BICYCLE & PEDESTRIAN PERCEIVED LEVEL OF TRAFFIC STRESS FOR URBAN AREA

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ABSTRACT *Jaipur, a city of 3.10 million people in India is facing traffic problems due to an increasing volume of vehicles. In order to reduce pollution and traffic congestion the municipality created an ambitious policy on improving bicycle infrastructure and cycling. However, after finishing the first bicycle routes in recent times, the usage of these routes remains rather low. A survey was developed to obtain information about the strengths and the weaknesses of bicycle routes in Jaipur using a GPS methodology as a basis. After conducting the survey on two bicycle routes, the information obtained shows the safety, directness and comfort degree of the bicycle routes. Observations show that Jaipur takes bicycle routes seriously, but aspects as uniform signage and attention for cyclists at intersections still pose challenges. The information obtained is used to suggest improvements for the routes. Furthermore, the survey developed in this research might be useful to measure other bicycle routes in emerging economies. The average effective width of the outside through lane, motorized vehicle volumes, motorized vehicle speeds, heavy vehicle (truck) volumes, pavement conditioned percentage of on street parking are considered as the influencing factors in defining levels of service criteria of bicyclist in urban street. Emphasis is put on the calibration of BLOS model developed by the Florida Department of Transportation in classifying the levels of service of the bicyclist provided by road infrastructure.*

Keywords: *Bicycle level of service (BLOS) , Level of Service (LOS) ,Affinity Propagation (AP), Self-Organizing Map (SOM) Average Silhouette Width (ASW) ,etc.*

Introduction

Bicycling and walking are the fundamental form of mobility and are the mode of freedom of transportation for people who are too old or too young to drive. Cycles are an important means of transportation in the cities, towns and rural areas of India. Due to renewed interest in the environmental movement, cycles have become popular in recent times. For a pollution-free environment, it contributes a lot since a cycle does not make noise and does not emit pollutants and occupies less space than motorized vehicles.
It was expected that about 80 percent of demand would be covered by road transport systems (Datla, 2004). At present, there is no adequate methodology to assess the level of service (LOS) provided by the urban streets of India. It is important to develop adequate methodologies for analysing the level of service of urban streets.
The Greek philosopher Heraclitus once said that the difficulty faced by human society was to combine that degree of freedom without which law is tyranny, with that degree of law without which freedom becomes license. The democracy of Athens, the Magna Carta in England and the constitution of the United States were elaborated essentially from that same precept. Our society is organized on the basis of the group of laws established to guide people in their conduct. The people of America created a vast domain of commercial and industrial enterprises and built large cities in proper planning and defining the level of service criteria of the roads. It is alarming to note that 32 percent of these vehicles circulate only in metropolitan cities, which make up approximately 11 percent of the total population.

In India, urban areas are about to explode, with official data indicating a rapid population explosion, which could reach 530 million in 2021. In 1951, there were only 5 Indian cities with a population greater than 1 million and 41 cities greater than 0.1 million inhabitants. Great part of the Indians live in 0.56 million villages. In 2011, there are 3 cities with a population greater than 10 million and 53 cities with a population greater than 1 million. More than 833 million Indians live in 0.64 million villages, but 377 million live in some 8,000 urban centres. By the year 2031, it is anticipated that there will be 6 cities with a population greater than 10 million. In the 1991-2001 decade, immigration to major cities caused a rapid increase in the urban population. The percentage of urban Indian +*
As stated by Litman (2007) an improved pedestrian safety and a safer walk able environment will help the community in achieving the following:

For non- drivers the accessibility would improve.
Cost of transportation will sharply reduce.
The parking efficiency in the area would be greatly enhanced.
There would be improvement in aesthetics.
Reduction in land needed for road construction.
Reduction in the level of pollution and it acts as a support for transit.

