Application of Complete Streets Concept on the Central Business District of Tacloban City Focused on Urban Bikeway Design

Christine G. CACDAC [a], Jose Regin F. REGIDOR [b]

[a,b] *Institute of Civil Engineering, College of Engineering, University of the Philippines-Diliman, Quezon City, 1101*
[a] *Email: cgcacdac@up.edu.ph*
[b] *Email: jfregidor@up.edu.ph*

Abstract: Application of the complete streets concept on the Central Business District of Tacloban City focused on the urban bikeway design needed to alleviate traffic congestion on its grid-type network. Having bicycle lanes can improve safety, economic growth and community livability in the area. This study justified that reduction of the capacity of a traveled lane could still accommodate the traffic volume of each street. Four of the Knapp's Feasibility Factors: roadway and environment, total volume and level of service, pedestrians and bicycle activities, and on-street parking are used to assess each road in the downtown. This assessment together with the guidelines from NACTO and AASHTO were the basis for formulating the applicable design treatment in every street considered. The output of the study was a design layout for bikeways along every street in the CBD of Tacloban City, along with the analysis and justifications of the result.

Keywords: Complete Streets, Urban Bikeway Design, Traffic Congestion

1. INTRODUCTION

1.1 Background of the Study

Tacloban City has been proclaimed by President Gloria Arroyo as a Highly Urbanized City by virtue of Proclamation No. 1637 on Oct. 15, 2008. Being at the center of the transport link of the Luzon and Mindanao road network, it became the gateway of the region and the center of commerce, trade and industry, education, and communication and technology.

As the most progressive city in Eastern Visayas, it has a 2.13 percent annual growth rate which in turn made it the highest populated city among the five ranking cities in the region. (Tacloban City, 2016). According to the City Planning and Development Office, Tacloban City is an expeditiously expanding city in terms of population. The total population from Philippine Statistics Authority as of August 1, 2015 is 242,809. Given the increasing demand in business and population, the city has only 198.049 kms. road networks which lead to traffic and congestion of vehicles. Traffic congestion in the city has been one of the perennial concerns lately. To lessen this congestion, the city has conducted Traffic Impact Assessments and has led to the relocation of its ports and terminals outside the city center. However, this would not be able to solve worsening traffic congestion due to increasing daily vehicle trips and considering that it still has the 19th century Spanish road network pattern where it is characterized by narrow city blocks and a closer structure setback. The lack of working traffic lights on its intersections, unregulated on-street parking and rampant jaywalking has aggravated the problem. One of the proposed solutions that had been raised last 2016 was to widen existing roads to the maximum standards. However, this could not be applied to several roads due to limited road space which in turn makes road expansion impossible to achieve. Worsening traffic congestion and pedestrian frustration from lack of crosswalks (Jopson, 2010) can be alleviated and proper lane allocation for parking can be done by completing the streets and introduction of appropriate space lanes such as Bicycle Lanes.

In the Philippines, the Marikina Bikeways Project (MBP) which had been funded by a grant from the Global Environment Facility of the World Bank (WB) is the first bikeway project in the country. This is one of the resolutions proposed by Marikina City Mayor Marides Carlos-Fernando to the worsening traffic congestion of motorized vehicles in the city. With this benchmark, this research project is persuaded to apply complete streets concept.

Tacloban City as a newly classified Highly Urbanized City, must learn the ways of other highly urbanized cities local and abroad, who have successfully steered their city to become economically and socially responsive and administratively capable with their fiscal management system. (Tacloban City, 2016)

1.2 Objective

The main objective of the study is to apply the complete streets concept focused on urban bikeway design to alleviate the increasing rate of traffic congestion and develop a people-oriented space in the Central Business District of Tacloban City. Since designing is not a one-size-fits-all approach, it requires a case-to-case basis analysis which leads to its specific objectives which includes; to assess every road along the CBD considering Knapp's Feasibility Factors, to develop suitable street design based on the established criteria and design guidelines from NACTO and AASHTO, to assess every design and give the corresponding benefits of having a Bikeway in the area.

1.3 Contribution of the Study

The primary contribution of this study is to present context-sensitive designs for Tacloban CBD streets using the complete streets concept focused on Bikeway layout to demonstrate the viability of bicycles as an alternative transport mode for intra-city trips and increase the community acceptance of using bicycles and non-motorized transport (NMT).

In line with this is the provision of design treatments that would also be beneficial in improving place's safety, operations, community livability, and can deliver positive economic effects in the area. Particularly for safety, these design treatments can reduce vehicle speeds which correlates with higher comfort level thus reduces the case of crash rates; for operations, which can improve traffic flow by reduction of number of conflict points while increasing a road's efficiency; for community livability and walkability, proper street design can reduce traffic noise and provides consumer transportation cost savings; and for cost effectiveness, complete streets concept can be an alternative to road widening, it can be properly designed by re-using the existing pavement width and curbs.

