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Evaluation of Signaled Pedestrian Walkway in the Capital of the Amazonas

JOEL NASCIMENTO DE ANDRADE
Federal Institute of Amazonas

Abstract

The pedestrian lane's main premise is to generate safety for pedestrians, most lanes do not have traffic lights due to Brazilian traffic code legislation, as the driver must stop in front of a lane, however, this stoppage is often not respected. , requiring the implementation of semaphore. The proposed object is to carry out the calculations of the traffic parameters, in accordance with the Webster model, on one of the main arterials. This is an analysis of some crossings in the city of Manaus, presenting many points of traffic conflicts between pedestrians and vehicles, whose public power option for some of these cases was the adoption of traffic lights. Through the usual traffic engineering models, the objective is to demonstrate if these traffic lights are within the criteria through counting and analysis.

Keywords: Djalma Batista boulevard, Manaus City, Walkbility.

INTRODUCTION

Most metropolises lack a good inspection in the technical analysis of the road system of the respective transit agencies, in Manaus the result is visible, because in some avenues that have Travel Generating Poles, such as schools, supermarkets, malls, banks and others service locations, there is a high rate of fatalities on the roads, according to information from the agency responsible for city traffic. In the last decades, the disordered horizontal growth of Manaus had a significant impact on the city's traffic, the inadequate installation of crosswalks in some arterial avenues was one of the events of this analysis. According to data treated by ManausTrans in 2011, Avenida Djalma Batista had a high rate of traffic accidents in the years 2011 to 2016, among the 10 largest avenues with large flows, it is in sixth position. Based on this information, motivation will be given for the investigation to characterize the main pedestrian crossing of the wide avenue.

For the analysis of the operational performance of traffic in urban pedestrian crossings, a study tool developed by Professor JR Setti (Dept. of Transport Engineering Dept. of Transport Engineering School of Engineering of São Carlos School of Engineering of São Carlos) stands out. Carlos UNIVERSIDADE DE SÃO PAULO): the handout " *Road Intersections: Traffic Lights''* , whose method is based on the Manual model *"On Uniform Traffic Control Devices (MUTCD) FHWA"*.

One of the items for the characterization of the pedestrian lane of an arterial road is the need to install traffic lights in strategic locations or/and the relocation in the precise location, so the criterion for choosing Avenida Djalma Batista will be given to the verification criterion of the need for traffic lights of the object of study of Professor JR Setti for fixed-time traffic lights, where 11 criteria are established for the traffic light to be installed, if the road is among one of the eleven criteria, it means that there may be a lack of installing the traffic light , then, according to data from the ManausTrans source, the selected road (Av. Djalma Batista) fits into one of the 11 criteria as it has significant rates of types of accidents (run overs) in the last 6 years with 109 cases.

According to Macedo, the Brazilian bibliography provides some guidelines, but does not establish criteria or reference values that justify the demarcation of lanes and the decision regarding the implementation of these devices depends on the common sense of professionals responsible for traffic. (Pluris, 2006. Macedo)

According to Andrade (1989, p. 18-19), mathematical models can also be divided into two large groups: *simulation* models and *optimization* models, the author's definition for both models is: The simulation model represents the real world, allowing the analysis of alternatives before their implementations, providing considerable freedom and flexibility regarding the most appropriate choice. In this way, it allows the problem administrator to predict through simulations what would happen in hypothetical scenarios, if he chose to perform such procedures, which makes it possible to choose the most appropriate option, and the other model is the optimization model, which is structured to choose between the existing solutions to the problem, the best possible solution that improves a certain objective established by the problem administrator, in view of the resources available for the real problem, in the case of optimization the solution is considered as an optimal solution for the established objective. In general, the solution is obtained by systematic methods of resolution.

In view of the facts, the optimization process will be one of the main issues regarding the results of the present work, through the analysis of guidelines of the webster model, the DENATRAN Code Manual and the Uniform Traffic Control Devices (MUTCD) manual. USA and Other countries (Canada).

