TRAFFIC CONGESTION ANALYSIS OF MOLINO ROAD AND DAANG HARI ROAD INTERSECTION AND APPLICATION OF CONTINUOUS FLOW INTERSECTION (CFI)

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ABSTRACT

This paper analyzed Molino Road and Daang Hari Road Intersection and applied the Continuous Flow Intersection which was compared to the current condition of the intersection and the proposed intersection design. The study conducted a 16-hour manual traffic count in 14 days with 7 days of the holiday season that started from November 24 to November 30, 2018, and 7 days of the non-holiday season that started from January 28 to February 3, 2019. The researchers interviewed 3 traffic enforcers, a barangay representative, 13 commuters, 3 motorists, and the Bacoor Traffic Management Development planner to highlight the problem factors that affect the performance of the intersection. The simulation tool PTV Vistro determined the result of the gathered data and the design tool PTV Vissim planned the Continuous Flow Intersection. The results showed that the conducted manual traffic countingfor both holiday and non-holiday season determined the AM peak hour that starts from 6am to 9am and PM peak hour that starts from 4pm to 9pm. The PM peak 5pm to 6pm data was used by the researchers on the analysis of Level of Service. The level of service of the current condition of the intersection falls to F for both holiday and non-holiday.After the optimization of the signal timing and CFI design application the result changed to D for the holiday and C for the non-holiday. Results showed that the proposed design improves the current condition of the intersection.

Keywords: PTV Vistro, PTV Vissim, Traffic Congestion, Intersection, Continuous Flow Intersection

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INTRODUCTION

Users of the road were pedestrians, bicycles, motorcycles, and vehicles that were classified into two: private cars and public vehicles such as PUJ, bus and tricycle. Due to insufficient space on the roads, traffic flow can be disturbed and can be a major problem. It has acquired hundreds or thousands of attention from the citizens and also from the government. The trips usually are snaillike and are not reliable on traffic congestion areas. There are several factors that cause traffic congestion including the collision of cars, road constructions, rapidly growing community of the city, vendors who force to put their businesses on the main road, vehicle owners who park their car just anywhere, and unreliable transportation system which leads to citizens being dependent on their vehicles. The intersection may be the heart of fatalities around the world because a high chance of bumping into someone else's path is constant whether driving on a small or big city.There are several common or traditional types of intersections, one is the four-way where two roadways meet and usually, a traffic signal controls the said intersection. Next, the T-junction it is also a two roadway that meets but one is a major road and the other is minor. The third type is the Y-junction it is like the T-junction, but two roadways will merge into one lane. Lastly, a roundabout is where vehicles follow a counterclockwise direction going to their desired exit of the road.

Theoretical Framework

The traditional intersection is where two roadways meet; it is the usual problem that causes traffic congestion in some areas because vehicles have different movements at the same time especially at unsignalized intersections. In the present time, there are factors that people consider buying cars. This affects the volume of cars passing through certain areas. Another arising problem in the Philippines is the ongoing road projects that affect the traffic flow and the rapid growth of the population. Through PTV Vistro, it evaluates the traffic system of the desired location and if proven negative, PTV Vissim helps us design new modeled roadway that can be effective or a solution to the traffic flow problem. There may be a possible alternate solution to this problem, the Continuous Flow Intersection (CFI) or Displaced Left-turn (DLT) is one of the alternative designs solutions that engineers came up to. The design of CFI is internationally accepted although few areas in different countries implemented CFI, some countries have uncertainty to use the design

Traffic Congestion

There are some hindrances or challenges of solving issues about the traffic system in our country. Increase in population, undisciplined drivers, pedestrians and motorist continue to worsen as a delay of time of going somewhere. It also exposed the pedestrians and vehicles in total risk. The traffic volumes and demands that lead us to complicated problems in the intersections generate us to design an alternative way on how to deal with traffic congestions. There are two descriptions of congestionsfirst of which is traffic-based. Traffic-based is defined when traffic demand is more than the maximum volume of traffic that can usually travel alongside a particular section of road. On the other hand, alternative economicbased states that congestions avoid the vehicles to imposed due to the connections among speed and the total volume of traffic. It defines where the traffic system is in full capacity. Another way to solve the problem of traffic congestion is to take away a number of vehicles on a map in which traffic congestion can be avoided. Vehicles are not allowed to violate traffic rules. They can merge in any part of the chart that was provided. U-turns can only be taken from a traffic crossing and not in the middle of the road. The efficiency of this routing system is judged by the normal period of time that the vehicle traveled.