2. LITERATURE

Streets with different surroundings and constraints require different design considerations and treatments. According to AASHTO (2012), a good bicycle plan starts from the community's current stage. The Knapp's Feasibility Factors Research Study on Road Design is to be adopted for the road assessment of every street in the Central Business District of Tacloban. The factors Roadway Function and Environment, Overall Traffic

Volume, Capacity and Level of Service, Turning Volume and Patterns, Pedestrian and Bicycle Activity, and Parallel Parking are to be evaluated as follows:

Table 1: Knapp's Feasibility Factors, Characteristics and Sample Evaluation Questions

Factor	Characteristics	Sample Evaluation Questions
Roadway Function and Environment	● Actual, Expected, and Desired Primary Function (Access Mobility, or a Combination of the two) ● Community Objectives for the Roadway ● Available Right-of-Way ● Current and Expected Adjacent Land Use	● What is the primary current, expected, and desired function of the roadway? ● Is the goal for the roadway improvement increased safety with somewhat lower mobility? ● Is the right of way limited?
Overall Traffic Volume and Level of Service	● Peak-Hour Volume ● Intersection and Level of Service ● Volume of Vehicles and Capacity of the Road ● Types of Vehicles ● Existence of Turn Lanes Type of Route Scheme (one-way or two-way)	● Is a decrease in arterial travel speed of 5mph (8kph) or less acceptable? ● What is an acceptable reduction in intersection level of service? What level of daily traffic volume exists (assuming a 50/50 split and 10% of daily volume occurs during peak hour)
Pedestrian and Bicycle Activity	● Number and locations of pedestrians ● Number and Location of Bicyclist Use ● Characteristics of Pedestrians and Bicyclists ● Cross Sectional Width	● What is the pedestrian and bicyclist friendliness of the roadway? ● Do pedestrians and bicyclists have safety concerns? ● How will pedestrians and bicyclists interact with parallel parking? ● Can a bike lane be added after the conversion?
On-Street Parking	● Number of Parking Maneuvers ● Operational and Safety Impacts	

Aside from roadway function and environment, studies indicated that the most significant factors influencing bicycle use are traffic volume, speeds and capacity. The road capacity used in the Central Business of Tacloban will be based on the Philippine Road Capacity studies undertaken by the Planning Services of the Department of Public Works and Highways (1975-1977,1979) as shown in Table 2:

Table 2: Basic Hourly Capacities according to Road Type (DPWH, 1979)

Road Type	Carriageway Width (m)	Roadside Friction	Basic Hourly Capacity
Highway	≤ 4.0	None or Light	600
Highway	4.1 – 5.0	None or Light	1,200
Highway	5.1 – 5.5	None or Light	1,800
Highway	5.6 – 6.1	None or Light	1,900
Highway	6.2 – 6.5	None or Light	2,000
Highway	6.6 – 7.3	None or Light	2,400
Highway	2 x 7.0	None or Light	7,200
Urban Street	≤ 6.0	Heavy	1,200

Urban Street	6.1 – 6.5	Heavy	1,600
Urban Street	6.6 – 7.3	Heavy	1,800
Urban Street	2 x 7.0	Heavy	6,700

2.1 Guidelines and Standards

Good design practice must acknowledge a context sensitive design approach with a standard understanding of its users and functions. Roadway width and Bikeway Facility are the design treatment's great factors. Design guidelines were determined based on the assessment of each road.

NACTO Urban Bikeway Design considers street design as a balance of function and movement needs. Safety and livability are the driving parameters in design. Design in general is a variable and can be subjective. However, on this research, designs were technical on the four Knapp's feasibility factors, NACTO guidelines and case studies of complete streets concept. The design guidelines and general considerations used came from the NACTO Urban Bikeway Design, Street Design Guide and AASHTO (1999) Guide for the Development of Bicycle Facilities.

2.1.1 Design guidelines for the roadway component

Roadway width is one of the limitations that needs to be consider while planning the design. It restrains the width of every road component

a. Bikeway Component - Six (6) feet is desirable bike lane width which are adjacent to curb face. Places where illegal parking in bike lanes is a concern and if it's from the face of a curb or guardrail to the bike lane stripe. At least 5ft width bike lane near a parking lane and an additional 2 ft to those bike lanes adjacent to a guardrail or other physical barrier.
b. Vehicle Component - Lane widths of ten (10) feet are appropriate in urban area and have a positive impact on a street's safety without impacting traffic operations. For designated truck or transit routes, one travel lane of 11 feet may be used in each direction.
c. On-street parking Component - Parking Lane widths of 7-9 feet are generally recommended. Cities are encouraged to demarcate the parking lane to indicate to drivers how close they are to parked cars.
d. Pedestrian Component - The pedestrian component is the accessible pathway parallel to the street. This space ensures that pedestrians have enough and safe place to walk. Pedestrian Lane widths of 5-7 feet in residential settings and 8-12 feet in commercial areas are recommended.

2.1.2 General considerations for different bikeway facilities

Conventional Bike Lanes are best use on streets with greater than or equal to 3,000 motor vehicle average daily traffic with a posted speed of greater than or equal to 25mph. They are applied on streets with high transit and traffic vehicle volume, regular truck traffic, and high parking turnover.

Left-side Bike Lanes are conventional bike lanes on a one-way street or median divided streets with frequent bus stops or truck loading zones on the right side of the street. Also used on streets with high parking turnover, high volumes of right turn movements by motor vehicles and with a significant number of left-turning bicyclists.

Marked Lanes are considered for space constrained roads with narrow travel lanes, variable volume count with speed of 35mph. Useful where there is a rampant case of on-street parking on collectors or minor arterials.

