Analysis of the Effect of a Traffic Discipline Zone on Vehicular Flow along Estrada Street from Singalong Street to Taft Avenue

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Abstract: Estrada Street is used as a major access road to three major educational institutions, namely: De La Salle University (DLSU), De La Salle – College of Saint Benilde (CSB), and St. Scholastica's College Manila. Due to a lack of traffic enforcement and visible traffic signs, there is a great number of traffic violations which lead to traffic congestion along Estrada Street. The Department of Science and Technology (DOST), in partnership with the Civil Engineering Department of DLSU, plans to implement a Traffic Discipline Zone (TDZ) along Estrada Street. Within the TDZ, new traffic management schemes, such as the installation of CCTV cameras and painting of road markings, will be done in the effort to address the traffic congestion caused by violations in the study area. The volume counts and violation counts were obtained from video footage collected from three cameras placed along the study area. From the video footage, the main cause of queueing was said to be the stopping of PUVs and jeepneys. With this in mind, the group then used DYNAMEQ to model various scenarios of traffic management schemes and their effect on the flow of traffic along Estrada. From the simulations, the shared pedicab lane was the best option.

Key words: traffic engineering, traffic discipline zone, traffic management

1. Problem Setting

1.1 Background of the Study

Estrada Street is used as an entry road for three schools: De La Salle University Manila, De La Salle-College of St. Benilde, and St. Scholastica Manila. Traffic build up along Estrada Street heightens in the morning when students are brought to school, and late in the afternoon when both students and

workers from the area leave their campuses and offices. A traffic discipline zone is a “zero tolerance zone” wherein there is a heightened priority to catch traffic violators. These are implemented in areas experiencing problems with traffic flow, especially due to traffic violations. In an article published by The Jakarta Post on December 15, 2012, Adj. Sr. ComrBudiyanto, a traffic police operational chief from Jakarta, referred to Traffic Discipline Zones, or “KawasanTertibLalu Lintas”, as they are locally called in Jakarta, as areas that have “an accommodative atmosphere for discipline driving”. This strategy has been implemented in developing countries, such as India and Indonesia, in order to address traffic problems in congested areas. The De La Salle University - Civil Engineering Department together with the Department of Science and Technology (DOST) has a current project that involves the implementation of the Traffic Discipline Zone along Estrada Street. The traffic discipline zone would promote better traffic flow and lessen the violations occurring along Estrada Street. The implementation of the traffic discipline zone will take effect around July 2016.

1.2 Statement of the Problem

The distance of the stretch of Estrada Street from the stoplight on Singalong Street to Taft Avenue is 300 meters; to the sides of which are various establishments and a school, St. Scholastica. It is visibly noticed that the queuing of cars that pass through this route heightens from 6:30-8:30 am with a peak hour of 7:00-8:00am, around the time of the start of classes of the three academic institutions previously mentioned, and again during “rush hour”, from 5:15-6:15pm on weekdays. A traffic discipline zone is a “zero tolerance zone” wherein there is a heightened priority to catch traffic violators. These are implemented in areas experiencing problems with traffic flow, especially due to traffic violations.

1.3 Main Objective

The main objective of the study was to simulate traffic management schemes for the prospective Traffic Discipline Zone based on the queuing caused by the traffic violations.

In order to meet the main objective, the following steps were taken:

1. Basic parameters, such as vehicular volume and road measurements, were taken.
2. The peak hours were computed; these were used as the timeframe for the video gathering.
3. The violations which caused the most delay time and longest queues were determined.
4. Different traffic management schemes were modelled based on the violations which caused the most queuing.
5. The effects of the simulated traffic management schemes were evaluated.

2. REVIEW OF RELATED LITERATURE

2.1 Traffic Violations

Republic Act No. 4136 is the act the compiles the laws related to land transportation in the Philippines. According to Section 46, vehicles are not permitted to park or stand still at an intersection. This was source, as well as Manila Ordinance 8092, were used to determine the violations occurring along the study area. Since this act is said to govern the entire Philippines, this law was used to prove that the vehicles stopping along Leon Guinto-Estrada intersection. The Traffic management code of the city of Manila is mostly written by Hon. Joel R. Chua, Hon. Ernesto C. Isip Jr., Hon. Manuel M. Zarcal, and Hon. Marlon M. Lacson. This code is otherwise known as Manila Ordinance no. 8092. This document contains all the laws pertaining to the proper conduct of private vehicles, public vehicles, and pedestrians in accordance to traffic. This ordinance provides the

specific laws that govern the tally of violations along Estrada st. The sections under Article 10, parking and stopping of vehicles, are the basis for the violations studied in this paper.

2.2 Traffic Congestion

Yang S. (2014), uses the theory of queuing in the Journal, "The Application of the Queuing Theory in the Traffic Flow of Intersection" to evaluate how the capacity of certain roads in China are affected because of the inevitable increase in car volume. The study found out through testing that more lanes would in turn give shorter lengths of queue. This was not recommended since providing more lanes would provide higher costs of construction and really is unnecessary.

