Reducing the effect of local conditions on the capacity intersection approaches with the support of intelligent transportation identification software

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ABSTRACT

Public transportation in Peru was regulated in the mid-90’s to encourage improvements in service, routes and quantities of vehicles. Since then, contrary to what was expected, traffic jams, accidents, and overall poor levels of service are encountered in expressways, avenues and intersections alike. Mismanagement, lack of knowledge, political interests and even constitutional restrictions do not help improving the current conditions (Quistberg, Koepsell, Boyle, Miranda, Johnston and Ebel, 2014).

Within this context, this paper focuses on conditions at intersections that can be improved if proper organization is provided. Saturation and capacity of intersections approaches are governed by equations by factors. The Highway Capacity Manual HCM (Transportation Research Board TRB, 2010) explains these factors, like grade, bus blocking, parking maneuvers, right and left turns, pedestrian and bicycle activity, number of lanes, presence of heavy vehicles, and other similar factors.

The purpose of this paper is to identify such conditions, rank them, and provide solutions (which may include traffic sanctions/tickets) to reduce their effect on the capacity of intersection approaches. The paper will apply Systems Dynamics. With the support of intelligent transportation solution will provide the foundations of the “E-Lean Traffic” concept based on the application on System Dynamics approach, the use of Internet of Things technology and methodologies as “Lean Manufacturing” in Industrial Engineering and “Lean Construction” in Civil Engineering.

Keywords: System Dynamics, Saturation and Capacity of intersections, Intelligent Transportation Solution and E-Lean Traffic.

1. INTRODUCTION

Since the establishment of communities, human beings have sought to reduce time and costs in the journeys between point A and point B. The Institute of Transport Engineering founded in 1930 developed the Traffic Engineering Handbook that has been renewed until its last 7th edition published in the year 2015. In this book it is mentioned that "the modeling and solutions to the problems arise in situations where the choice of an appropriate transport system or an appropriate logistics technology depends on the possibilities of predicting the order transition to chaos, and vice versa" (Wolshon and Pande, 2016). Although this study is not based on predictions, we must consider recognition of patterns that allows us to reduce uncertainty and thus identify indicators of management within a complex system based on data taken from reality. As mentioned by Oreskes, Shrader-Frechette and Belitz (1994) “The use of models to make predictions can really be deceptive, if there are deep uncertainties.”

The public transport management in Metropolitan Lima can be considered complex since there are three different offices in management: Ministry of Transport and Communications, Municipality of Lima Metropolitana and the Regional Government of Callao since its Transportation through Metropolitan Lima. In addition, public transport belongs to the offices involved, but private companies participate in competitions to obtain the contracts assigned by routes over a period of time.

“One of the great challenges is that they occur in systems where there are many components and mechanisms that interact in a variety of ways and the system can only be observed in part. As a result, the models are “non-unique” and undetermined by the Knowledge available” (Oreskes, Shrader-Frechette, and Belitz, 1994). In fact, public transport in Peru has gone from being completely public (management and supply of government units) to a mix of public-private. Although public transport intends to provide a better service and streamline the flow of traffic by reducing expenses related to management, transport management companies do not monitor their units or the delays produced by them.

In this context, the study examines the effect of local conditions on the capacity intersection approaches in a signalized intersection and proposes solutions from intelligent transportation identification software point of view.

2. PROBLEM STATEMENT

Ate Vitarte has 630,085 citizens with a density of 4, 515 hab/km², it is surrounded by the districts of Lurigancho on the north; by La Molina and Cieneguilla on the south; by Chaclacayo on the east; by San Juan de Lurigancho, El Agustino, Santa Anita and San Luis on the west; and by San Borja and Surco on the southwest. Due to its size, Ate Vitarte plays an important role in the traffic flow of Lima.
Metropolitana. For this study, we considered one signalized intersections and measure the Traffic Level of Service (LOS) twice, first by measuring the cycle on the field and the second by applying the equation.

3. METHODOLOGY

The HCM Signalized Intersection Methodology, shown in illustration 1, was applied in order to consider the variables to measure considering the TRB 2000 due to following factors:
1. Lima Metropolitana does not actuate traffic signals
2. There is a limited amount of coordinated intersections (less than ten avenues in the entire city)

Illustration 1. Signalized intersection methodology (TRB, 2000)

Steps taken:

1. Choose the ideal intersection for the research among them, considering factors such as lane grouping and demand flow rate, saturation flow rate and capacity, and divided by zones A and B
2. Analyze the data and calculate On-The-Field LOS
3. Apply the TBR equation and calculate LOS
4. Compare results
5. Using On-The-Field observations model a Dynamic System applying Forrester Diagram
6. Analyze the results
7. Final Conclusions and Recommendations

3. RESULTS

Step 1. Illustration 2 shows Geometric Schematic and Allowable turning movements’ representation:

Illustration 2. Av. La Molina vs. Av. Separadora Industrial Intersection with traffic signal

Step 2. Analyze the data and calculate Traffic Level of Service (LOS) standards

Tables 1 and 2 show the data in zones A and B.

Table 1. LOS with traffic light cycle measured in field – zone A in the morning

Table 2. LOS with traffic light cycle measured in field – zone B in the morning
Step 3. Apply the TBR equation and calculate Traffic Level of Service (LOS) standards. The results are shown in tables 3 and 4.

Table 3. LOS with traffic light cycle measured by equation – zone A in the morning

Table 4. LOS with traffic light cycle measured by equation – zone B in the morning

Comparing the results:

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<th>On the Field</th>
<th>By TBR Equation</th>
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<tr>
<td>Zone A</td>
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<tr>
<td>Zone B</td>
<td>B</td>
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On the Field Observations showed the following:

1. Líneas Piratas, which means people who use their private car or bus to provide off the law public transportation
2. Tiempo de Espera en Vía, which means that regulated and non-regulated transportation vehicles take more than five (5) minute average to wait for passenger on the road

These two new participants of the transportation system were considered in the System Dynamics model presented in illustration 3 below:

Illustration 3. Dynamic system represented by a Forrester diagram using software VENSIM.

Showing the following:

4. CONCLUSIONS

“Líneas Pirata” and “Tiempo de Espera en Vía” affect directly the Traffic Volume

As Teichman et al. (2017) mention we have to “rethinking public transportation and logistics as collaborative scenarios” and in this case engage the government into the effort. If the government is involved, “Líneas Piratas” and “Tiempo de...
Espera en la Vía” will be taken into consideration when planning Transportation Infrastructure such as the capacity of highways, signalizing intersections and public transportation lines registration and control.

The application of smart cameras which recognize the waiting time per unit and by taking a clear image of the vehicle plate and location information will help take the legal policies against them.

For public transportation vehicles apply adaptive routing for VANETs in City Environments by clustering the vehicles in order to optimize the communication as recommended in the paper Application of Cognitive Techniques to Adaptive Routing for VANETs in City Environments (Blanco et al., 2013)

9. REFERENCES