2.1.3 Bicycle lanes at intersections

Bicycles, motorists, and pedestrians experienced the most intense conflicts on intersections. Bicyclists tend to re-route due to different orientation and placement of the bicycle lane on the next street. Conflicts between motorists and bicyclists on intersections I-5 and I-12 were found due to the orientation of the bike lanes along Avenida Veteranos Avenue, Salazar Street, and Paterno Street. Bicyclists need to turn left from Avenida Veteranos to the said streets. These are shown in Figure 6.

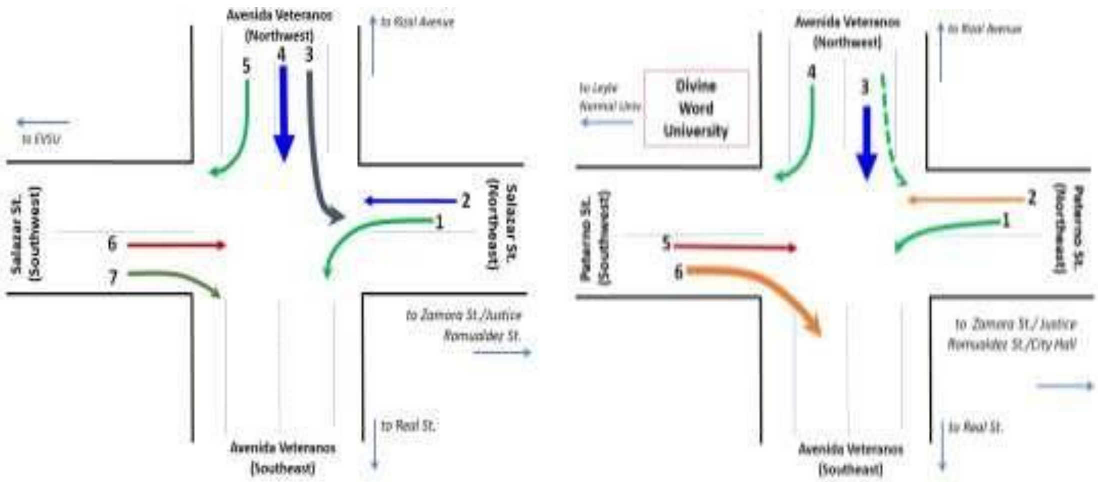

Figure 1. Movements at Intersection I-5 and I-12

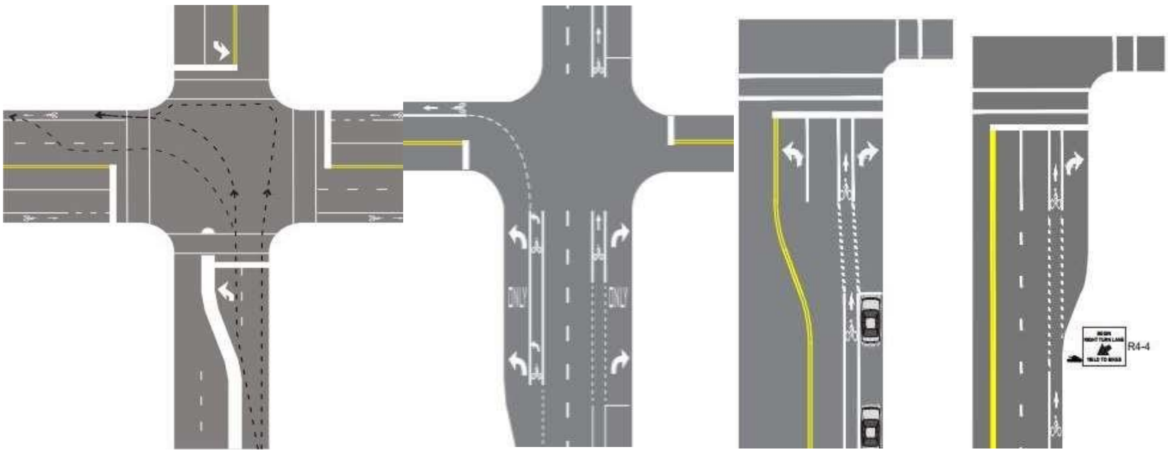

Figure 2. Intersection with right turn and left turn considerations (AASHTO, 2012)

Good design on an intersection must not cause conflicts on intersections. Figure 7 is an illustration of a good design from AASHTO (2012) that shows possible design on intersections with a right turn and left turn considerations. These designs especially the left turn considerations are best suitable for intersections I-5 and I-12. *"In two of the methods, the* *bicyclists merges left in advance of the intersection to turn from the same location as other left-turning vehicles. In the other method, the bicyclist proceeds straight through the intersection, stops on the far side of the intersection (at the corner) and turns the bicycle to the left, and then proceeds across the intersection again on the cross street, or as a pedestrian in the crosswalk. The method is more common in locations with high volumes of motor vehicles, and/or where there are high speeds because it is more difficult for bicyclists to merge left"* (AASHTO, 2012).