2.3 Traffic Discipline Zone

The article, "What is a Traffic Discipline Zone", which was published by The Jakarta Post on December 2012, explains the use of a traffic discipline zone. Jakarta's Traffic Police Operational Chief, Adj. Sr. ComrBudiyanto defines a traffic discipline zone as a "zero tolerance zone" which has an "accommodative atmosphere for discipline driving". Budiyanto states that these zones are important to remind road users not to violate traffic laws. This article gives a general definition as to what a traffic discipline zone is and the benefits of implementing a traffic discipline zone.

3. METHODOLOGY

3.1 Conceptual Framework

The main causes, shown in Figure 1, of traffic congestion as suggested in the study are the large volume of cars, and the disobedience to the laws along Estrada. These causes will be studied by characterizing the traffic conditions along Estrada St. as well as identifying the different traffic violations occurring in the area. The underlying causes are the different types of violations that will be considered, which are taken from Manila Ordinance. 8092. The violations to be considered are parking and waiting, counterflowing of pedicabs and the stopping of vehicles at the intersections. The violation of traffic laws cause a build-up of cars along the road which contributes to the traffic congestion problem. The characterization of traffic conditions will include the volume, density and flow of the street as well as intersection studies of the three main crossroads along Estrada; Singalong, Leon Guinto, and Taft Avenue. These factors will modeled using transportation software to analyze the effect of a traffic discipline zone as a solution. A number of simulations was run to identify the most effective solution for the area.

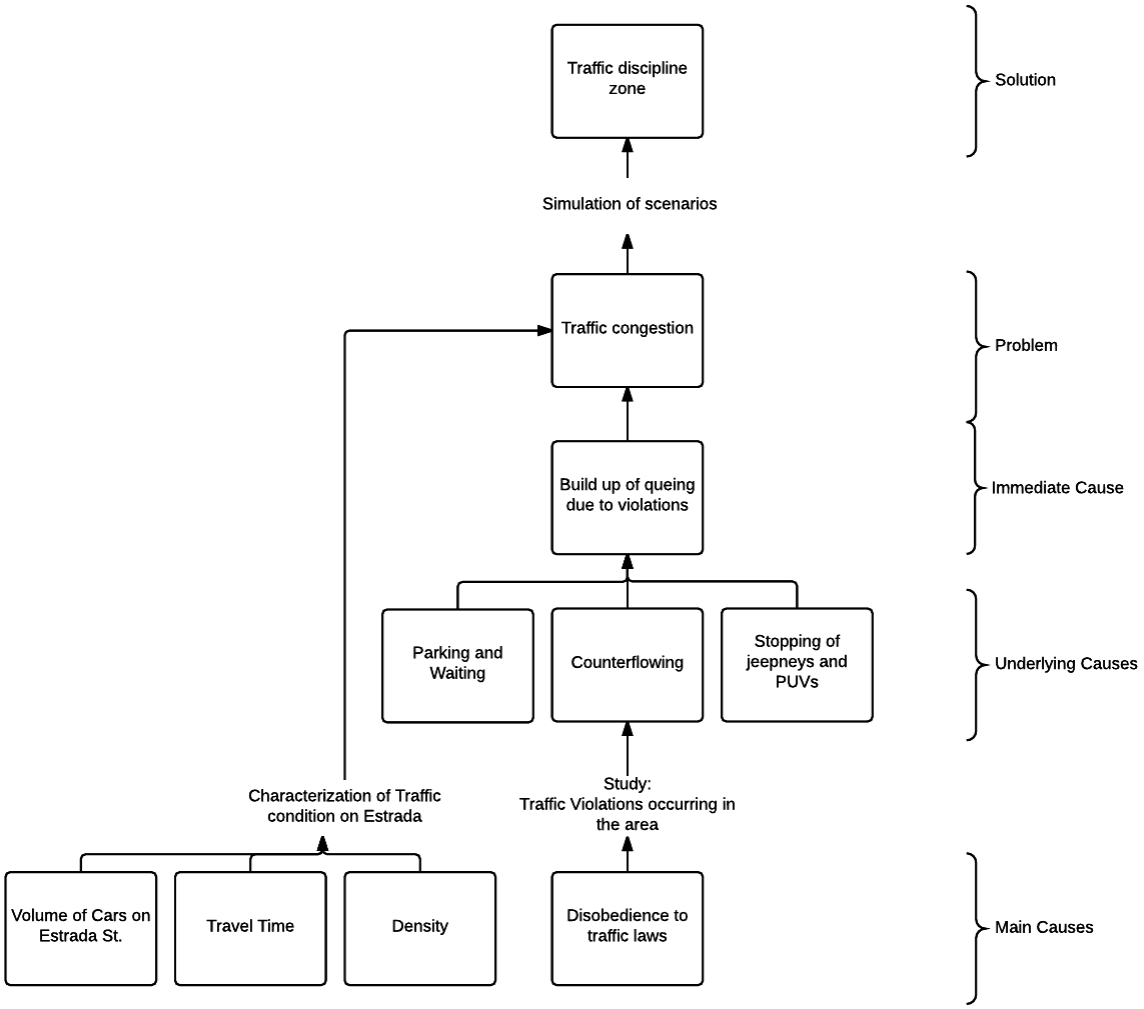

Figure 1. Conceptual Framework

3.2 Volume Count

The manual counts were taken by groups of 3-5 students at each station, as shown in the diagram above. Instead of buying handheld counters, the surveyors downloaded the "Talley Counter" applications on their smartphones to reduce the cost. Each vehicle type was taken into consideration. The vehicles were counted as they crossed the specified intersection assigned to the surveyor.