The Webster model, originated in 1964, still has great validity today, given that a lot of traffic light programming software is based on its definitions, this model is also adopted by Denatran in the determination of fixed times of isolated traffic lights.

According to Brasil (1984, p. 61), the regulation of traffic lights provides good traffic performance in terms of fluidity and safety. Among the various calculation methods developed in order to establish traffic light configurations, the webster model stands out, chosen by the author because it is the most complete and detailed, allowing the determination of traffic light times, guaranteeing better traffic performance at intersections.

According to Lima, when studying the problem of traffic control at intersections, a detailed analysis of the characteristics of a given intersection is necessary, observing factors such as the capacity of its approximations, geometry, location, among other factors that interfere directly or indirectly in the attendances. demand requests from the intersection as a whole. (2005, p. 42).

According to Poltosi (2005, P. 1), optimization is the process used to determine the best solution among a set of solutions, which is performed through a mathematical model that describes the problem in question, which contains resources, restrictions, decision variables and the objective to be achieved.

DENATRAN (1987) recommends that the implementation of demarcated crossings "should be restricted to places where their correct use can be guaranteed, so that they actually achieve the objective for which they were created: to increase pedestrian safety". It is, therefore, a generic recommendation.

With these definitions, *in loco* data were taken from the main pedestrian crossing of Avenida Djalma Batista, so that it can be verified if the traffic light with the pedestrian crossing meets the expectations of the calculations of the parameters of the model proposed by Webster and if they really present a comfort zone. and safety for both pedestrians and drivers.

DIAGNOSIS, PROPOSITIONS AND RESULTS

Avenida Djalma Baptista, according to ManausTrans, is located between 3 distinct neighborhoods of the Amazonian capital in the South Central Zone, is approximately 5.05 km long and is one of the main public places in Manaus as it houses financiais centers and commercial attractions, such as shopping centers.

Image 01 – Djalm Boulevard. Picture by Rede Amazonica

According to Millenium 2020, at Djama Batista there are shopping malls, the Manaus Bus Terminal, universities such as the State University of Amazonas, Carrefour international supermarkets, financial institutions, McDonald's, commercial buildings, representatives of the main car brands in the world, such as BMW, Chevrolet, Renault, etc. Among its best-known commercial points are the three towers of the Business Tower, which encompasses the Millennium Shopping business complex.

The pedestrian lane in question is classified in the type of level crossing, as they are those in which the pedestrian and vehicles are not physically separated at different levels of the ground, that is, they cross at the same level, having a length of approximately 18 meters and an approach width of 9 meters for each lane.

According to image one, the crosswalk where the analyzes in question were made is located, the choice of which was made due to the large flow of pedestrians and the nearby PGV`s.

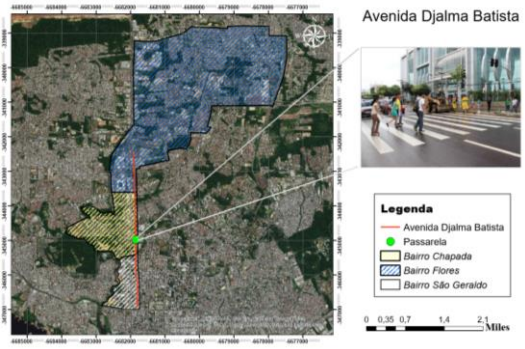


Image 02 – Map of the Main crosswalk with traffic lights on Avenida Djalma Batista.

The avenue has 9 crosswalks, among the 9, 5 have traffic lights, and among the 5, 4 are positioned at intersections, and in the analysis, only the one that is among the 5 traffic lights not positioned at an intersection was used.

The installation of the traffic light on this avenue was installed by the active agency that is under the supervision of DENATRAN guidelines, so the traffic light in the crosswalk of this street is following the WEBSTER model, since the DENATRAN manual states that they use the model to program traffic lights.