3: COMPLETE STREETS AND EVALUATION OF EXISTING CONDITIONS

3.1 Complete Streets

As defined by Smart Growth America (2017): *"Complete Streets are streets for everyone. They are designed and operated to enable safe access for all users, including pedestrians, bicyclists, motorists and transit riders of all ages and abilities. Complete Streets make it easy to cross the street, walk to shops, and bicycle to work. They allow buses to run on time and make it safe for people to walk to and from train stations."*

One of important features in the complete streets concept is the introduction of bikeway in the road space. The scheme is contextualized along the lines of "people-oriented" transport rather than "car-oriented". Also, the problem on air pollution due to vehicle emission, increasing fare rate and volatile gas price have made significant impacts in terms of the treatment of bicycle as a mode of transport.

3.2. Road Assessment of Tacloban City CBD's Existing Conditions

Four of the Knapp's Feasibility Factors Research Study were adopted on road assessment to every street in the CBD, which includes; roadway functions and environment, Over-all traffic volume, capacity, level of service, pedestrian and bicycle activity and on-street parking.

3.2.1 Roadway functions and environment

Roadway width is a limiting factor when considering the re-organization of a given corridor. Roadway geometries are essential to know the measurement limitations of each street design.

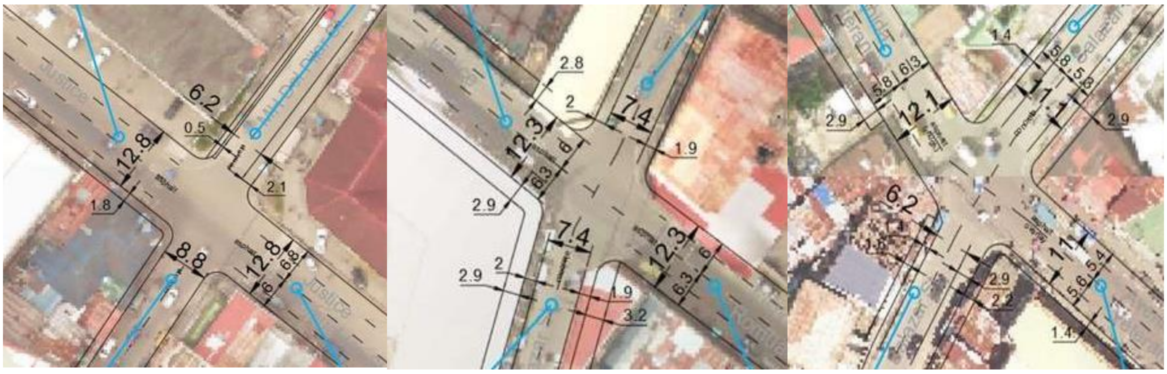

Figure 3. Roadway Measurements of Intersections I-1, I-2, and I-5

Figure 4. Roadway Measurements of Intersections I-6,I-7, and I-11

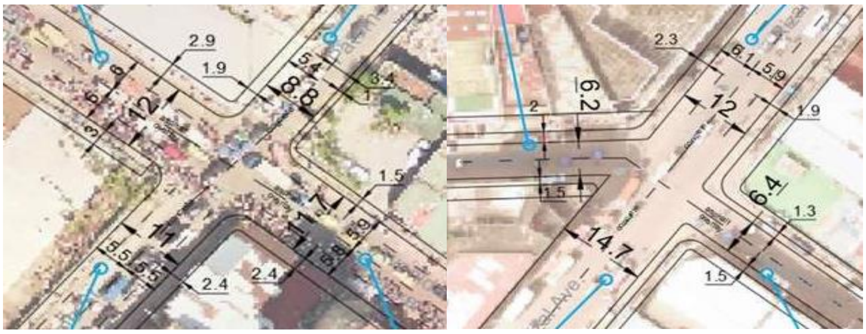

Figure 5. Roadway Measurements of Intersection I-12 and I-13

The road measurement data as shown on figures 1,2, and 3 has been problematic due to not uniform dimension all throughout the road. Per block has different width measurement. However, the least available measurement width was used. These data are essential on width measurements allocation of each road component.

In terms of function, it was noticed that all streets have a roadway function of access to property. According to the State of Rhode Island Division of Statewide Planning, accessibility refers to the ease of entering or exiting a roadway to or from adjacent priorities with low-speed**.** It can be noticed that the CBD of Tacloban consists mainly of commercial areas with a little residential.

Figure 6. Existing Land Use of the Central Business District of Tacloban

The red color marks the commercial areas while the yellow one constitutes to the residential part as shown in figure 6. The city blocks along the streets consist mostly of commercial establishments, medium-density condominiums, residential areas and local stores. The existence of private business institutions established a continuous transaction with consumers and residents that make it an active street for everyone and a major cause of traffic congestion of the area.

3.2.2 Overall traffic volume, capacity and level of service

The volume count data were derived from the Tacloban study (NCTSFI, 2018). Among the intersections in the study, only eight of these were used in the analysis of the study; I-1 Justice Romualdez St. MH del Pilar St, I-2, Justice Romualdez St. Salazar St. - Sen. Enague St., I-5 Avenida Veteranos - Salazar St., I-6 Congressman Mate Avenue - Avenida Veteranos, I-7 Rizal Avenue- Burgos St., I-11 Real St. - Avenida Veteranos, I-12 Avenida Veteranos - Paterno St. and I-13 Rizal Avenue- Gomez St.

