Creation of Public Transport Queue Lane Space along Regalado Highway: A Model and Simulation

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***ABSTRACT* – The long queues waiting for a bus, or a jeep is one of the domino effects of hours of traffic jams. The surge of private vehicles, especially when the pandemic started, also added another issue to the long commuting hours for the public. Every scenario played is to ensure efficiency on public transport vehicles avoiding the cause of traffic jams along Regalado Avenue. A DES model is formed from the traffic flow scenario along Regalado Avenue and Quirino Highway and is developed using AnyLogic Simulator.**

I. Introduction

The rising volume of public and private transportation focused mainly on the NCR cities is now a matter of vehicle and commuting issues for the public. The heavy traffic is not new news for the public commuters; however, avoiding jams on buses and jeepneys is increasingly challenging. Proper stops and terminals are established along the roads of these cities, yet they are not adequate for the daily commuters. Even before the pandemic hit the country, the Filipinos' traffic and the public commute is a long concern.

One of the existing factors contributing to the anguish of public commuters is the public vehicles stopping anywhere to fill their loads with passengers, which causes a traffic jams and even human traffic flow. The long queues waiting for a bus, or a jeep is one of the domino effects of hours of traffic jams. The surge of private vehicles, especially when the pandemic started, also added another issue to the long commuting hours for the public. The number of cars transiting EDSA daily in 2018 was 251,628, far exceeding the average number of public transportation buses, which was 13,356. In 2017, only 3% of EDSA traffic was made up of public utility buses. Sixty-seven percent of the route was occupied by private vehicles. That did not, unfortunately, prevent the MMDA from

conducting a dry run of a provincial bus ban last August [1].

Road quality is another factor that adds to the daily traffic commute of the public. Only 45% (14,200 km) of the system's 31,400 km of national highways were considered satisfactory or acceptable in November 2011. They compared this number to the percentages in 1982 (about 52%) and 2001 (about 47 percent). The percentage for local roads in 2009 was substantially smaller, at around 20% (or around 35,300 km of 176,300 km). About 0.6 percent of gross domestic product is still invested annually in road infrastructure, which is significantly less than the corresponding figure for most Southeast Asian nations. As a result, there have been few attempts to improve or expand the network [3]. Along the roads of Regalado Avenue in Fairview, Quezon City, the typical traffic of public commuters shows concern with buses and jeepneys cluster along the right-side lane, which eats up much time waiting for passengers while blocking the primary side of the road. All the factors include traffic jams from public transportation, private vehicles, human traffic flow, and road quality.

II. Road Analysis and Process Overview

A. Traffic Flow Lane Flowchart

An average public commuter has two ways to wait for transportation to go to work. Their first option is to wait in the terminal lane, where vehicles are waiting for passengers, and another one is that they find passing public transportation with vacant seats for them to ride to work. The vehicles from the one avenue could proceed to the highway and choose forward or backward lanes. Most public vehicles make a queued stop at the side of the highway to ride some passengers. Public commuters tend to be picky with what they ride, which leads to the long queue of public transportation to wait for passengers willing to fill the capacity load of the vehicle.

Every scenario played is to ensure efficiency on public transport vehicles avoiding the cause of traffic jams along Regalado Avenue. Traffic flow in figure 1 below shows the simple diagram of switching lanes and proper lane for public vehicles to gather passengers.