Related Work

Botma, H(1995). Method to Determine Level of Service for Bicycle Paths and Pedestrian- Bicycle Path. *Transportation Research Record*, 1502, Transportation Research Board, Washington, *D.C.*1995.

Davis (1987) developed the Bicycle Safety Index Rating (BSIR) consists of two sub-models, one for road segments and one for intersections. The safety of track segments depends on traffic volume, speed limit, outer lane width, pavement condition and variety of geometric factors. The safety of intersections is a function of traffic volume, type of signaling and various geometric factors.

Epperson (1994) modified the BSIR and called the pathway condition index (RCI) in Broward County, Florida. The RCI was further modified, placing less weight on paving and location factors and increasing the interaction between the width of the curb band, the speed limit and the volume of traffic. Sorton and Walsh (1994) determined the cyclist's safety in terms of stress levels as a function of three primary variables - peak traffic volume in the lane, motorized vehicle speeds in the sidewalk range and mid- thread. Secondary variables, such as the number of commercial roads, were recognized but were not included in the analysis due to funding constraints.

Landis (1994) developed the Intersection Hazard Score (IHS), which was based on RCI and other previous models. The variables in this model included traffic volume, speed limit, external track width, pavement condition and number of entrances.

Hunter et al. (1999) studied the differences between bicycle lanes and wide lanes. They watched videotapes of nearly 4,600 cyclists and assessed operational characteristics and interactions between cyclists and drivers. Overall, they concluded that the type of bicycle facility had a much lower impact on operations and safety than other features of the site and recommended that bicycle lanes and wide lanes be used to improve riding conditions for cyclists.

Torbic et al. (2001) have developed new configurations of rules for safety and comfortable driving of the rider. Three primary steps were involved in developing the new configurations. Firstly, the simulation was used to evaluate different configurations as to their potential to be bike friendly. Secondly, various configurations that had the greatest potential to be compatible with bicycles were installed and field experiments were conducted to better evaluate their effectiveness. Finally, the field data were analyzed and the configurations that were installed were classified based on their ability to provide a comfortable and controllable ride for cyclists.

Zolnik and Cromley (2006) developed a multi-level bicycle level service methodology, using the frequency and severity of collision of bicycle motor vehicles in the GIS environment. This new methodology complements bicycle service level methodologies in mental stressors, incorporating the characteristics of cyclists involved in collisions of motor vehicles, as well as the physical stressors in which collisions of motor vehicles occurred to evaluate the level of service of the bicycle .

Carter et al. (2007) developed a Macro-level Intersection Bike Safety Index (Bike ISI) using video data and online ranking surveys, which incorporated both safety measures. The ISI Bike utilized data on traffic volume, number of lanes, speed limit, presence of bicycle lanes, parking and traffic control to give a classification for an intersection approach according to a six-point scale.

Duthie et al. (2010) examined the impact of design elements, including the type and width of the bicycle facility, the presence of adjacent motor vehicle traffic, parking rotation rate, land use and the type of automobile cyclist interface to define the road configurations that lead to the driver and rider's safe behavior.

Kendrick et al. (2011) attempted to measure and compare the simultaneous exposure of ultrafine particles (PFU) to cyclists on a traditional bicycle lane and a bicycle lane for urban areas. Exposure concentrations of ultrafine particles were compared in two environments: (a) a traditional bicycle lane adjacent to the vehicular traffic lanes and (b) a cycle lane design with a parking lane separating cyclists from vehicle traffic lanes. The concentrations of the UFP number were significantly higher on the typical bicycle lane than on the bicycle lane. The authors have shown that a cycle lane design may be more protective of cyclists than a traditional bicycle lane in terms of reducing the exposure concentrations of PFUs.

Methodology

Bicycle route inspection contains a list of large parameters, which are measured in the field and analyzed. For example, parameters such as the width of the bicycle lane, the quality of the pavement and the speed of intersection traffic. Some Dutch parameters are used in this research and some Dutch parameters are also adapted to Indian conditions. The adaptation is based on observations of Indian traffic, road conditions, user behavior and discussions with the residents of Jaipur.