3.3 Plate Survey

For the plate surveys, there were a minimum of two surveyors per station: one dictated the plate numbers and another wrote down the plate numbers. Due to the large number of vehicles passing the area, more plate numbers could be taken down correctly by having more than just one person assigned at each station for plate surveying. The plate surveys were used in order to keep track of the vehicles the passed through the study area. Only the numerical values of the plate numbers noted since it would be unlikely for the same three or four digit number combination to repeat within the same hour. From the data obtained from the manual counts, the weekday morning peak hour was determined to be 7:00-8:00 am. This was used as a reference for the video footage to be analyzed. The volume counts obtained from the manual data gathering were also used in the simulations on DYNAMEQ.

3.4 Video Recording of Sections

Due to the large number of vehicles passing through the study area throughout one day, cameras were used in order to gather data during the morning peak hour. Primarily, the video footage was used for observing the queuing of cars due to vehicles stopping at the Leon Guinto Estrada intersection; however, the footage can also be used to obtain volume counts of vehicles passing by, as well as obtain violation counts on counter flowing pedicabs. Two cameras were on customized 10-foot stands in order to get a better view of the incoming traffic. One of the cameras was positioned at the Leon Guinto-Estrada intersection which would show the vehicles stopping at the intersection. Another camera was placed 120 m from the first camera in order to have a clearer view of the queuing of cars along the study area.

4. PRESENTATION OF DATA

4.1 Travel Time

The actual time and cumulative time the trial car traversed each link. Angelo King International Center (AKIC) to Singalong intersection has a distance of 108.13 m, Singalong to Leon Guinto has a distance of 211.70 m, and Leon Guinto to Taft Avenue has a distance of 80.76 m. The trial car traversing Singalong to Leon Guinto intersections take up most of the time throughout the whole network. The average travel time, as seen in Table 1, from AKIC to Singalong is 31.86 s, having an average speed of 6.10 m/s, Singalong to Leon Guinto takes 59.77 s having an average speed of 5.64 m/s, Leon Guinto to Taft Avenue has an average speed of 5.26 m/s in 25.86 s. The individual travel time per trial varies because of different factors like the volume of vehicles, traffic light, pedestrians crossing, and violations. As observed, the speed of the trial car decreases as the actual time approaches the peak hour. A great shift is evidently observed at the 6:00 am and the 6:43 am marks.

Table 1. Average Travel Time

Route	Average Time (s)
AKIC to Singalong	31.86
Singalong to Leon Guinto	59.77
Leon Guinto to Taft	25.86

Figure 2 shows the segments traversed by the marked vehicles summarized as well in Table 2. The AM data was taken from 7:00AM – 8:30AM while the PM data was obtained from 4:45PM – 6:30PM. Comparing the average times and speeds for the different conditions, it can be observed that majority of the average times in the AM are shorter than that of the PM, thus having a faster average speed. The shorter average time in the AM is most likely due to lesser vehicles traversing Estrada Street.

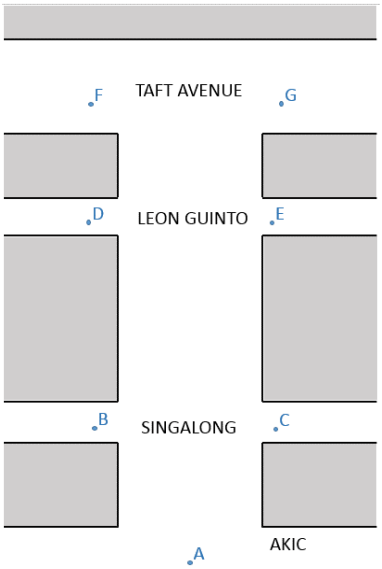

Figure 2. Routes Considered in the Study Area

Table 2. Average Travel Time per Route

TRAVEL TIME								
			AM			PM		
Route		Distance (m)	No. of vehicles	Ave. Time (s)	Speed (m/s)	No. of vehicles	Ave. Time (s)	Speed (m/s)
1	A-B	108.13	2	360	0.30	0	-	-
2	A-C	108.13	2	240	0.45	0	-	-
3	A-D	319.83	1	180	1.78	1	240	1.33
4	A-F	400.59	5	264	1.52	34	399	1.00
5	A-G	400.59	1	240	1.67	8	435	0.92
6	C-D	211.70	1	240	0.88	0	-	-
7	C-F	292.46	1	240	1.22	1	420	0.70
8	C-G	292.46	1	300	0.97	0	-	-
9	E-F	80.76	4	150	0.54	9	120	0.67
10	E-G	80.76	1	180	0.45	1	60	1.35

4.2 Coding Violations

Figure 3 summarizes the total number of coding and not coding vehicles that traversed the study area. For the AM peak hour, there was a total of 27 coding violations, which only comprises 2% of the total volume of vehicles during the peak hour. During the PM peak hour, there was total of 39 coding violations, which comprises 3% of the total number of vehicles passing the study area during the peak hour. These values are only small fractions of the total vehicle volumes, therefore the effects on traffic flow may be negligible.