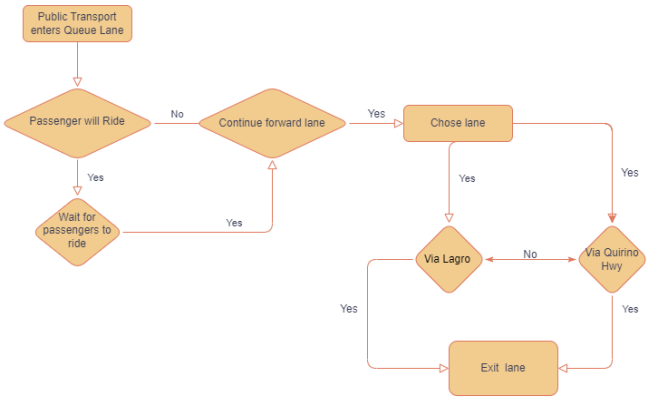

Fig 01. Traffic Flow Lane Flowchart of Regalado to Quirino Highway Roadmap

B. Road Map and Network

The road network mapping along Regalado Avenue to the intersection of Quirino Highway and Lagro is not that complex; however, it still poses reasons to accumulate traffic jams. The researchers decided to excerpt the road map from Google Earth, starting from the road along with Commonwealth hospital until the back lane to Lagro and starting point of the Quirino Highway forward lane. The most cause of traffic jams

is the illegal lane on the right side of the road where they pick up and drop off passengers, which poses significant hazards and risks for motorists and the public commuters on the sidewalk. The road is located along a commercial area near malls and condominiums, which causes higher vehicle traffic. Below are figure 2 and figure 3 for the comparison of the road map via satellite from Google Earth and remodeled version when queue lanes are added.

Fig 02. 2D satellite view of the roadmap

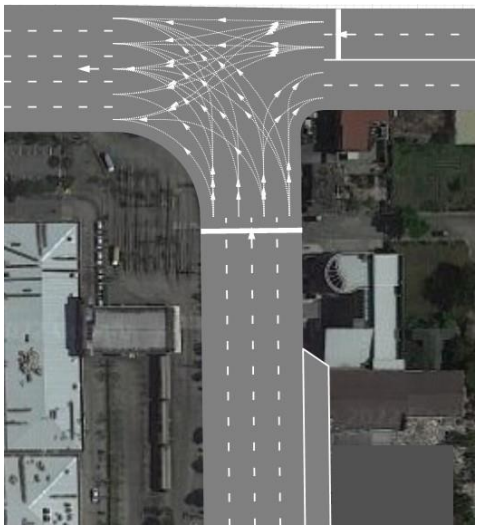

Fig 03. Remodeled version of the roadmap using Anylogic

III. Discrete-Event Simulation Model

With the aid of suitable software, discrete-event simulation (DES) is frequently used to model and simulate actual situations. DES modeling techniques must be employed whenever the entity under examination may be characterized as a series of actions. A DES model is formed from the traffic flow scenario along Regalado Avenue and Quirino Highway and is developed using AnyLogic Simulator. AnyLogic is a multimethod simulation modeling tool. It enables dynamic response, discrete event, and agent-based techniques and an application for cross-platform emulation that runs on Windows, macOS, and Linux. Since using the AnyLogic simulator application, the model can be rendered in 2d and 3d models. Below are the 2d and 3d model of the simulation:

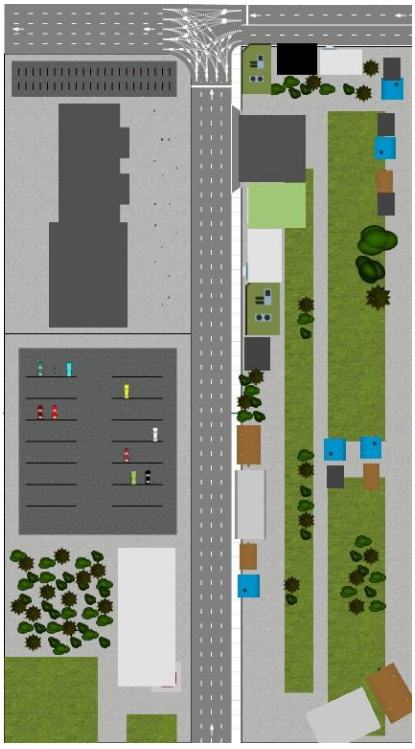

Fig 04. 2D Model of Road map and Network

Fig 05. 3D Model of Road map and Network

The researchers used the car blocks to give movement and simulate the vehicle's direction. The car blocks used are car-source, car-dispose, car move-to, and road network descriptor. Two car sources are used; the car source indicates where cars are put into a specific location in the road network, one from Regalado road and one from Lagro road. Select output is used to connect more lines o different destinations; this select output has five ports to connect with, and only three are used to connect the queue lanes, Quirino highway, and the Lagro lane. From the first out-port, the f irst car move-to lane is labeled for the queue lane; the car move-to dictates the direction of each vehicle entering the road; it is ordered to have a delay every .5 second. The delay represents the passengers riding and exiting the public vehicles. The public vehicle has two options to take; whether they are headed to Quirino Highway or take the Lagro road, another select output is used with three ports to represent this direction. Other vehicles can directly turn on Quirino Highway and via Lagro without using the Queue lane that is intended for the public vehicles only. Another car source would be from Lagro and could only take one road since the Regalado and Quirino Highway are only one lane. All cars exiting the road are represented by car-dispose. The basic direction model is shown below:

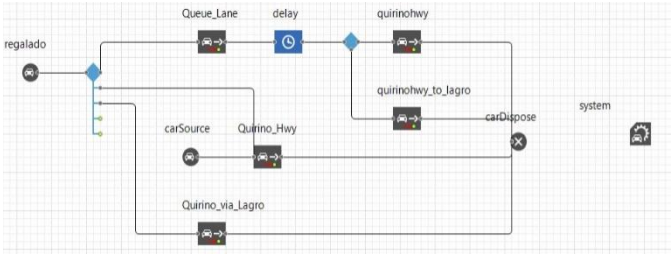

Fig 06. Direction flow code for the simulation

Traffic Density

From the perspective of the user and administrators, traffic density is a significant macroscopic parameter of traffic flow and is used to evaluate transportation efficiency. It is also used in motorway regulation and tracking systems as the primary control parameter [2]. It reveals the extent of the traffic jams on the roads. A traffic congestion forms when the density reaches the limit, and the flow is zero. The density is calculated as the m represents the automobiles present along a road segment of length denoted by L. The formula is shown below:

$$density = m/L$$

Using AnyLogic Simulator, two scenarios are assumpted and documented to show the difference between real-time and the alternative solution for the traffic jams along Regalado Avenue. Green markings have a value of 60km/h, and red markings show a 10km/h speed. This indicates that the faster the speed of the vehicle, the smoother traffic flow and lesser traffic density, while the slower the speed has a higher traffic density and congested traffic flow.