One risk of using Dutch parameters in India is the different environment. Therefore, each parameter is selected according to four criteria.
Criteria for selecting parameters to measure the quality of bicycle paths in Jaipur:
1. Excellence of the indication of a quality aspect in Jaipur (as security)
2. objectivity
3. Measurement efficiency and analysis
4. Variation in responses

Variation in responses indicates whether one parameter has different responses at different sites. If there are no islands of traffic in Jaipur, the availability of islands of traffic will not be a parameter.
All parameters of attractiveness and coherence are removed in the selection process, mainly because they are time consuming for this research.

Experimental Setups

Experimental setup is n approach of considering the essential set of experiments suitable and useful for the creation of new highway and roads in rural or in urban area. Bicycle records have been collected from concerned police station from their accident record books. All these accident points have been verified with policemen as well as local villagers at the site.
The testing methodology will consist of the following step:
a. Collection of data
b. Accident records
c. Traffic volume
d. Average Daily Traffic
e. Average Annual Daily Traffic

Data Collection and Analysis

A survey has been carried out in Jaipur whose criteria is shown below and results have been shown in Table no.2
A questionnaire with a total of 21 variables is developed to measure the perception of pedestrians in five different areas:

1) security
2) comfort
3) obstruction of suppliers
4) ease of movement and accessibility
5) environmental condition.

It is believed that every target could affect the performance of the sidewalk. However, you are not responsible for those elements with the greatest impact and to what degree. In the present study, all items are scored on a five-point Likescale, with "one" representing total discord, and "five" for total agreement. To collect data, non-local interviews were conducted at the study site. The pedestrians were interviewed and asked to interview. The answer is yes (no).

QUESTIONS FORMAT:
NAME-
AGE -
SEX-

- **SAFETY**
  - I feel safe from travel, slips and falls. Does a road have any provision for zebra crossing?
  - I handle the danger of vehicular traffic
  - I insure bullying or physical insurance
  - I think I think a sidewalk can accommodate the flow of pedestrians

- **VENDOR'S ATTRACTION**
  - I am interested in goods sold by suppliers
  - I do not like sidewalks, for shop windows and it's not just about walking
  - I intend to buy something in hawkers
  - Continue in my perception, a sidewalk is good at serving the flow of pedestrians
  - I think there are a lot of pedestrians making a sidewalk

- **COMFORT**
  - I have space to avoid the obstruction without decelerating my pace.
  - I can move freely from without any physical obstruction.
  - I feel comfortable walking through the sidewalk
  - I can move freely without obstruction from vendors
  - I think that the sidewalk is clean
  - I can move freely without obstruction

- **MOVEMENT EASINESS AND ACCESSIBILITY**
  - I can choose my walking speed freely
  - I think that the total width of sidewalk is wide enough
  - I can overtake other pedestrians easily
  - I can view the bus stop clearly
  - The sight distance to bus stop is adequate

- **ENVIRONMENTAL CONDITION**
  - I do not like to walk on a sunny day.
  - I'm only going in the morning.
  - I only go at night for marketing

An overview of the case study area with link and curve to the right only in the LTS motor vehicle range applied can be seen below in Criteria for left cyclists in intersections and signaled criteria for cycling through movement in unsignalized intersections are excluded from this map(Figure no.1). The LTS is color coded with blue = LTS 1, green = LTS 2, orange = LTS 3, red = LTS 4 and gray indicating limited access routes. The map has a limited number of roads and cycle paths coded in blue or LTS 1, however, a large part of the map has green or LTS 2 roads and bike paths. The prevalence of LTS 2 facilities was also observed in the MTI study and indicates the prevalence of local or neighborhood streets in the area of the case study .shows the distribution of the central miles of the road and the LTS cycleway. More than half of the centerline miles in the case study area are encoded as LTS 2, however, further analysis of connectivity must be performed to determine if these LTS 2 installations have created a network of connected bicycles. Connectivity analysis was not performed in this thesis. Instead, an analysis of the bikeshed from the Atlanta BeltLine Eastside Trail to the LTS 1 and LTS 2 facilities was completed. A bikeshed is the distance a rider can travel from a certain point out in this case the EastLine Belt East Trail.

