation of Parking Violations

Figure 1 shows the workflow of the simulation of parking violations developed in this study. The generation of a 'violater' and assigning it a path of travel by assigning a random stop location (y) inside the simulated edge and duration is performed using TraCI. Here the base scenario is the traffic scenario into which TraCI inputs' violators'. The general path of travel assigned to a 'violator' is shown in Figure 2 below.

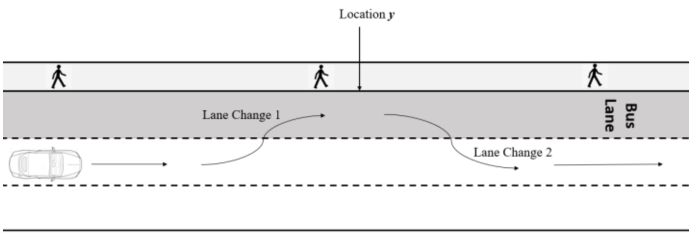

Figure 2. Violator vehicle's path of travel

This methodology mitigates manual modification of frequency and duration of violation by automating the iterations in the violation generation process. Thus, it automates the scenario generation and output generation, which eases the process of measuring the impact of frequency and duration of parking violations on the performance of a BPL. This is especially useful given the high computational times of simulation scenarios.

3. RESULTS & DISCUSSION

The methodology was tested in an artificial network (1.05km straight, 3-lane edge with a 50m warm-up distance) with predefined vehicle flows for 15 mins. The scenarios were developed for 4 different bus flows (20, 60, 120, and 180 buses per hour) and 5 stopping durations per flow (10s, 15s, 30s, 45s, and 60s). The computational time of a scenario differed depending on the frequency and duration of violations and the bus flow. The outputs showed that the average travel time of buses increases exponentially as the no. of violations increases, confirming that they negatively impact the average travel time of buses.

The developed methodology imitates the randomness of violation location and time observed in the real-world parking violations in the simulation. This methodology can generate parking violations for any traffic scenario to explore their impact on the BPL performance. The code can be customised with only a few simple adjustments. They are the length of the edge and the simulation duration. However, a disadvantage is the long and uninterrupted computational time for successfully completing simulation run and output generation.

4. CONCLUSION AND RECOMMENDATIONS

The study focuses on developing a methodology for microscopic simulation of parking violations to measure the impact of parking violations on the performance of a BPL. The methodology uses TraCI to insert 'violators' and manipulate their path of travel to make them perform parking violations at an assigned location for a given duration.

A limitation of the methodology developed is that it uses only one vehicle type as 'violators.' Therefore, developing the methodology further to include generating several types of vehicles as 'violators' is a future research avenue. Initial simulation results showed that the increasing insertion of 'violators' impacts the travel time of buses in BPL, which will be analysed as a part of future research works.

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