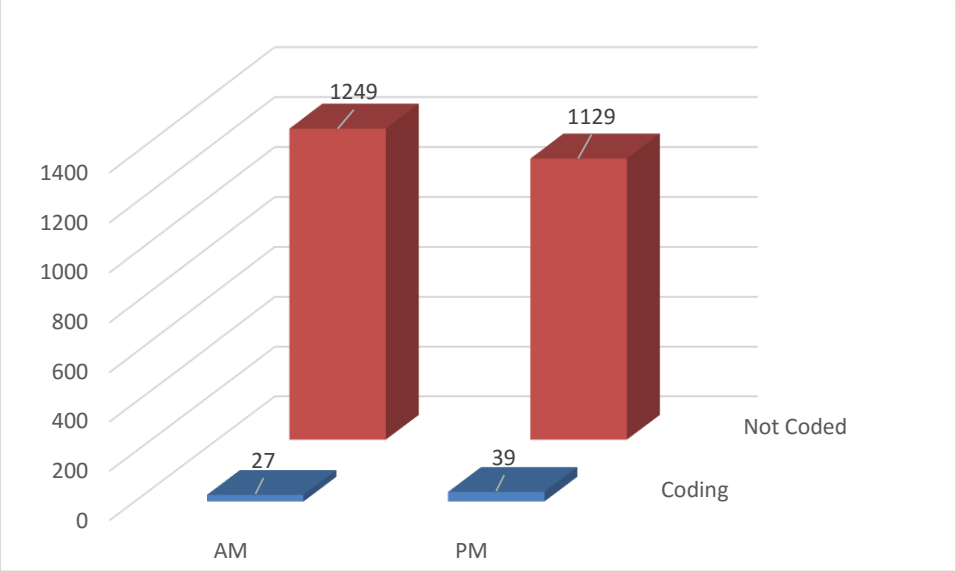

Figure 3. Coding Violations and Not Coding during AM and PM Peak Hours

4.3 Peak Hour Volume

The peak hour of the AM is from 7:00-8:00 am. There was a total of 1606 vehicles, as shown in Figure 4, that passed the study area at this time. The peak occurred close to the start of classes for the schools in the area, which are 7:30 am.

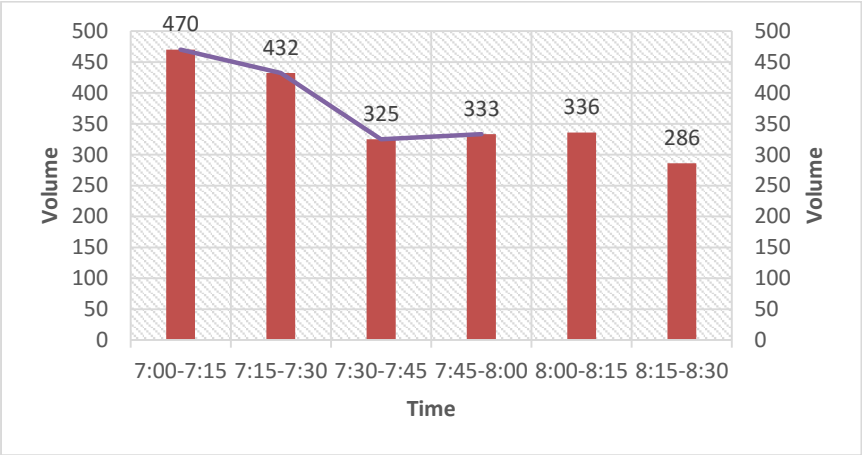

Figure 4. Volume Count (AM)

Figure 5 shows the volume of vehicles passing through the study area, as well as their origins and destinations. It can be seen that majority of the vehicles exit at either Leon Guinto or Taft. These vehicles are most likely headed to De La Salle University, College of St. Benilde, or St. Scholastica.

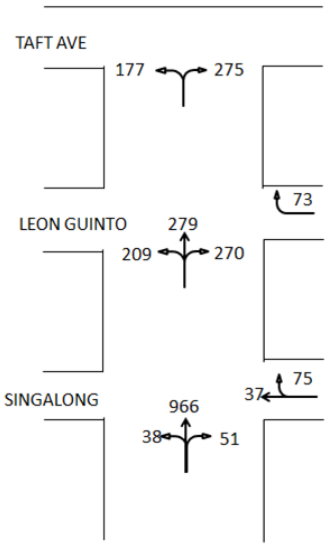

Figure 5. Volume per Exit

The peak hour for the PM shift occurred from 5:15-6:15 pm. There was a total volume of 1168 vehicles, as shown in Figure 6.

