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Design of a Bike-Friendly Protected Intersection Between A. Soriano Avenue and Juan Luna Avenue Extension, Cebu City

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***Abstract*—** *The Philippines, along with 191 other countries, was affected by the coronavirus disease in 2020. The government encourages people to ride bicycles to help prevent the spread of the Corona Virus disease 2019 (COVID-19 virus), which benefits people's overall health and well-being. However, as the number of cyclists rises, conflicts involving bicycles and motor vehicles also rise. This research aims to mitigate bicycle-vehicle intersection conflicts by designing a bike-friendly protected intersection between A. Soriano Avenue and Juan Luna Avenue Extension, Cebu City. Moreover, the researchers summarized the volume counts in 15-minute intervals over an hour, and the observation was done twice a day for two days. The results and significant findings showed that the volume of bicycles that passed through the intersection was 126 per hour. In addition, the average number of right-turning motor vehicles per hour was 711. Furthermore, the road width along the intersection was 11.875 meters and had a bike lane width of 2.44 meters. It was necessary to design and construct a bike-friendly protected intersection in the area studied to reduce the conflict points at the intersection between bicycles and motor vehicles. Finally, the bike-friendly protected intersection design will significantly improve the safety of all road users.*

***Keywords*—** *Bicycle-Vehicle Conflicts, Bike-Friendly Intersection, Intersection Conflicts, Protected Intersection.*

I. INTRODUCTION

As everyone suffers with the pandemic, it has triggered a wide-ranging intervention in public services, including mass transportation, where restrictive measures are taken and imposed to minimize its profound impacts on contracting and spreading the virus when utilizing the public transportation systems. The transportation sector underwent an unprecedented sea of change, compelling the system to face adaptive and transformative challenges. So, the government sector introduced bicycling as an alternative mobility option to foster equitable public transportation amid the pandemic.

To adequately adapt to the new mode of transportation, they also asserted that the new way of transportation would involve technology-driven, integrated, and sustainable alternatives that will not only address COVID-19 transmission but will also transform road transport to become efficient and reliable, environmentally friendly and safe to the public. It showed that people prefer bicycle facilities separated from traffic [1]. Bike facilities with physical separation, such as posts or curbs, also improved comfort [2]. Furthermore, the study shows that having suitable designs may be critical to increasing the number of people who ride bicycles beyond the existing bicyclists [3]. Moreover, reallocating the roadway from motor vehicles to cycling is vital to providing facilities for cyclists [4].

The intersections are the most common location for vehicle-bike conflicts. Moreover, there is a need to protect cyclists from such dangerous incidents by providing safe places for cyclists and automobiles to operate at peak efficiency [5]. Separating cyclists and cars positively affects cyclist safety and reduces points of conflict between cyclists and vehicles. Therefore, as cities intend to make streets safer and more welcoming for bicyclists of all ages and abilities, intersection design is the key. Consequently, better bike networks need safer intersections.

The Dutch intersection, or the protected intersection, is a clever yet surprisingly simple solution to an issue that has afflicted communities. It is particularly effective since it focuses on the intersections where bicyclists and cars are most likely to collide. A protected intersection is an extension of the protected bike lanes on the intersection specifically designed to facilitate and ensure the safe navigation of cyclists on the protected bike networks and to distinguish the route that the cyclists must take at the intersection [6]. Furthermore, the bike-friendly protected intersection is a good design as it is relatively new to the country, particularly in Cebu City. The design specifications of the Dutch intersection of the previous studies follow their respective country's design standards. Hence, this became the gap in the study since our country also has specific design criteria for constructing intersections.

This research will further promote the safety and comfortability of the bicyclists, motorists, and pedestrians who will cross the intersection.

II. SOURCES AND METHODS

2.1. Sources of Information

The researchers used the observation method to gather the study's primary data. They observed the flow of vehicles at the intersection, the number of bicycles that passed the intersection, and the surrounding structures within the area. Furthermore, the researchers used the secondary data for the DPWH Design Guidelines, Criteria and Standards (DGCS) and Cebu City District Engineering Office – DPWH, Cebu City Transportation Office (CCTO).