The 16-hour traffic counts used 18 vehicle categories as follows: Bicycles, E-Bike, Motorcycle, Pedicab, E-pedicab, Motorcycle, Motor cab for Hire (MCH), Passenger Car/SUV/Private up/Van, Taxi, Public Utility Jeepney, Van for hire/UV Express, Mini bus (PUB), Standard Bus (PUB), School/Company Tourist Vehicles, Pick-up/Delivery Truck, Rigid Truck, Semi-Trailer, and Others. These data were used to check the efficiency of the road network by the comparison of traffic volume and its calculated capacity, and to plan prioritization of roads improvement schemes.

Road traffic is comprised of different vehicles with varying characteristics which gives different impact on the capacity of the road. Passenger car units (PCUs) are used where the effect of a vehicle type on the road is expressed as so many times that a typical passenger car would have. These factors were multiplied to the volume of each roadway then divided by the capacity to get the corresponding level of service. Table 3 shows the PCU used in the study.

Table 3. Corresponding PCU of each Vehicle Type Observed

Vehicle Type	PCU	Vehicle Type	PCU
Bicycle/e-Bike	1.5	Van for Hire/UV Express	1.5
Motorcycle	0.5	Mini Bus	1.5
Pedicab / E-pedicab	0.5	Standard Bus	2
Motor Cab for Hire	1.5	School/Company Tourist Vehicle	1.5
Passengers Car/SUV	1.5	Truck	2
Taxi	1.5	Semi- Trailer	2.5
Public Utility Jeep (PUJ)	1.5	Other	1.0

Peak Traffic Volume is known to be the maximum number of vehicles observed to pass on a given point on a road in each time. Peak volume data were used in the calculation of the level of service of each road. Table 4 shows the summary of peak traffic volume, capacity and LOS classification of each streets.

Table 4. Peak Traffic Volume Count, Capacity and Level of Service

Street	Volume (veh/hr)	Capacity (pcu/hr)	Volume/ Capacity Ratio	Level of Service
Avenida Rizal Avenue	1,778	2,400	0.74	D
Salazar Street	2,330	1,200	1.94	F
MH del Pilar Street	935	1,200	0.78	D
Paterno Street	1,882	1,200	1.57	F
Real Street	2,796	2,400	1.16	F
Avenida Veteranos	2,636	2,400	1.1	F
Burgos Street	2,040	2,400	0.85	D
Gomez Street	797	1,200	0.66	C
Justice Romualdez Street	1,889	2,400	0.79	D

As shown in figure below, the function of the roadway and its computed volume demand found that there is a correlation between the level of service of a certain place to its land use. It showed that the most congested roads are those streets having big businesses and institutions. Intersections 2, 5, and 11 have the worst level of service; LOS F. At these streets, various institutions and businesses are placed. Figure 5 illustrates the summary of the level of service going to each street.

Figure 7. Level of Service on each intersection in the CBD of Tacloban City

The road capacity used in the Central Business District of Tacloban City was based on the Philippine Road Capacity studies undertaken by the Planning Services of the Department of Public Works and Highways (1975-1977,1979). Capacity represents the ability of the system to handle traffic whereas level-of-service looks at the system from the driver's perspective. Road Capacities under Philippine conditions are about 20% higher than those reported in the 1965 U.S. Highway Capacity Manual. It could be due to the average passenger car unit on Philippine roads which is smaller compared to that in the US.

This study reduced the roadway width of streets to give spaces for bikeways. Aside from completing the street, the maximum allowable volume that can be accommodated must be computed, given that the capacity was reduced with the same current level of service. The designed traveled way was reduced to approximately 10 15% of its original roadway width. Given this, the capacity was also reduced to the same percentage range as shown in the 4th column of the table 5 below.

Table 5. Computation of the New Volume Demand from the Reduced Capacity

Street	**Volume (Bicycles not included)**	**LOS Criteria**	**Reduced Capacity**	**Maximum Allowable Volume Demand**
Avenida Rizal Avenue	1,420	0.85	2,040	1,734
Salazar Street	2,120	2	1,020	2,400
*MH del Pilar Street	935	0.85	1,200	1,020
Paterno Street	1,710	2	1,020	2,200
Real Street	2,459	2	2,040	4,080
Avenida Veteranos	1,971	2	2,040	4,080
Burgos Street	1,861	0.85	2,040	1,870
*Gomez Street	797	0.70	1,200	840
Justice Romualdez Street	1,655	0.85	2,040	1,734

*Street with Sharrow type Bikeway Facility, their volume includes bicycles

The allotment of separate bikeway facility reduced the volume demand in the traveled lane. The volume count of e bikes/bicycles from the survey was subtracted to the maximum total volume count in the street to arrive at the volume covered only by motorists, such as PUJ, pedecabs, private vehicles, etc. The current level of service within each street was retained, however, the values used for the consideration of the maximum allowable volume demand were the upper limit in the range of each LOS. The reduced capacity was multiplied to its corresponding LOS upper limit value to get the maximum allowable volume demand.

Table 6. Comparison of the Volume Count Survey Demand and the Computed Maximum Volume it can accommodate

Street	Existing Volume (bicycles not included)	Maximum Volume	Percent Deviation (%)
Avenida Rizal Avenue	1,420	1,734	22
Salazar Street	2,120	2,400	13
*MH del Pilar Street	935	1,020	9
Paterno Street	1,710	2,200	29
Real Street	2,459	4,080	66
Avenida Veteranos Street	1,971	4,080	107
Burgos Street	1,861	1,870	0.5
*Gomez Street	797	840	5
Justice Romualdez Street	1,655	1,734	5

*Street with Sharrow type Bikeway Facility, their volume includes bicycles

Table 6 shows the comparison of the existing motorist's volume to the computed allowable volume given the reduced capacity of each street in the Central Business District of Tacloban. It justifies that despite the reduction of traveled lanes, it can still accommodate the surveyed volume demand within the area with its current level of service. The introduction of Bikeway spaces does not compromise the operation in the traveled lane.