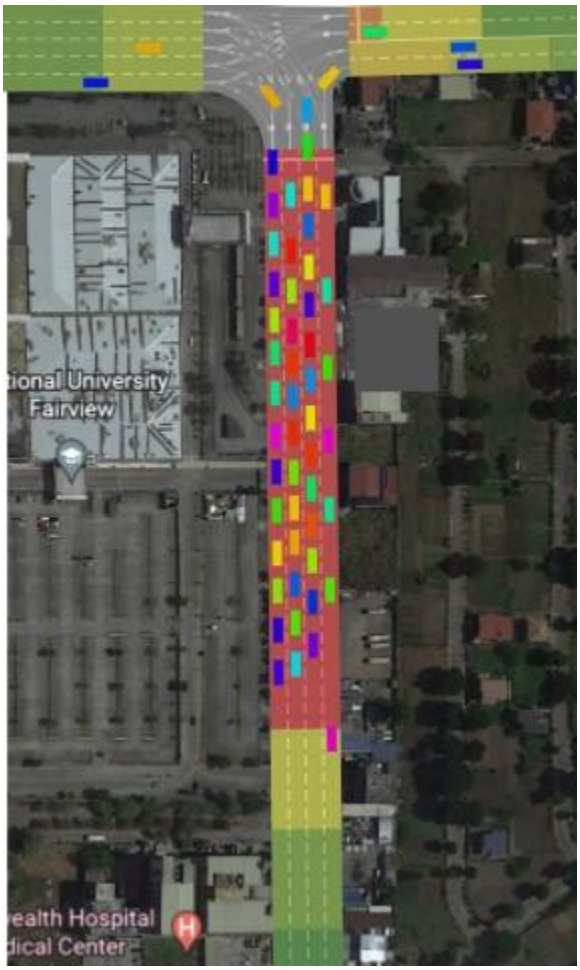

Fig 07. Traffic Density of real-time traffic flow along Regalado Avenue

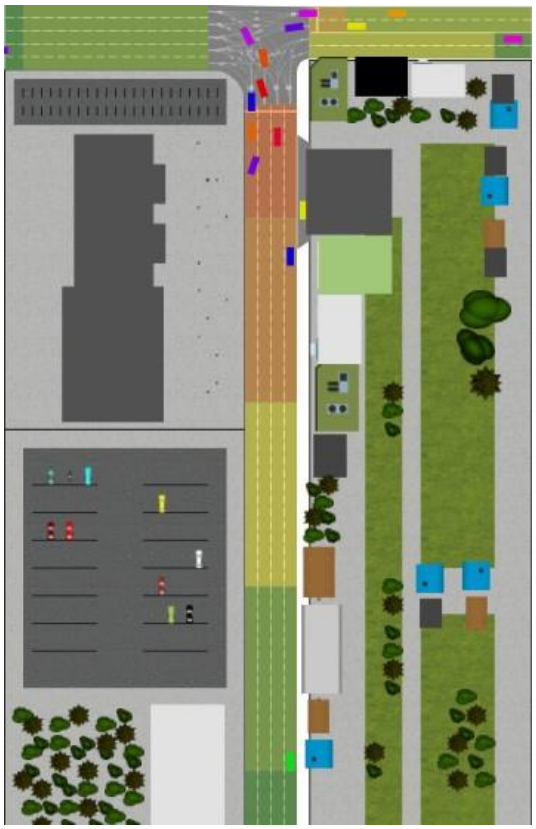

Fig 08. Traffic Density of Simulated Scenario of Queue Lane Implemented

In comparison, traffic congestion accumulated in Fig 7 started to have red markings alongside the mall on the left side. Some private vehicles were pinched on the right-side lane due to public vehicles switching lanes from the farther side of the road. On the other hand, as shown in Fig 8, the sample simulation of adding the queue lanes for the public transport vehicle proves to be quite a handful in avoiding congestion and traffic jams and is efficient for both private and public vehicles and passengers. Both simulations are timed, lasting for one hour, from 2 pm to 3 pm. Three scenarios are ran each of which is a 2hr and 3hr simulation runtime. The time set used in the simulation is the most recorded in real-time for the "rush hour" of

passengers to get a ride home, having more volume of cars along the avenue.

IV. Results and Discussion

Showing the traffic density, the volume of the car in the road network is determined. Different scenarios are played in the simulation by testing the best direction in the intersection from different lanes and even how efficient the length of the queue lane must be. Two scenarios are highlighted and compared with each other. The simulation of a real-time event and the one with the queue lane was proposed. Both simulations included a road network descriptor, a tool from AnyLogic to determine the whole map of the road created, and each of its values is entered manually to discover the volume size of the vehicles passing by. The function used to determine the volume is variableName.***size()***, where variableName stands for the variable names in the code. The graph below represents the car volume for the real-time simulation using a time plot chart from the application.

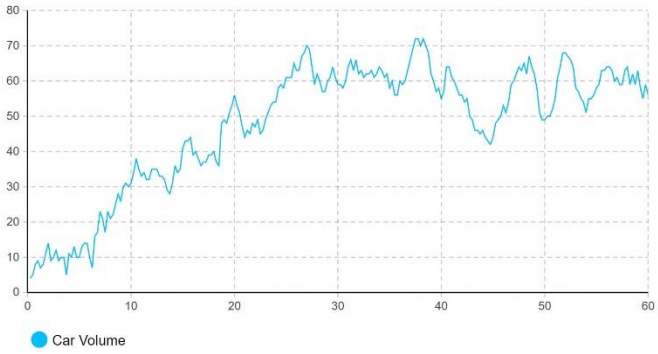

Fig 09. Car Volume in Real-time Simulation

The y-axis represents the volume of cars passed down the road, and the x-axis represents the whole hour of the simulation. The time-plot chart peaked at least 70 vehicles stuck in traffic jams, indicating traffic congestion that lessens the number of passing cars from Regalado to Quirino Highway.