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2.2. Research Procedures

The researchers manually counted and tallied the number of bicycles and right-turning motor vehicles that passed through the intersection over one hour. The volume counts were summarized in 15-minute intervals for an hour, and the observation was done twice a day for two days.

This research used Total and Average Volume to analyze and interpret the data. After the interpretation, the researchers designed the components and the geometric features of the proposed protected intersection.

III. Results, Design, and Discussion

3.1. Average Number of Bicycles that Pass the Intersection between A. Soriano Avenue and Juan Luna Avenue Extension, Cebu City

TABLE 1. Number of Bicycles that Pass the Intersection

Date	Time	Number of Bicycles coming from:				
		D1	D2	D3	D4	TOTAL
February 24, 2022	9:55 – 10:10 A.M.	8	5	12	4	29
	10:10 – 10:25 A.M.	6	9	5	2	22
	10:25 – 10:40 A.M.	9	11	4	8	32
	10:40 – 10:55 A.M.	6	9	4	11	30
						113
February 24, 2022	1:55 – 2:10 P.M.	9	7	10	4	30
	2:10 – 2:25 P.M.	4	3	10	4	21
	2:25 – 2:40 P.M.	4	6	5	12	27
	2:40 – 2:55 P.M.	5	4	0	6	15
						93
February 25, 2022	7:35 – 7:50 A.M.	34	11	16	9	70
	7:50 – 8:05 A.M.	19	9	11	2	41
	8:05 – 8:20 A.M.	13	7	4	10	34
	8:20 – 8:35 A.M.	8	11	8	10	37
						182
February 25, 2022	8:55 – 9:10 A.M.	13	11	7	4	35
	9:10 – 9:25 A.M.	9	5	10	4	28
	9:25 – 9:40 A.M.	9	13	9	3	34
	9:40 – 9:55 A.M.	4	8	5	2	19
						93

LEGEND:
D1 = M.J. Cuenco Avenue and Pope John Paul II Avenue
D2 = F. Cabahug St. and Kaohsiung St.
D3 = Central Nautical Highway and 2nd St.
D4 = Sergio Osmeña Jr. Boulevard

Table 1 shows the number of bicycles that passed the intersection. The bicycle counts were summarized in 15-minute intervals for an hour, and the observation was done twice a day for two days. During the first day and first hour of the observation, 113 bicycles passed the intersection. In the second hour, a total of 93 bikes passed the intersection.

Furthermore, on the second day and during the first hour, 182 bicycles passed the intersection. Lastly, on the second hour, a total of 116 bicycles passed the intersection.

The average volume was 126 bicycles per hour. The data was gathered on two separate days and for two hours per day to be more credible and relevant data for the study.

3.2. Average Number of Right Turning Motor Vehicles that Pass the Intersection between A. Soriano Avenue and Juan Luna Avenue Extension, Cebu City

Table 2 shows the number of right-turning motor vehicles by tallying the number of motor vehicles that crossed the intersection. The right-turning motor-vehicle-counts in 15-minute intervals for an hour were done twice a day for two days. During the first day and first hour of the observation, 655 right-turning motor vehicles crossed the intersection. In the second hour, 1057 right-turning motor vehicles crossed the intersection.