METHOD

The methods used in this study are Road inspection. The researchers visited and examined the junction then conducted an audio-recorded interview to Bacoor Traffic Management Development chief and traffic admin, 13 commuters, 1 barangay representative, 3 motorists and 3 traffic enforcers to know the current condition of the intersection. Analysis of the traffic system using PTV Vistro was done where researchers conducted a 16-hour manual traffic count consisting of 7 days of the holiday season that starts from November 24 to 30, 2019, and 7 days of the non-holiday season from January 28 to February 3, 2019. The data that was gathered was used to analyze the level of service (LOS) of the intersection. The planning of the Continuous Flow Intersection (CFI) to the road junction and utilization of PTV Vissimis the third where the proposed design was created and evaluated to incorporate all vehicle class in a single model. Lastly, the researchers compared the results of the current condition of the intersection to the proposed intersection design and highlighted the problem factors that affect the performance of the intersection to evaluate the results.

DESIGN

The researchers gathered data from the manual traffic count atDaang Hari road and Molino road Intersection was used as an input to PTV Vistro, the simulation tool evaluated the intersection and showed the level of service of the intersection. Level of service (LOS) is a measurement of operational performance of an intersection, roads, and highways. By determining the level of service of each intersection, there are factors to consider such as a number of lanes, lane width, median length, crosswalk width and length, approach, lane configuration, and phase diagram. It also depends upon actual traffic volume and layout of traffic.