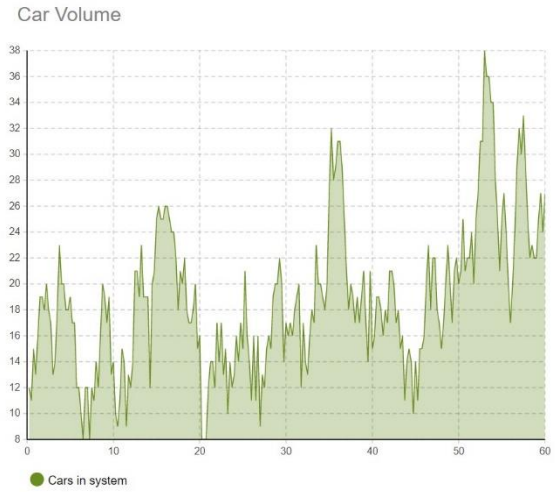

Fig 10. Car Volume in Experimental Simulation

The time-plot chart in Figure 10 above shows that the maximum number of cars congested in traffic is 38. A lot lesser car volume stuck on the road due to the addition of queue lane and allowed more free lanes for both public and private vehicles. The time-plot chart is simulated and recorded synchronously with the traffic simulation for an hour. When a passenger train goes from the front of a line of five cars to the back, it cuts the time it takes to cross a junction in half; when it moves to a minimum position of five in a line of seven cars, it increases the efficiency of passing traffic by 20% [4].

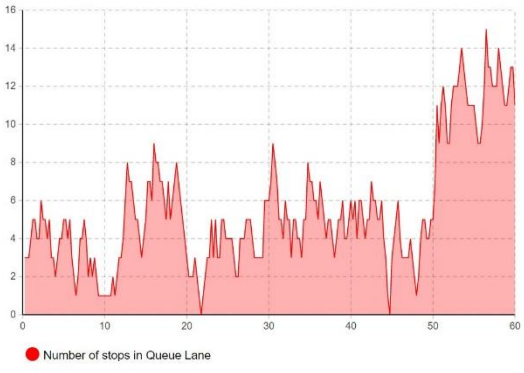

Fig 11. Public Vehicle using the Queue Lane to Drop off and get Passengers

As shown above, the number of stops in the queue lane to get and drop off passengers is recorded using the time-plot chart. The full stops recorded were 15 vehicles close to ending the one-hour simulation, indicating that most public vehicles used the queue lane from the peak of 38 vehicles recorded in the car volume shown in Figure 10.

V. Conclusion

In comparing the two scenarios, each showed significant results which determined the efficiency of adding queue lanes along Regalado Avenue. Road mapping using the road network descriptor compares traffic density of real-time and experimental simulations along these roads. Traffic congestion resulting in jams of vehicles is inevitable; however, coming up with viable solutions to alleviate these problems benefits not only the drivers but also public commuters in the country. Adding queue lanes shows and proves its efficiency and effectiveness. Not only avoiding being stuck between public vehicles dropping off or getting passengers, but more lanes are also opened to smoothly head in the direction drivers are going. Of course, the discipline of public commuters and the drivers to follow the queue lanes are uncontrollable factors that must be considered for future study. This modeling and simulation serve as a guide and a suggestion for the authorities to help improve the quality of the road network along Regalado Avenue and Quirino Highway. This research is limited only to the said road networks, and effectiveness may differ for other locations in the cities of the Philippines. Queue lanes help mitigate the underlying consequences and existing issues of traffic build-up in the country and enhance such stops and terminals by having only a delay and not a waiting line for public vehicles.

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