DENATRAN, in the Manual of Traffic Lights (DENATRAN, 1984), recommends that if the number of pedestrians crossing in both directions of the road is greater than 250 pedestrians per hour, the installation of traffic lights for vehicles is justified. That is, the number of pedestrians crossing the road may be a justification for implementing the traffic light for vehicles, which, in a way, would facilitate the crossing of pedestrians when the traffic light was red for vehicles and would even justify the implementation of the crosswalk for pedestrians and of the pedestrian focus group.

In other countries, there is another delimitation for criteria for the number of pedestrian crossings, for example, in Canada, where the manual of traffic control devices of Ontario, Canada (Ontario Manual on Uniform Traffic Control Devices for canada, 1988) makes recommendations specific to the implementation of traffic lights for pedestrians between intersections. Under free-flow conditions, installation is recommended when there is an average of 120 crossings per hour during the busiest 8 hours of the day and an average of 290 vehicles per hour crossing the site during the same 8 hours.

The criteria for analyzing the traffic light in line with the pedestrian lane are in accordance with table 1.

1st Criterion	**2nd Criterion**	**3rd Criterion**
DENATRAN Traffic Lights Manual.	Models of manuals for traffic control from other countries.	Some parameters of the Webster Model.

Table 1 – Criteria adopted by the author.

Following these guidelines from the Brazilian manual and from manuals from other countries, volumetric counts of vehicles and pedestrians were carried out, in accordance with the webster model, in three different shifts on the avenue, so that the veracity of the data with the guidelines of the manuals, the data are presented in the following tables:

First day

	Sense		
Time course	**Center-Neighborhood**	**Downtown District**	**pedestrians**
11:00 am - 11:15 am	598	555	198
11:15 am - 11:30 am	614	561	195
11:30 am - 11:45 am	623	569	209
11:45 am - 12:00 pm	646	591	183
12:00 pm - 12:15 pm	667	614	174
12:15 pm - 12:30 pm	694	619	170
12:30 pm - 12:45 pm	734	636	158
12:45 – 13:00	715	624	147
Total	5291	4769	1430

Table 2 – On-*site* Volumetric Counting on Avenida Djalma Batista from 11:00am to 1:00pm.

Second day

	Sense		
Time course	**Center-Neighborhood**	**Downtown District**	**pedestrians**
17:30 - 17:45	533	428	203
17:45 - 18:00	619	430	179
18:00 - 18:15	608	440	191
18:15 - 18:30	478	489	203
18:30 - 18:45	539	425	209
18:45 - 19:00	517	345	119
19:00 - 19:15	609	428	155
19:15 - 19:30	534	321	102
Total	4437	3306	1361

Table 3 – On-*site* Volumetric Counting on Avenida Djalma Batista from 5:30pm to 7:30 pm.

Third day

	Sense		
Time course	**Center-Neighborhood**	**Downtown District**	**pedestrians**
6:30 am - 6:45 am	393	498	164
06:45 - 07:00	432	520	178
07h00 - 07h15	493	578	110
7:15 am – 7:30 am	409	610	97
7:30 am – 7:45 am	534	723	92
7:45 am – 8:00 am	629	758	112
8:00 am – 8:15 am	538	792	142
8:15 am - 8:30 am	602	753	202
Total	4,030	5,232	1,097

Table 4 – On-*site* Volumetric Counting on Avenida Djalma Batista from 6:30am to 8:30 am.

In the three shifts, the traffic light duration time and the duration time of opening intervals from one to the other were also analyzed, as shown in Table 5.

Duration	**Interval duration time**
17 seconds	240 seconds

Table 5 – Duration time of traffic lights.