Table 1.- Segment attributes

Segment Attributes							
No. of lanes	No. of vehicles in peak 15minutes	Percentage of heavy vehicles	No. of through lanes	Average travel speed on street	Bicycle lane (Y/N)	Pavement condition rating 1-5	On Street Parking (%)
Six lane	650	2	1	45	N	5	2%
Four lane	360	6	1	45	N	4.5	4%
Two lane	900	9	1	45	N	3	7%
Two lane	1050	13	1	45	n	2	10%

Table 2-Results of Questionnaire Survey Performed

Name	age	sex	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		19	20	21
DAS	45	M	2	3	3	1	1	1	2	4	2	1	1	1	1	1	1	2	3	3		3	1	1
JOY MISHRA	53	M	1	2	3	2	2	3	3	2	2	2	1	1	2	2	2	3	3	3		4	1	0
DIPAN	28	M	2	2	2	3	1	2	1	1	1	1	1	1	3	2	3	2	2	3		3	1	1
SHITAL AGARWAL	21	F	1	2	3	3	2	2	2	1	1	2	3	3	3	1	2	2	3	2		2	1	1
MEENAKSHI	14	F	1	2	3	4	3	1	2	3	2	3	4	4	4	4	2	2	2	3		2	2	0
PARIJA	33	M	1	2	3	4	3	1	2	3	2	3	3	3	3	4	2	1	3	2		2	2	1
BITTU	35	M	2	2	3	4	3	1	2	2	2	2	4	3	3	4	2	1	3	2		2	2	1
PADHI	25	M	1	2	3	4	3	1	2	2	2	3	4	4	4	4	2	2	2	3		2	2	1
BABU	25	M	1	3	3	4	3	1	2	2	3	3	3	2	2	4	2	2	3	2		2	2	1
MOHARANA	32	M	2	2	3	4	3	3	2	1	3	3	3	4	2	4	3	2	3	3		2	2	1
VICKY	22	M	2	2	3	4	3	1	2	3	3	3	2	2	4	4	1	2	3	3		3	2	1
S.SETHI	56	M	1	2	3	4	3	3	2	2	1	3	4	4	4	4	3	2	3	2		2	2	1
SAHU	35	F	1	2	3	4	3	1	2	4	2	2	4	4	4	4	2	2	3	3		2	2	1
DIBKAR DAS	44	M	1	2	3	2	3	2	2	1	2	2	2	4	4	4	2	2	3	3		3	2	1
AJIT Lal	36	M	1	2	3	4	3	1	2	2	1	3	4	4	2	4	2	2	4	3		3	2	1
RAMBABU	30	M	1	2	3	2	3	2	2	3	3	2	4	2	2	4	2	1	3	3		1	2	1
SUBHASHREE ROUT	20	F	1	2	3	4	3	1	2	4	3	3	2	4	4	4	3	1	3	2		2	1	1
MAJHI	22	M	1	2	3	4	3	1	2	1	3	2	4	4	4	4	3	2	3	3		2	1	1
MADHU	19	F	1	2	3	2	3	2	2	1	2	3	4	2	2	4	2	2	3	4		2	1	1
PINTU	22	M	1	2	3	4	3	1	2	1	2	3	4	4	2	4	3	2	4	3		2	1	1