Figure 1.Daang Hari road and Molino road Intersection
Source: Google Maps

Conceptual Framework

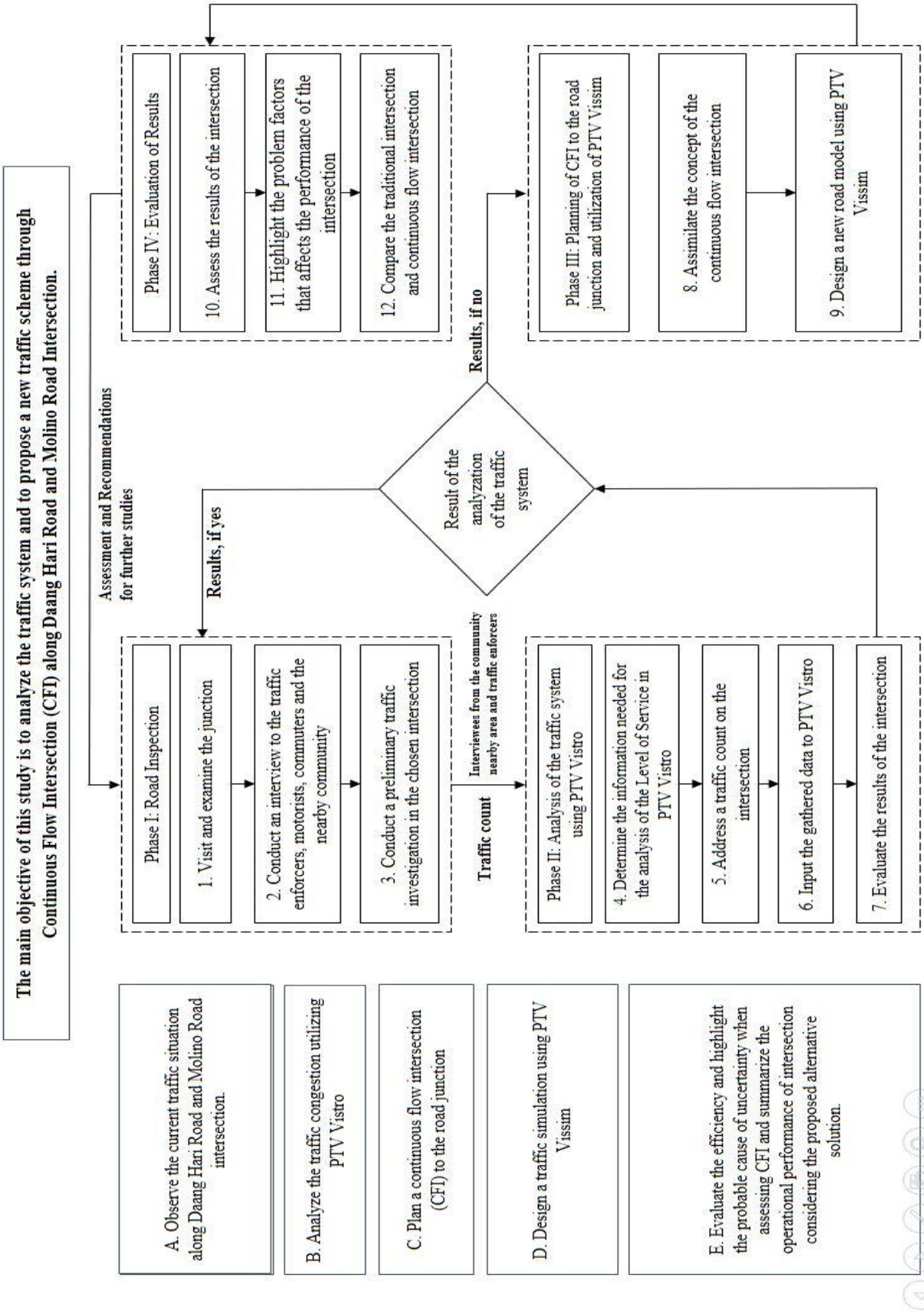

Figure 2. Conceptual Framework

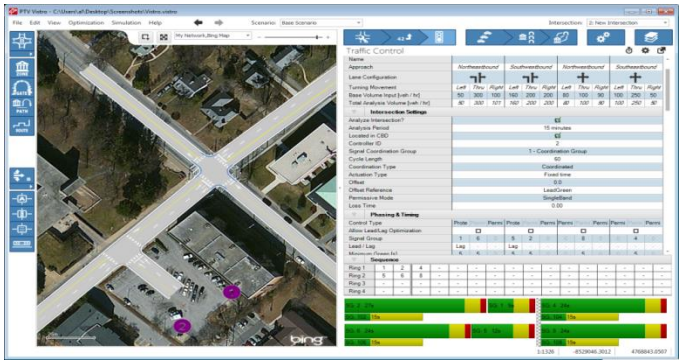

Figure 3. PTV Vistro
Source: http://vision-traffic.ptvgroup.com

Table 1. Level of Service Criteria for Signalized Intersections

Level of Service	Average Control Delay (seconds/vehicle)	General Description
A	≤10	Free Flow
B	>10 – 20	Stable Flow (slight delays)
C	>20 – 35	Stable flow (acceptable delays)
D	>35 – 55	Approaching unstable flow (tolerable delay, occasionally wait through more than one signal cycle before proceeding)
E	>55 – 80	Unstable flow (intolerable delay)
F[1]	>80	Forced flow (congested and queues fail to clear)

Source: *Highway Capacity Manual 2010*, Transportation Research Board, 2010.
1. If the volume-to-capacity (v/c) ratio for a lane group exceeds 1.0 LOS F is assigned to the individual lane group. LOS for overall approach or intersection is determined solely by the control delay.

Figure 4. Level of Service Criteria
Source: http://www.seatacwa.gov

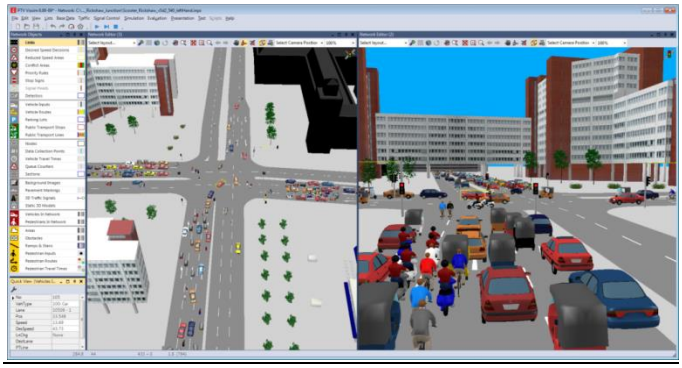

Figure 5. PTV Vissim Road Model
Source: http://vision-traffic.ptvgroup.com

RESULTS AND DISCUSSION

Current Design and Situation of Daang Hari Road and Molino Road Intersection

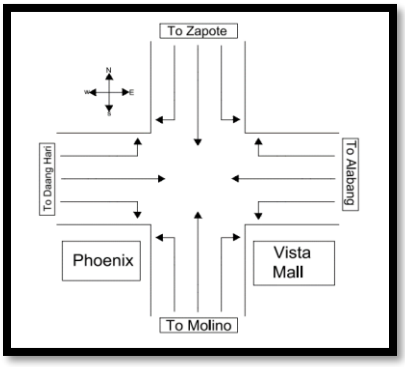

Figure 6. Road Map of the Intersection

Passenger Car Unit (PCU) or Passenger Car Equivalent (PCE) is a metric that is used in Transportation Engineering, to convert the other vehicle classes.