TABLE 2. Number of Right Turning Motor Vehicles that Pass the Intersection

Date	Time	Number of Bicycles coming from:				
		D1	D2	D3	D4	TOTAL
February 24, 2022	9:55 – 10:10 A.M.	31	72	14	57	174
	10:10 – 10:25 A.M.	25	68	6	39	138
	10:25 – 10:40 A.M.	36	84	6	51	177
	10:40 – 10:55 A.M.	36	77	13	40	166
						655
February 24, 2022	1:55 – 2:10 P.M.	37	131	10	106	284
	2:10 – 2:25 P.M.	32	133	7	94	266
	2:25 – 2:40 P.M.	50	123	9	63	245
	2:40 – 2:55 P.M.	45	129	7	81	262
						1057
February 25, 2022	7:35 – 7:50 A.M.	23	49	4	30	106
	7:50 – 8:05 A.M.	48	64	5	34	151
	8:05 – 8:20 A.M.	37	54	2	21	114
	8:20 – 8:35 A.M.	30	49	9	32	120
						491
February 25, 2022	8:55 – 9:10 A.M.	37	60	8	38	143
	9:10 – 9:25 A.M.	45	64	5	55	169
	9:25 – 9:40 A.M.	32	64	6	51	153
	9:40 – 9:55 A.M.	35	75	14	52	176
						641

Furthermore, on the second day and during the first hour, 491 right-turning motor vehicles crossed the intersection. Lastly, 641 right-turning motor vehicles crossed the intersection in the second hour.

The average volume was 711 right-turning motor vehicles per hour. The data was gathered on two separate days and for two hours per day to be credible and relevant data for the study.

3.3. Road Dimensions along the Intersection

TABLE 3. Road Dimensions along A. Soriano Avenue and Juan Luna Avenue Extension

Road Name	Road Width	Bike Lane Width
A. Soriano Avenue	11.875 m	2.44 m
Juan Luna Avenue Extension	11.875 m	2.44 m

Table 3 shows the data through coordination with the DPWH Regional Office 7. The road width of Juan Luna Avenue Extension is 11.875 meters. Moreover, the road width of A. Soriano Avenue is also 11.875 meters. On the other hand, the bike lane width of A. Soriano Avenue and Juan Luna Avenue Extension are both 2.44 meters.

3.4. Types of Vehicles that are Allowed to Pass the Intersection

According to DPWH Regional Office 7, all vehicles are can pass the intersection along A. Soriano Avenue and Juan Luna Avenue Extension, Cebu City.

3.5. Social Condition

The social condition of a bike-friendly protected intersection design will become an icon to the locality because it is relatively new to our country, particularly in Cebu City. Furthermore, the proposed bike-friendly protected intersection

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will improve the operating performance of motor and non-motorized vehicles, enhance the safety outcomes for cyclists and pedestrians, and attract new cyclists to an eco-friendlier mode of transportation.

3.6. Design of the Bike-Friendly Protected Intersection

Fig. 1. A Proposed Design of a Bike-Friendly Protected Intersection between A. Soriano Avenue and Juan Luna Avenue Extension, Cebu City.

Figure 1 shows a bike-friendly protected intersection design along A. Soriano Avenue and Juan Luna Avenue Extension, Cebu City, with measurements that conform to the DPWH Design Guidelines, Criteria, and Standards. The design catered to a flow rate during 15 minutes of the design hour.

3.7. Design of the Bike-Friendly Protected Intersection

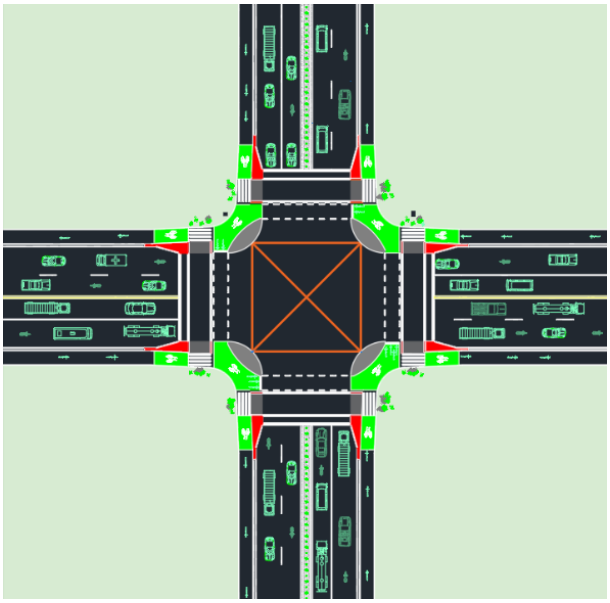

Fig. 2. Top View of the Proposed Design of a Bike-Friendly Protected Intersection between A. Soriano Avenue and Juan Luna Avenue Extension, Cebu City.