RAKESH KUMAR	25	M	1	2	3	2	3	3	2	2	1	4	2	2	4	4	1	1	3	2		2	3	1
SAMAL	26	F	1	2	3	4	3	1	2	1	1	3	2	4	4	4	2	2	3	3		2	2	0
BISNUP RIYA	12	F	1	2	3	2	3	3	2	2	4	2	4	4	4	4	1	2	3	3		2	3	1
SBAGH	15	M	1	2	3	3	3	3	2	1	2	3	3	4	4	4	2	1	3	2		2	3	0
NAYAK	22	M	1	2	3	4	3	1	2	3	4	4	3	4	2	4	2	2	4	3		2	2	0
MOHAN	54	M	1	2	3	3	3	3	2	3	4	4	4	3	2	4	2	2	3	2		1	2	0

Summary and Conclusion

Most Indian cities lack racing networks that meet the stress tolerance of most current and potential cyclists. Lack of roads and cycle paths are perceived as a way to feel more or less intense when shared. The objective of this study was to respond to the reformulated version of the GPS service quality tool. A quality of service tool such as GPS provides a method for categorizing roads and cycle paths based on perceived stress level. This research refined a GPS machine as the MTI, however, a current and potential typology of cycling and the their views and traffic projects on the machine to measure the quality of GPS service should be modified based on the results of future research.

This study was performed to find LOS qualitatively. The qualitative method is a better method to determine the LOS, since it is necessary to respond in real time to the people, thus providing an option for a better and more accurate result. the inverse variance and the table of scores of LOS were determined by the current testing of each level of the PLOS of the area of study.

Future research which includes LTS will likely analyse connectivity and routes. The roadway and bikeway database used in this research includes direction information for the roadway network, however, the bikeway network is more simplified. This means that a link with a conventional bicycle lane in one direction and a shared travel lane in the other direction will be categorized only by the bicycle lane. Simplifying the roadway and bikeway network assists in creating maps which can be easily read. However, the roadway and bikeway network should be developed in the future to include directionality.

While the simplified roadway and bikeway LTS presented in this thesis were beneficial for visual presentation, this method created some areas of concern. The primary issues were: roadway links with a bicycle facility in one direction, but not the other resulting in a lower LTS categorization, intersection approaches where the bicycle facility was dropped in one direction, but not the other resulting in a higher LTS categorization for the link, roadways where bicycling is restricted due to streetcar rails in one direction, but not the other resulting in an LTS categorization in a restricted access area, and on street parking located by a bicycle facility in one direction by not the other resulting in a lower LTS categorization.

Significant research needs to be conducted to refine the LTS quality of service tool including; validating the four types of bicyclists, refining the traffic and facility characteristics which are used to calculate LTS level for a link, developing stronger intersection LTS criteria, and creating a more robust bikeway and roadway database that 92 Includes direction specific LTS data. While, additional work is needed on the LTS tool, this tool holds promise since it includes consideration of the stress tolerance for the entire population, not just current bicyclists.

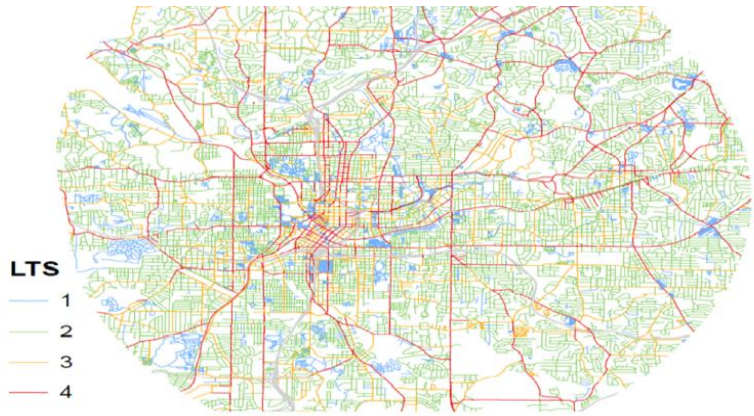

Figure 1: LTS in Case Study Area

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