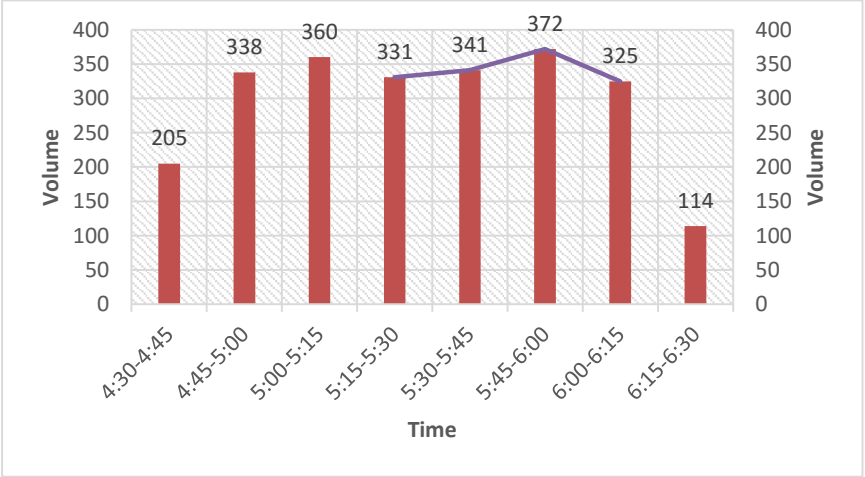

Figure 6. Volume Count (PM)

4.4 QUEUEING ANALYSIS

Queuing with the use of the Graphical Method was used to quantify the delay caused by violations along Estrada St. The network considered was from Singalong intersection to Leon Guinto, since there is no presence of a traffic light. Formation of queues cannot be fully analyzed if a traffic light is present. Lap times are recorded when a car passes through the respective markings wherein both free flow times and queued vehicles are observed. The graphical method requires that the distance in meters and the time in seconds be plotted to obtain their relationship. Figure 7 shows the area between the free flow series versus the queued vehicles. The area computed will represent the average delay of the queue represented in veh-min.

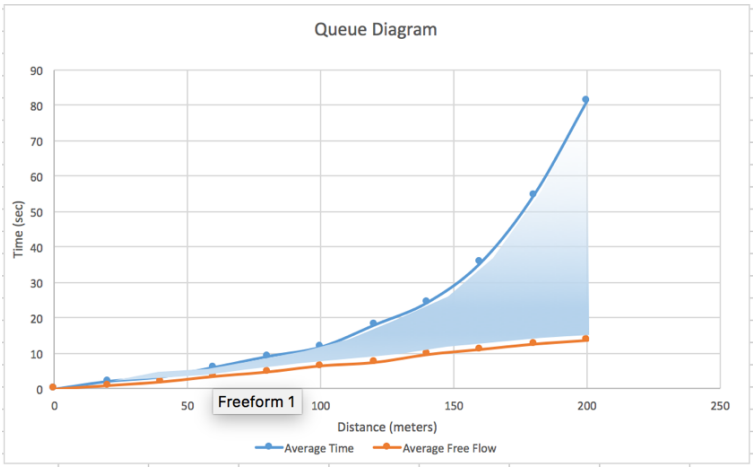

Figure 7. Area for the Average Delay

Two video footage collections were made in the study. The first was obtained in the month of April wherein only DLSU has classes ongoing. A total of 24 queues were observed. Figure 8 summarizes the breakdown of the queues made; it is evident that 25% of the queues were due to the blocking of Leon Guinto intersection.

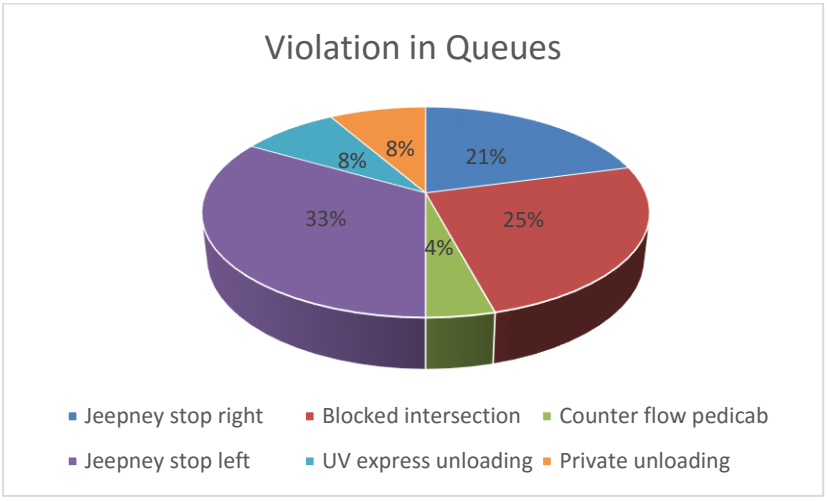

Figure 8. Violations in Queues for DLSU Only

Figure 9 reflects the average vehicle delay for the queues cause by the violations. Private car unloading along Estrada has the highest vehicle delay which has a value of 45.22 veh-min. It was recorded that that certain violation took 49 seconds along the 160 m and 180 m markings and 48 seconds along the 180 m to 200 m markings. Table 3 summarizes the cumulative time it took the private car to traverse the link. Table 4 summarizes the cumulative time a certain vehicle took when the violation made was the counterflow of pedicab. The tables also show the recommended cumulative time if the vehicle travels at a free flow speed.