3.2.3 Pedestrian and bicycle activity, on-street parking

High cases of pedestrians in the area were observed from survey and google map street view. People from residential areas with quite a distance from commercial areas, like groceries and local stores, tend to walk instead of using vehicles and transit. They were seen to stroll from one establishment to another. However, space for pedestrians has been one of the concerns along the area. Vendors and illegal on-street parking opt to occupy these spaces.

Off-street parking is available in front of areas especially on banks and malls to give spaces for their customers. However, cases of rampant illegal on-street parking were still noticed, especially along streets of Justice Romualdez Streets and Avenida Rizal Avenue where the bulk of commercial establishments are found. Existing on-street parking like those along Avenida Veteranos Street was always occupied.

Table 5 shows the volume count of the different vehicle classification passing through each street from 6am to 10pm. A total of 314,496 vehicle count was recorded from the survey area. Every street has a corresponding presence of bicycles or e-bicycles. This means that a bikeway component must be present in the right-of-way to accommodate these numbers or to attract more bicyclists.

Table 7. 16-hour Vehicle Count on each street

Streets	Bikes/ Ebike	Passenger/ Private Cars/ SUV	PUJ	PUB	Truck/ Trailer	Motorcycle/ Pedicab	Others	Total
Avenida Rizal	**358**	24,663	22,049	718	3,611	18,301	532	70,232
Salazar Street	**210**	7,869	2,882	144	838	26,098	315	38,356
MH del Pilar	**68**	3,270	102	40	197	7,912	68	11,657
Paterno	**172**	5,033	1,573	125	316	7,949	171	15,339
Real	**337**	11,898	105	363	973	8,809	413	22,898
Avenida Veteranos	**665**	31,889	26,814	1,007	3,784	25,515	827	90,501
Burgos	**179**	4,177	999	140	863	13,041	100	19,499
Gomez	**105**	1,860	48	86	301	10,719	47	13,166
Justice Romualdez	**234**	11,702	11,989	375	832	7,211	505	32,848

4. DISCUSSION

In this study, the application of complete streets concept focused on urban bikeway design was employed. For a community that is embarking upon bicycle planning, like Tacloban City, comprehensive road assessment and analysis were needed to generate a context-sensitive design of the 12 streets within the Tacloban City ‘s Central Business District.

Designing is not a one-size-fits-all approach and it is important to recognize that every project is unique and requires context-sensitive approach. In the case of the Tacloban City CBD, an in-depth assessment of each street was done. Diagrams below show the flow of the study in generating design treatments of the 12 streets.

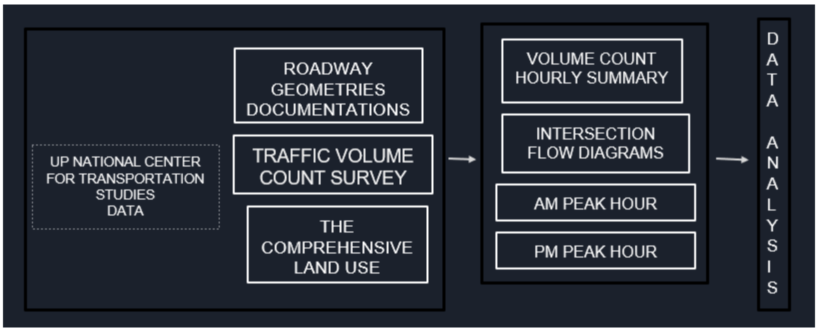

Figure 8: Data Collection

The first step is a data collection. This was conducted by UP National Center for Transportation Studies. The gathered data include Roadway geometries documentation, traffic volume count survey, and comprehensive land use.

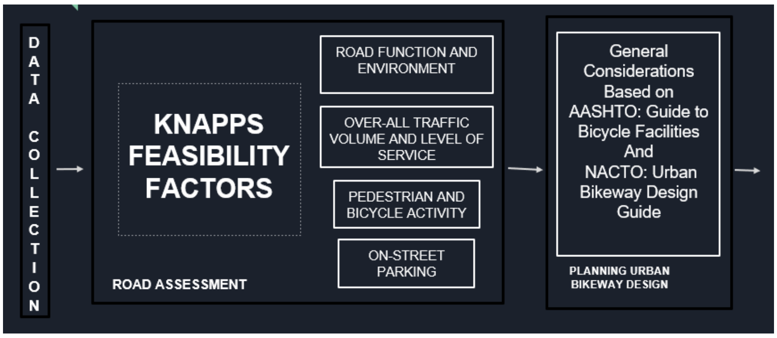

Figure 9: Data Analysis

For the analysis part, a good bicycle plan starts from community's current stage. It should be tailored to the unique conditions of the community. Thereby, using the 4 Knapp's Feasibility Factors for the general assessment of the current conditions of the street. For planning of the Urban Bikeway Design, General considerations were mainly based on AASHTO and NACTO.