A. Corner Island – the design of the corner island has a curb radius of six meters to efficiently accommodate the design vehicles, primarily composed of passenger vehicles. Moreover, the curb radius will encourage the larger vehicles to a slower or crawl-speed turn and allow them to use multiple receiving lanes.

B. Pedestrian Island – The dimensions of the width of the road and the width of the bike lane are 11.875 meters and 2.44 meters, respectively. Furthermore, the length conforms with the crosswalk's width of 4 meters. Lastly, the design height of the pedestrian island was 100 mm, and it has ramps at its ends to accommodate persons with disabilities.

C. Bike Queue Area – The design of the queueing area for the bicycles has a depth of 3 meters from the center of the stop bar, and has a total area of 7.32 m².

D. Forward Stop Bar for Bicycles – The design width of the forward stop bar for bicycles was 0.3 meters and had a setback distance of 0.3 meters from the roadway to the center.

E. Recessed Stop Bar for Motor Vehicles – The design width was 0.4 meters and had a setback distance of 14.52 meters from the roadway to the center. Also, the design width of the forward stop bar markings for a motor vehicle was 0.4 meters.

F. Zebra Pedestrian Crossing

G. Crosswalk – The zebra pedestrian crossing and crosswalk had a design length of 4 meters. Also, the markings have a design width of 0.3 meters.

H. Bike Lane – A one-lane bikeway must have a minimum width of 1.22 meters, which leaves 0.60 meters for the bike width and 0.31 meters for weaving space on each side, resulting in a desirable surface width of 1.22 meters or a minimum of 2.44 meters for a two-lane bikeway. Lastly, the bike lane markings along the intersection have a design length of 1 meter, and the distance between its gaps was also 1 meter.

I. Elongated Island – It should be at least 1.2 meters wide and 6 to 8 meters long. It also had a design length of 7.55 meters and a design height of 150 mm.

J. Lane Width – The designed lane width was 11.875 meters.

K. Road Width – The intersection width was equal to the total width of the road section. The lane line and centerline markings had a design width of 0.15 meters. And the edge line markings had a width of 0.1 meters. Lastly, the junction box marking located at the center of the intersection has a design length of 19.315 meters and a design width of 0.2 meters.

L. Median – Due to the road width constraint, the design used the minimum width of the median, which was 1.5 meters. Moreover, the width of the median concrete wall was 0.15 meters.

M. Bicycle Turning Radius – The bicycle's turning radius design in the protected intersection has a turning radius of 5 meters.

3.8. Bike Traffic Flow in the Intersection

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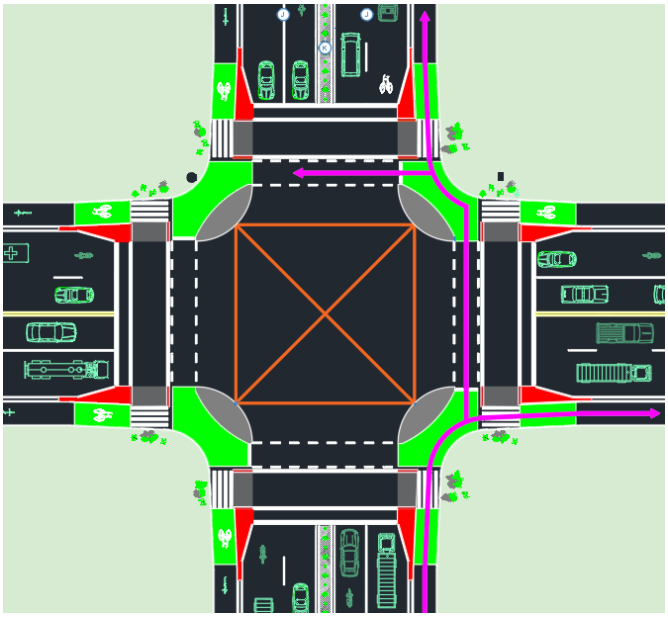

Fig. 3. the Bike Flow Design in the Intersection.