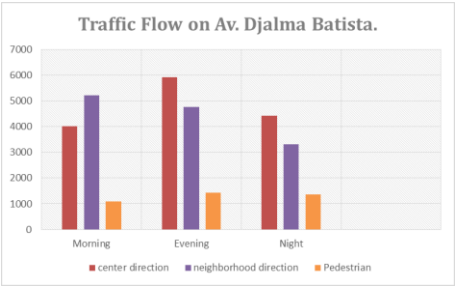
The volumetric count was performed in one shift every day, for two hours and an interval every 15 minutes. For a better understanding, Table 5 presents the final counts of the three different shifts.

Shift	Final countdown (Central-Neighborhood direction)	Final countdown (Neighborhood-Center direction)	Final Count (Pedestrians)
morning	4,030	5,232	1,097
afternoon	5291	4769	1430
nocturnal	4437	3306	1361

Table 6 – Final counts of the three shifts.

RESULTS

The schedules with the highest flows of motorized and non-motorized vehicles are shown in the charts below.



Graph 1 – Visualization of the flow of vehicles in different shifts.

It is notable that the greatest flow of vehicles near the pedestrian lane towards the center towards the neighborhood is in the afternoon (More usual due to the departure of the PGV to the comfort zone), towards the neighborhood center it is in the morning (More usual due to leaving the comfort zone to the PGV) and the pedestrian flow does not show a notable oscillation, however it is noticeable that in the afternoon shift the flow is the highest.

Road service level.

For the definition criterion, the road service level is understood to be the capacity that the avenue can receive and the amount of vehicle movement flow, whether proportional to its size or not. The North American traffic company a manual for criteria, called *HCM,* with 6 criteria of verification of the way, being from A (ideal conditions of free flow) to F (complete congestion) The road in question is at level D, according to the criteria of the *HCM,* where there is Pedestrians have their speed restricted and find it difficult to overtake other pedestrians. Opposing flows and changing trajectories greatly

increase the likelihood of conflict. It can still be considered a reasonable fluidity in the displacements.

Data analysis using the Webster Model.

According to the booklet by Professor JR Setti (Department of Traffic – USP) in line with the guidelines for the Webster method, for the traffic parameters the fórmulas organized in table 7 are adopted.

Item	Initials	Parameter	Fórmula
01	Cp	Signaled Approach Capability	$Cp = S.\frac{gef}{C}$
02	gef	Effective green time	$gef = g + ta - Ii$
03	Tp	Total Lost Time	$Tp = ta + Ii$
04	S	saturation flow	$S = 525 . L$
05	y	Occupancy rate	$y = \frac{q}{S}$
06	X	degree of saturation	$X = \frac{q}{Cp}$

– Cycle Time, – Normal Green Time, – Yellow Time, – Lost Time per Phase, L – Approach Width, - Vehicular Flow

Table 7 - Source: Adaptation by Webster (1964 apud LACORTT, 2013).

According to Webster (1964, apud LACORTT, 2013), the Signaled Approximation Capacity = Cp, corresponds to the product between the Effective Green Time = gef, and the Saturation Flow = S, divided by the Cycle Time = C, according to Item **01.** On the other hand, Item **02,** the Effective Green Time g= gf, is defined by the sum between the Normal Green Time = g, and the Yellow Time = ta, subtracted by the Lost Time Per Phase = Ii. It is noteworthy that the values of Cycle Time=C, and the value of Normal Green Time=g, were estimated after an *in loco* research . In Item **03,** the Total Lost Time= tp, refers to the sum of the Yellow Time= ta, with the Lost Time per Phase= Ii.

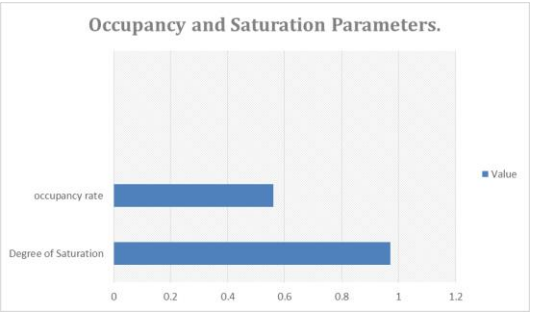
The saturation flow (S) of an approach, measured in vehicles per hour of green time (v/htv), can be estimated by item **04** where L corresponds to the width of the approach, that is, the width of the road in meters.