Figure 10: Design Treatments

For the design part, choosing the design facility is both an art and science. The science relies on use of standards, guidelines and technical analysis tools, while the art integrates local knowledge, engineering judgment and public input. On this new design, it would be more of people-oriented scheme rather than car-oriented one.

The application of complete streets concept which is focused on Bikeway Design was limited only to the specified study area shown below wherein intersections are not included.

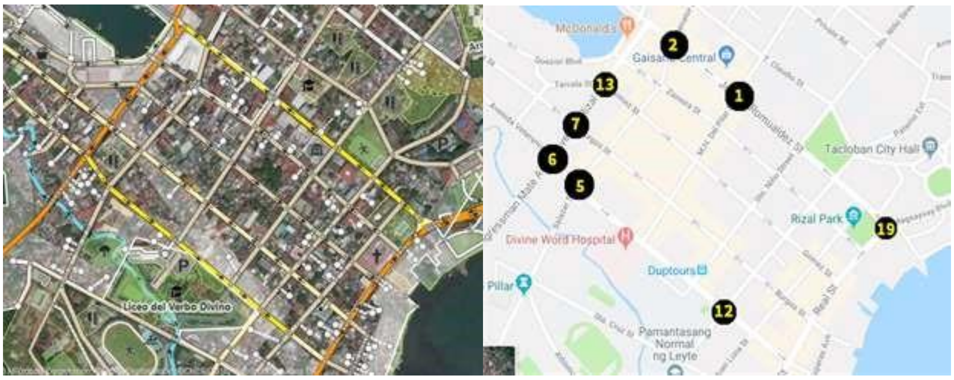

Figure 11: Map of the Central Business District of Tacloban

Boundaries: (Northwest: Justice Romualdez Street, Northeast: Quezon Boulevard, Southwest: Avenida Veteranos, and Southeast: Real Street)

4.1 Results and Analysis

Back on the past centuries, urban planners and engineers maximized road width design for motorists having a notion that wider lanes are safer and can help reduce congestion. Many cities in low- and middle-income countries have adopted this same approach -- a car-oriented approach rather than a people oriented one. Today, with new research and case studies showing the opposite of the status quo, it is time for cities to amend and reevaluate their own standards to promote a safer city.

A very effective tool for encouraging bicycling is to provide a visible network of bikeways, thus arrived at a decision of including bikeways in all the street design. The most appropriate bikeway facility used was a left-side bikeway, however, if the roadway width was limited, a sharrow or marked shared bike lane was employed. Among the 12 streets in the CBD, 5 were re-imagined with left-side bikeways, the other 5 were to have sharrows and the remaining 2 conventional bike lanes. Also, the result justified that despite the reduction of traveled lanes due to the introduction of bikeway facilities, it can still accommodate the surveyed volume demand within the area. The introduction of bikeways does not compromise the operation of motor vehicles along the remaining lanes.

Cycling is normally seen as leisure to everyone; however, a lot of research shows that cycling has greater value and purpose far beyond. On the traffic aspect, the addition of bikeway facilities can encourage more cyclists, reduce traffic congestion, and improve safety for all users. With the aid of bike lanes, cyclists can ride at their preferred speed, despite the movement of the adjacent motorist traffic. They can also travel on the roadway where they are more visible to motorists than if they would be riding on the pedestrian realm. Within the CBD area, where a large percentage of trips are more likely shorter than 2 kilometers, cycling can be the best way to travel.

The proposed traffic scheme for the Tacloban City CBD (NCTSFI, 2018) is a one-way circulation scheme. The recommended bikeway in this study is to provide bike lanes along the left side of the street. It is also advantageous for left turning bicycles or if a left-side bike lane decreases conflicts, like those caused by heavy right turn movements, or on-street parking, which is the case of some streets along the CBD. Along with this, it improves the visibility of cyclists by having the bike lane on the side of the drivers. Since on-street parking usually utilizes the right side of the streets, having the bike lane on the left minimizes door zone conflicts because of fewer door openings on the passenger side.

The sharrow or marked shared lane can be applied only if there is a roadway width constraint or any cases that make it impracticable to install a bike lane. This bikeway facility provides a more complete network and encourages bicyclists to travel with the flow of other traffic.

Designing is not a one-size-fits-all approach. It is important to recognize that every project is unique, which was based on road geometries, expected roadway volume demand and environmental situations. From Thinking beyond the Pavement, Maryland State Highway Administration Workshop, 1998 – "Context sensitive design asks first about the purpose and need of the transportation project, and then equally addresses safety, mobility, and the preservation of scenic, aesthetic, historic, environmental, and other community values. Context sensitive design involves a collaborative, interdisciplinary approach in which citizens are part of a design team." Refer to Figure 9, the summary of the design treatments for this study.