Figure 3 shows that right-turning bicycles can immediately turn without waiting for traffic signals. Furthermore, the right-turning bicyclists have no conflict with motor vehicles, which allows them to make a right turn at any time. Moreover, due to the corner islands and bike-way setbacks, the bicyclists going straight will be highly visible to the motor vehicle drivers while still at the Recessed Stop Bar. Lastly, the bicyclists will not have to merge along the traffic lanes when turning left.

IV. Conclusions, Recommendations

4.1. Conclusion

Based on the gathered data, there is a need to design and construct a bike-friendly protected intersection along A. Soriano Avenue and Juan Luna Avenue Extension, Cebu City, to mitigate the conflict points between bicycles and motor vehicles in the intersection. Furthermore, the bike-friendly protected intersection design will effectively increase the safety of all road users. Lastly, the bike-friendly protected intersection will provide comfort and convenience for vulnerable road users, especially pedestrians and bicyclists.

4.2. Recommendation

Guided by the findings and conclusions obtained from the data analyzed, the researchers recommended the following:

4.2.1. Future studies might include focus groups and surveys to determine how the road users adapt to the project and identify their level of satisfaction in navigating the Bike-Friendly Protected Intersection.

4.2.2. Feasibility study will be conducted to determine whether the design of the bike-friendly protected intersection is adequate for the locale of the study.

4.2.3. Since the study was limited only to the design and material cost estimates, future researchers can continue to work on the overall cost estimates and duration of the Proposed Bike-Friendly Protected Intersection.

4.2.4. Categorize the types of right-turning vehicles that will pass the intersection.

4.2.5. Also, conduct a feasibility study for new design developments to improve the design of the bike-friendly protected intersection and assure the project's viability.

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References

[1] Pdxs. PDXScholar, N. McNeil, C. M. Monsere, and J. Dill, "The Influence of Bike Lane Buffer Types on The Influence of Bike Lane Buffer Types on Perceived Comfort and Safety of Bicyclists and Perceived Comfort and Safety of Bicyclists and Potential Bicyclists Potential Bicyclists Citation Details Citation Details", Accessed: Aug. 03, 2022. [Online]. Available: https://pdxscholar.library.pdx.edu/cengin_fac/221

[2] J. Dill and N. McNeil, "Revisiting the Four Types of Cyclists: Findings from a National Survey:," *https://doi.org/10.3141/2587-11*, vol. 2587, no. 1, pp. 90–99, Jan. 2016, doi: 10.3141/2587-11.

[3] P. Pdxscholar, C. Monsere, N. Mcneil, and R. Sanders, "User-Rated Comfort and Preference of Separated User-Rated Comfort and Preference of Separated Bike Lane Intersection Designs Bike Lane Intersection Designs," 2020, Accessed: Aug. 03, 2022. [Online]. Available: https://pdxscholar.library.pdx.edu/cengin_fac

[4] R. Victorya, "Sustrans Design Manual Handbook for cycle-friendly design".

[5] J. Sadik-Khan Principal *et al.*, "Designing All Ages and Abilities Bicycle Crossings Cover Photos NACTO Executive Board Working Group NACTO Project Team Technical Review Advisory Committee NACTO Cities for Cycling Committee representatives," 2019.

[6] "They've Invented An Ingenious New Type Of Intersection That Could Save Lives | HuffPost Good News." https://www.huffpost.com/entry/dutch-junction_n_56a0260be4b0d8cc1098b7b3 (accessed Aug. 03, 2022).