In this study, the researchers used PCU to convert other vehicle classes to a passenger car and to know the volume of the intersection with the same vehicles of that class only.

Table 1 PCU Equivalent

Vehicle Type	PCEF
Motorcycle	0.5
Passenger Car	1.0
Jeepney	1.5
LCV	2.2
Bus/Truck	3.5

Table 2 Total Traffic Volume and Passenger Car Unit (Non-holiday)

Time	Total Traffic Volume	PCU/Hr Equivalent
6 am to 10 pm	528306	560036

Total Traffic Volume and Passenger Car Unit (Holiday)

Table 3 Traffic Volume

Time	Total Traffic Volume	PCU/Hr Equivalent
6 am to 10 pm	556163	697876

Table 4 Cycle Time of the Intersection

Color	Direction			
	To Paliparan	To Zapote	To Alabang	To Imus
Green	70	50	60	40
Amber	3	3	3	3
Red	159	175	170	185

The researchers accumulated the holiday data on November 24 to 30, 2018 and the non-holiday data from January 28 to February 3, 2019, from 6 am to 10 pm.The total traffic volume of the 14-day manual traffic count is shown in the appendices. 5:00 pm to 6:00 pm was the researcher's base data used in PTV Vistro to analyze the level of service (LOS) of the intersection.

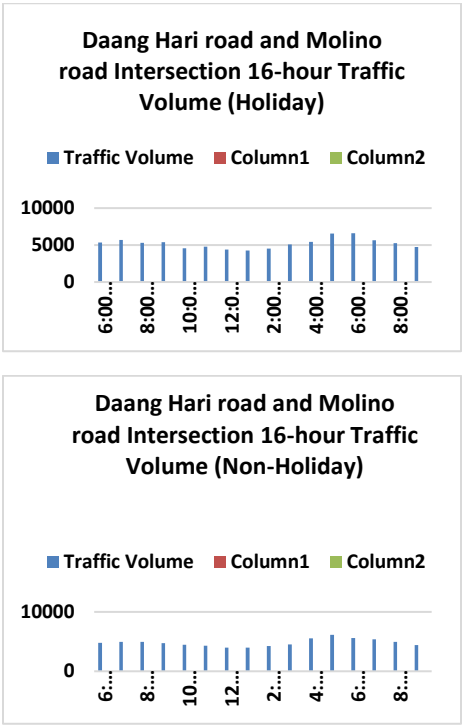

Figure 7. Traffic Volume Column Chart (Holiday and Non-holiday Season)

Data Analysis of the Current Condition

Table 5 Level of Service of the Current Situation of the Intersection

	Holiday Season	Non-holiday Season
Intersection Delay [s/veh]	676.65	672.99
Intersection LOS	F	F

Level of Service of the current condition of the intersection for the holiday and non-holiday season is shown in Table. It shows that the level of service of both seasons falls on the last level.

Data Analysis of the Proposed Design

Table 6 LOS of the Proposed Design (Removal of 1 Left Turn)

	Holiday Season				Non-holiday Season			
	North	South	East	West	North	South	East	West
Intersection Delay [s/veh]	845.16	523.24	1042.14	797.12	772.02	442.34	929.18	670.03
Intersection LOS	F	F	F	F	F	F	F	F

Table 7 LOS of the Proposed Design for the Holiday Season (Removal of 2 Left Turn)

	Holiday Season					
	East & West	North & South	North & West	North & East	South &East	South & West
Intersection Delay [s/veh]	840.47	319.30	598.60	915.59	563.79	295.69
Intersection LOS	F	F	F	F	F	F

Table 8 LOS of the Proposed Design of the Non-holiday Season (Removal of 2 Left Turn)

	Non-holiday Season					
	East & West	North & South	North &West	North & East	South &East	South & West
Intersection Delay [s/veh]	708.13	288.98	530.69	867.50	484.32	201.15
Intersection LOS	F	F	F	F	F	F