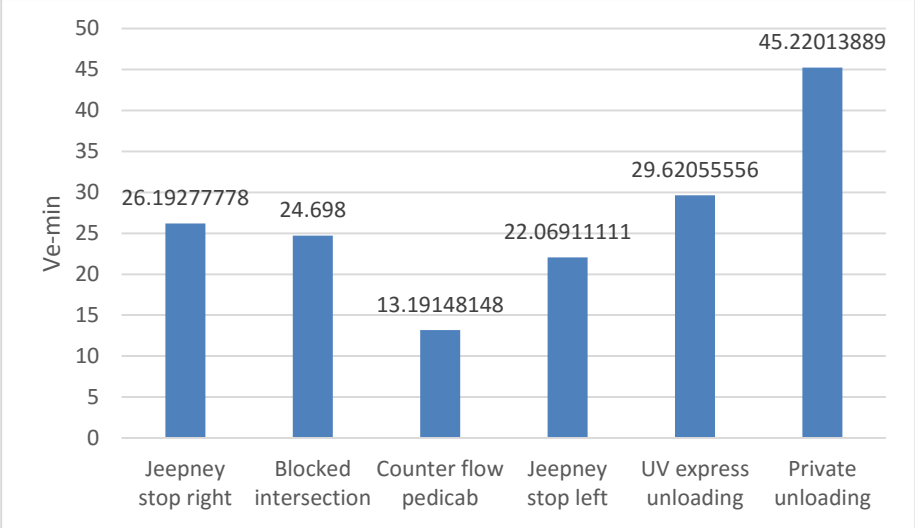

Figure 9. Vehicle Delay per Violation for DLSU Only

Table 3. Cumulative Time for Private Car Unloading

Distance	Time	Free Flow
0	0	0
20	2.76	0.99
40	8.17	2.04
60	9.69	3.6
80	17.9625	4.88
100	35.5425	6.6
120	40.8425	7.58
140	52.19	9.83
160	83.01	11.3
180	129.0025	12.8
200	188.7225	13.86

Table 4. Cumulative Time for Counterflow of Pedicab

Distance	Time	Free Flow
0	0	0
20	1.9	0.99
40	3.25	2.04
60	5.79333333	3.6
80	9.51	4.88
100	15.05	6.6
120	17.9933333	7.58
140	23.3566667	9.83
160	31.3166667	11.3
180	44.41	12.8
200	65.3866667	13.86

Figure 10 illustrates the master graph of the queue diagram for all the formed queues. It can be observed that all the graphs have the same trend; that is having very fast travel times from the 0 m to the 100 m markings then having significant changes in the travel time after the 100 m mark. The private car unloading has the largest area and pedicab counterflow has the least, as if almost negligible.

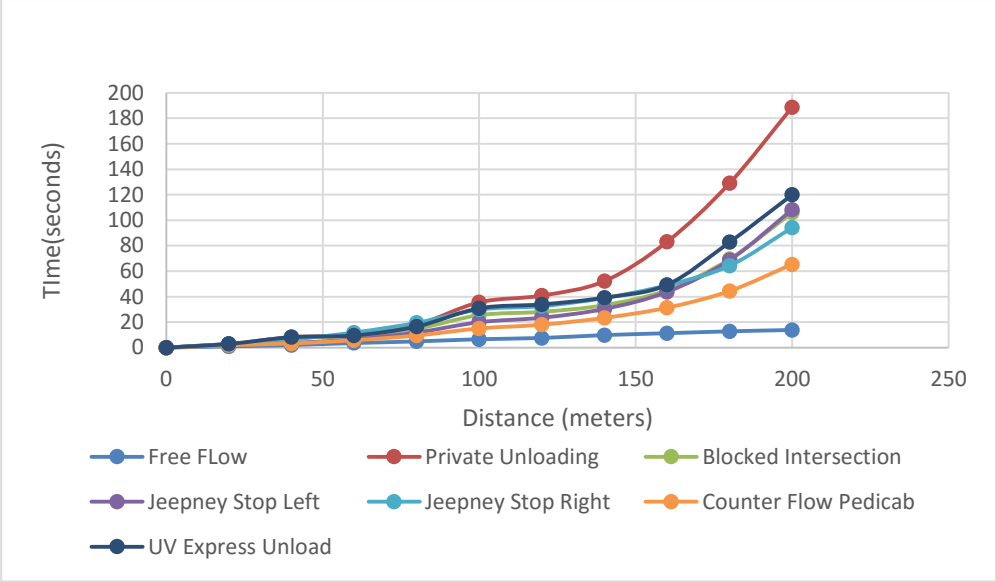

Figure 10. Master Graph of Queues

4.5 DYNAMEQ

A plate survey was done to identify the O-D trip matrix, shown in Table 5, for the network that was studied. The plate survey was done during a one and a half hour period to identify the peak hour volume from centroid to centroid.