Following the parameters guidelines, with the information obtained from the *on-site* data collection of the largest flow of vehicles between the three shifts (regardless of the direction of the road) = q, we have the following results as shown in Table 8.

parameters	For q = 5291
s	4725
Gef	228
cp	5355
tp	6
Y	0.56
X	0.97

Table 8- Parameters by the Webster model.

The data entered were adopted as stated in the resolutions, for the cycle time, a percentage of the interval time of the cycle from the opening of the signal until the end of pedestrian crossings was adopted, and for the time lost per phase, a percentage of the interval between the opening and closing of the traffic light, of approximately 3 seconds.



Graph 2- Occupancy Rates and Saturation Degree with visit data.

According to Webster (1964 *apud* LACORTT, 2013), the degree of saturation is a coefficient that indicates, within the real operating conditions of the intersection, how close the demand is to the hourly flow capacity. When the degree of saturation is greater than 1, it means that the request is greater than the capacity to service the approach, that is, a queue forms, which generates congestion due to vehicles that arrive and are not served. In the analyzed data, the degree of saturation with the influence of vehicles passing on the avenues at peak times is less than 1.

CONCLUSION

Considering the bibliographic analysis and the data collected from Via Djalma Batista in the city of Manaus, it was possible to verify that the crossing meets the criteria regarding the parameters of the Webster model and some guidelines of the Brazilian and international Traffic Manuals, on the other hand, it does not meet other criteria. of the manuals.

As for the road service level, the requirement of the publication of *Highway Capacity Manual (HCM)* authored by the National Academy of Sciences (US Organ non - governmental and non-profit), presented level

characteristics D, according to the literature showing of luxury close to instability, demonstrated by pedestrians who have little time to cross lanes in both directions.

As for Saturation, the road has a value lower than one, the webster model indicates that saturation values greater than or equal to one represent extremely saturated roads in terms of congestion, the Djalma road showed values very close to one, so that road must be analyzed again, as the projection in a few years may present such saturation and will not meet the demand of either pedestrians or vehicles.

Thus, for this crossing, it would be advisable to build an underground walkway with a direct connection to the PGV (Shopping Plaza Center), where there would be a significant improvement in the flow of vehicles.

Thus, through the characterization presented, it is suggested to continue this analysis with other counts and comparisons, however, it can be said that the most suitable for the place would be the crossing in unevenness.

BIBLIOGRAPHIC REFERENCES

ANDRADE, EL *Introduction to operational research: methods and techniques for decision analysis* . Rio de Janeiro. LTC, 1989.

BRAZIL. National traffic department. Manual traffic lights. 2. Ed Brasilia:. Denatran 1984.

DENATRAN (1987). Pedestrian Safety Manual. National traffic department. 2nd ed., Brasilia, DF.

Highway Capacity Manual (2010). Transportation Research Board. Washington, DC, USA.

LIMA, CMV Traffic *optimization* - An approach using genetic algorithms. 2005. Available at: < http://www.cin.ufpe.br/- tg/2005-1/cmvl.doc>. Accessed on: July 6, 2019.

MH MACÊDO AND JA SORRATINI. Recommendations for the implementation of pedestrian crossing devices. plural. Periodical article in Congress Proceedings. 2006.

Ontario Manual on Uniform Traffic Control Devices for canada (1988). 4th ed. Transportation Association of Canada. Ottawa, Ontario.

POLTOSI, M.. Programming solutions for combinatorial optimization problems. Universidade do Vale do Rio dos Sinos- 2005- Available at: http://www.inf.unisinos.br/-barbosa/pipca/consipro1/a13.pdf. Accessed on: July 11, 2019.