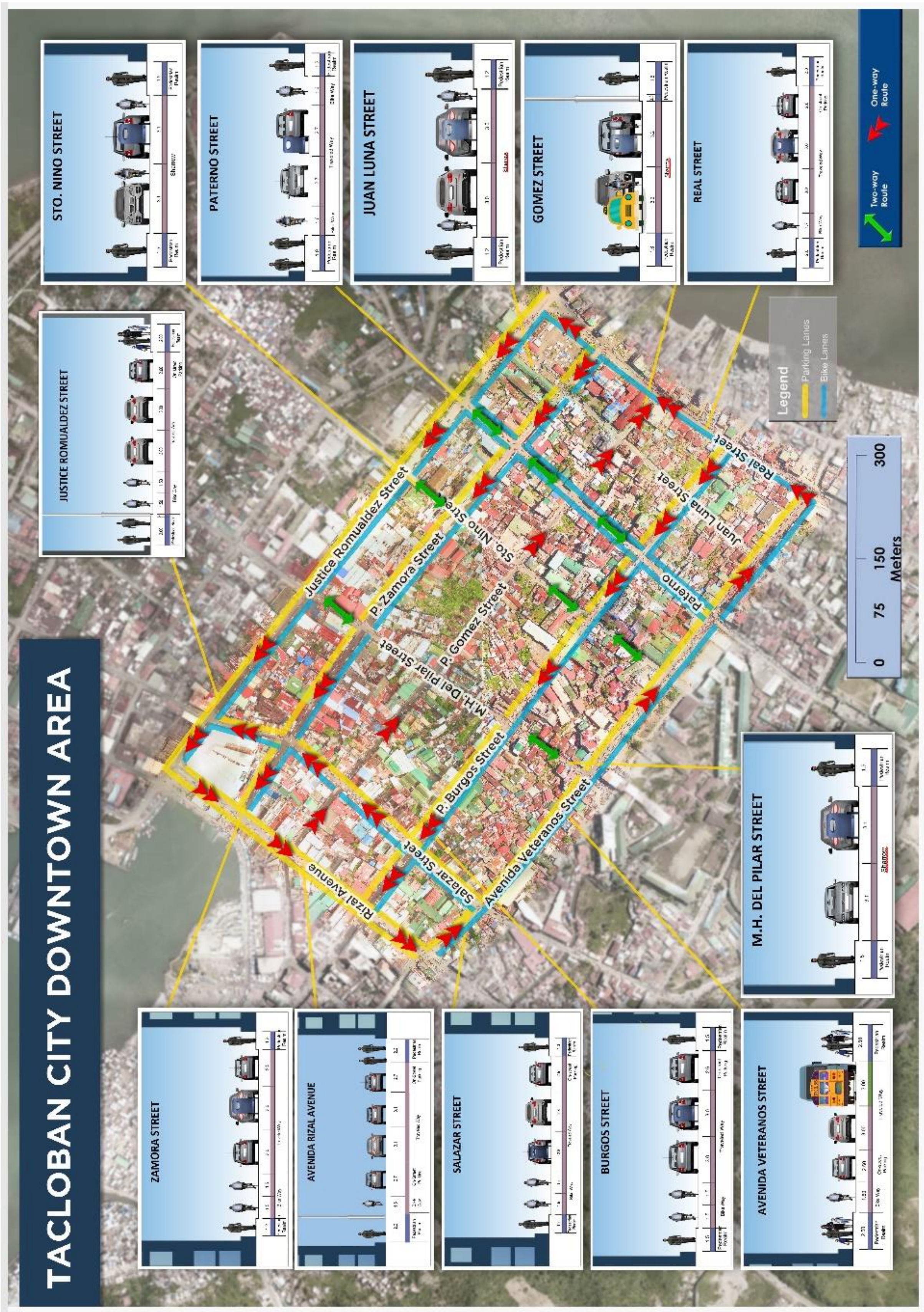

Figure 9: Example cross sections for Tacloban CBD streets

Every researcher has its own subjective design based his engineering judgement. The success of this study can't be seen directly due to some limitations of the study. Also, the provided designs won't necessarily be implemented, thus there were no concrete evidence for its success. However, these were established based from NACTO, AASHTO and other City Design Guides, patterned at different case studies, and supported with numerous calculations and analysis.

5. CONCLUSIONS

Gathered data was only conducted to 8 survey intersections within its Central Business District, thus resulting to a limited source of information on residential areas and other roadway sections connecting to Zamora, Sto Nino and Juan Luna Street. However, the available data were maximized to obtain necessary analysis and design treatments.
Based from the volume count of non/motorists passing, there are number of bicycles observed on every road in the survey. It is then a great suggestion putting a bike way on these streets to encourage more cyclists and prevent them from phasing out. If the road width is limited, sharrow can be done.

For some streets with high travel speeds like Justice Romualdez Street, adding bike lanes could lead to narrower travel lanes, coupled with lower speed limits, can foster a greater sense of awareness among drivers, thus promoting a safety and livable community.

Congestion within the area are caused mostly by motorists, however road barriers had been recognized to one of the reasons for traffic, especially on the southern part of Real Street. These barriers must be removed to obtain necessary spaces. Also, buses and big trucks must only be permitted to pass through along the outer roads of the CBD, which consists of Avenida Veteranos Avenue, Justice Romualdez St., Avenida Rizal Avenue, Salazar St. and Real St. These streets have wider lanes that can accommodate them without risking any space from other road space. Having buses at narrower roadway widths can lead to more congestion.

For the design part, the recommended width for the case of the road width in Tacloban is 2.85-3.1m only. Wider travel lanes may decrease safety in the area. If there's really no space for bike lanes due to limited road width, then slowing down cars is an option - it gives the same benefit as having a bike way while enhancing road safety.

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