Table 5. Developed O-D Matrix

O-D of ESTRADA		Destination						
		1	2	3	4	5	6	7
Origin	1	0	40	24	107	47	126	111
	2	0	0	0	0	0	0	0
	3	0	11	0	51	23	6	8
	4	0	0	0	0	0	0	0
	5	0	0	0	47	0	30	38
	6	0	0	0	0	0	0	227
	7	0	0	0	0	0	194	0

The 'current' scenario represented the actual condition of Estrada Street without a traffic discipline zone, based on the data obtained in the field. The “100% No Violation” scenario was modelled on the assumption that the TDZ is 100% effective and there will be no violations along the study area. The other scenarios modelled were potential management schemes that could be implemented in the TDZ. It must be noted that DYNAMEQ does not take into account the actual cycle times of signalized intersections. Tables 6 and 7 show the different values found once the different simulations were run through the DYNAMEQ software. The current situation in the DYNAMEQ modeler takes into account all of the violations occurring along the Estrada stretch. Each violation was simulated by slowing down the vehicle speeds at the lanes wherein they occurred. The tables show the “Current” situation to have a travel time of almost 250 seconds for the stretch of Leon Guinto to Singalong Street. It can be seen in the situation, “100% No Violation”, that the Estrada stretch can fully handle the volume and demand of vehicles, as specified in the OD matrix, during the morning peak. The delays in this situation did not even reach 1 second because there were no violations or blockages occurring on this road. The “100% No Violation” scenario was run to set an ideal situation wherein there would be no queues directly caused by traffic violations.

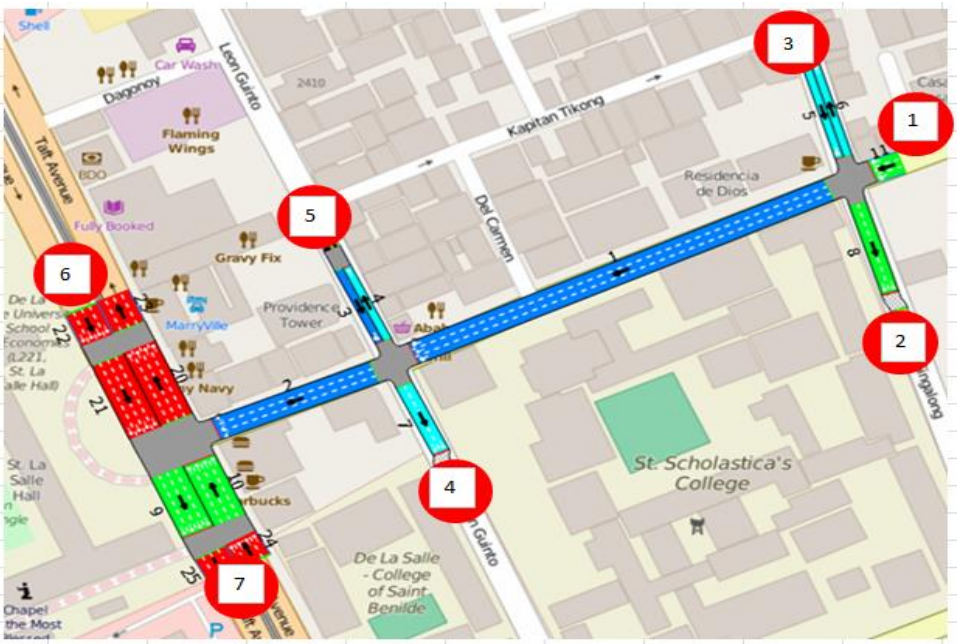

Figure 11. Centroids in the Scenario Simulation

Table 6. Outputs of Current, 100% No Violation, and One Jeepney Stop

	CURRENT			100% NO VIOLATION			ONE JEEPNEY STOP		
Link	Density ($\frac{veh}{km}$)	Travel Time (s)	Delay (s)	Density ($\frac{veh}{km}$)	Travel Time (s)	Delay (s)	Density ($\frac{veh}{km}$)	Travel Time (s)	Delay (s)
1	240.17	244.6		10.75	22.12	0.06	58.20	25.71	8.14
2	57.28	33.79	1.34	6.33	10.82	0.19	6.33	10.64	0.22
3	4.66	9.19	0.59	4.27	7.58	0.06	3.32	4.75	0.05
4	4.49	7.99	0.00	2.71	6.81	0.00	2.23	3.38	0.00
5	3.30	7.31	0.09	3.49	9.01	0.44	3.02	3.89	0.05
6	0.87	2.98	0.00	0.91	3.63	0.00	0.77	1.67	0.00
7	12.90	7.69	0.00	7.89	7.69	0.01	6.64	5.26	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	1.66	3.81	0.00
9	6.94	4.73	0.00	7.79	2.85	0.00	5.68	3.43	0.00
10	3.93	4.86	0.18	5.67	3.44	0.00	2.99	2.65	0.04
20	10.89	4.49	0.27	7.20	3.89	0.00	7.09	4.62	0.00
21	4.69	4.71	0.00	4.46	3.87	0.02	4.41	4.59	0.02

Based from the modelling, the presence of a jeepney stop, whether one or two, along this straight would cause significant delays. On average, having one jeepney stop along Estrada Street would cause an 8 second delay along the Singalong to Leon Guinto stretch while having two jeepney stops would have a 15 second delay. The presence of both a jeepney stop and a shared pedicab lane along this stretch is even worse, having a delay of 19 seconds. The worst scenario, “Jeepney Stop with Pedicab Lane”, produced a value of 19.62s for delay along the Leon Guinto to Singalong stretch. The best scenario modelled was the “Pedicab Lane” scenario with only a 0.35s delay for the same stretch.