Table 9 LOS of the Proposed Design for the Holiday Season (Removal of 3 Left Turn)

	Holiday Season			
	North, South & West	North, South & East	South, East & West	North, East & West
Intersection Delay [s/veh]	22.16	319.43	296.88	675.53
Intersection LOS	C	F	F	F

Table 10 LOS of the Proposed Design for the Non-holiday Season (Removal of 3 Left Turn)

	Non-holiday Season			
	North, South & West	North, South & East	South, East & West	North, East & West
Intersection Delay [s/veh]	28.23	324.68	210.36	741.73
Intersection LOS	C	F	F	F

Table 11. LOS of the Proposed Design (Removal of 4 Left Turn)

	All Left Turn Removed	
	Holiday Season	Non-holiday Season
Intersection Delay [s/veh]	25.36	18.70
Intersection LOS	C	B

The primary design of CFI is to eliminate or relocate the left turning vehicles. It adds a special bay that will oppose the traffic for approximately 100 meters before the main intersection and its radii will range from 45 meters to 60 meters. The advantages of the continuous flow intersection (CFI) are, fewer conflict points on the main intersection, capacity of the intersection will increase, can reduce intersection delays, crossing the intersection may be a lot less fatal, and decreases congestion. While the disadvantages are, pedestrian crosswalk length will expand, confusion in drivers will occur, and there may be additional signage before the main intersection.

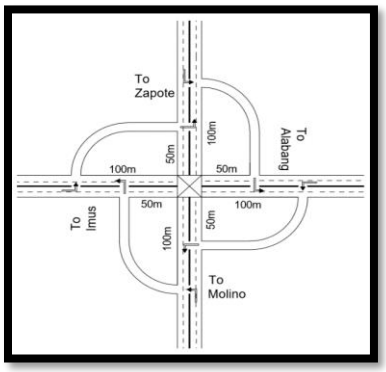

Figure 8. CFI Design

The level of service of the proposed design shows in the Table. In this study, the researchers used gradual reduction of left turn to identify what works best with the intersection and optimization of the signal timing to lessen the intersection delays and to improve the performance of the intersection. The result shows that removal of 4 left turns will result to a higher level of service.

Table 12 Projected Traffic Volume in 6 years

Type of Transport	Left		Thru		Right	
	Present	Projected	Present	Projected	Present	Projected
Private	1467.29	1910.79	2570.14	3347	433.71	573.92
Public	296.71	409.11	457.29	630.53	96.58	133.18
Freight	190.43	258.12	258.72	350.7	114.57	155.3

Table 13 Coefficient Values of Projected Scenario in 6 years on Southern Tagalog

Years	Type of Transport	Coefficient
1- 6 years	Private Transport	4.5
	Public Transport	5.5
	Freight Transport	5.2

$$V_F = V_B(1 + TRG)^n$$

Equation 1. The formula for the Projected Traffic Volume

Projected scenario volume in 6 years is shown in Table. The researchers used the formula and the multiplier from the Department of Public Works and Highways (DPWH).

Problem Factors

The problem factors that affect the performance of the intersection based on conducted interview from Bacoor Traffic Management Development (BTMD), barangay representative, traffic enforcers, commuters, motorists and community nearby are, traffic volume because the intersection has only a capacity of 900 vehicles/hour per lane and based on the researcher's traffic count data, each lane exceeded the maximum capacity, limited road network, influx of passengers, commercial growth and human error.

CONCLUSION

The level of service of the current condition using the PCU equivalent falls on the F level for both holiday and non-holiday season. Intersection delay for holiday season is 676.65 s/veh and for the non-holiday season is 672.99 s/veh. After having an output of the LOS of the current condition, the researchers used the traffic count data and applied it to the PTV Vistro using the proposed design and experimented the gradual reduction of left turns, the researchers concluded that the removal of all left turns in the intersection works best with the proposed design. Intersection delays with the total reduction of left turns decreased to 25.36 s/veh for the holiday season and 18.70 s/veh for the non-holiday season. It shows that it has only minimal delays compared to the traditional intersection.

After comparing the current design and the proposed design, the researchers concluded that theoptimized signal timing from vistro helped the overall performance of the intersection. Eliminating the left turning vehicles on the main intersection improves the performance from F level to either C or B level, even on the projected traffic volume in 6 years.

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