From this, it can be said that the presence of having only a shared pedicab lane along Estrada from Leon Guinto to Singalong has a minimal effect on the traffic. It seems the best option from these management schemes would be to offer a shared pedicab lane along the left side of Estrada, from Singalong to Leon Guinto. It is was also assumed, however, that the pedicabs would no longer be allowed to counterflow along Estrada Street.

Table 7. Outputs of Two Jeepney Stops, Jeepney Stop With Pedicab Lane, and Pedicabe Lane

	TWO JEEPNEY STOPS			JEEPNEY STOP WITH PEDICAB LANE			PEDICAB LANE		
Link	Density ($\frac{veh}{km}$)	Travel Time (s)	Delay (s)	Density ($\frac{veh}{km}$)	Travel Time (s)	Delay (s)	Density ($\frac{veh}{km}$)	Travel Time (s)	Delay (s)
1	60.74	35.78	15.25	87.72	60.39	19.62	36.74	24.84	0.35
2	6.42	11.08	0.44	7.29	10.75	0.33	18.69	12.11	0.20
3	3.60	5.75	0.07	4.30	4.91	0.26	4.43	9.93	0.34
4	2.64	6.57	0.00	3.97	3.89	0.00	3.22	7.80	0.00
5	3.38	7.07	0.29	0.86	2.00	0.00	3.45	9.00	0.33
6	0.89	2.84	0.00	4.30	4.91	0.26	0.90	3.63	0.00
7	7.83	8.58	0.00	10.21	6.24	0.00	13.96	12.19	0.00
8	0.00	0.00	0.00	1.92	4.57	0.00	0.00	0.00	0.00
9	5.64	6.49	0.00	3.54	4.64	0.03	6.09	3.44	0.00
10	3.81	6.44	0.02	5.67	3.43	0.00	3.84	3.47	0.07
20	7.09	7.85	0.00	3.75	3.42	0.03	8.22	3.89	0.00
21	4.46	7.78	0.03	7.06	4.62	0.00	4.44	3.87	0.03

5. CONCLUSIONS

Based from the results of the simulations, it can be concluded that a Traffic Discipline Zone can be implemented to limit traffic violations with a minimal increase in travel time delay. By determining the violations that cause the most queuing and longest delays, the management schemes can be designed to alleviate these specific violations. From the scenarios modelled, the smallest delays among the simulated scenarios was that with the shared pedicab lane only. It is not advisable to have jeepney and PUV stops along Estrada Street. The peak hours for vehicles along Estrada Street occur from 7:00-8:00 am and 5:15-6:15 pm. These times coincide with the start and end of classes for the nearby academic institutions, as well as the usual evening rush hour when people get off work. A combination of private vehicles, PUV's, jeepneys, motorcycles, and pedicabs pass through the study area. Majority of these vehicles are private vehicles which enter the study area before Singalong Street. Aside from jeepneys, most vehicles that pass the study area exit at Taft Avenue. From the queuing analysis, it was determined that the main causes of delays are the jeepneys and PUVs stopping along Estrada Street. Jeepneys are the most frequent cause of queuing while PUVs stopping to pick up and drop off passengers cause the largest delays for other vehicles. In order to plan an effective Traffic Discipline Zone, these violations must be addressed.

6. RECOMMENDATIONS

The researchers recommend that jeepneys should not be allowed to stop along Estrada Street due to the queuing and travel time delays caused. A shared pedicab lane may be implemented at the left

most lane in order to control the behavior of the pedicabs along Estrada Street; the counterflowing of pedicabs should be completely prohibited.

In order to further develop this study, it is recommended that the queuing along the Taft intersection and those at Leon Guinto by the College of St. Benilde and St. Scholastica gates also be taken into account since these occurrences affect the queues which start at Leon Guinto. During the data gathering, it was noticed that the queuing during the latter half of the peak hours tend to start from Taft Avenue, which was already outside of the initially planned study area. Due to the large number of pedestrians in the area, the effects of pedestrians on queuing can also be studied. The pedestrian cycle along Taft Avenue was observed to be too short for the number of pedestrians crossing. Moreover, cars from Estrada continued to turn left and right into Taft even at the green cycle of pedestrians. Further data gathering can be done to determine whether there is a peak during the middle of the day. Since the dismissal times of the academic institutions in the area are not synchronized, it is possible that there is a midday peak hour for vehicle. It is highly likely that the patters of the violations occurring during the midday peak may differ from the morning and evening peaks due to more space on the road and the higher speeds.

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